

# BOOK OF ABSTRACTS

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# Table of contents

<b>COMPUTER SCIENCE</b> .....	5
<b>ECOLOGY</b> .....	19
<b>LIFE SCIENCE</b> .....	43
<b>Mathematics</b> .....	73
<b>Applied Physics</b> .....	91
<b>Physics</b> .....	117





# COMPUTER SCIENCE



**Radboud University Nijmegen**  
The Netherlands 2012

# Development of hardware and software complex for the formation of three-dimensional image

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## Introduction

Today three-dimensional images are one of the most impressive and innovative forms of the process modeling and presentation. Spatial images are in high demand in such spheres as modeling, design, advertising, film making industry [1]. However, modern technologies of creation 3D visual images have number significant shortcomings.

- First, modeling is a complicated and multistep process that requires meticulous hand-work, patience and skill of the performer. As a consequence, not every person can completely realize his ideas.
- Second, a drawing as a preliminary sketch gives only monoplane image of the object, while for creation a three-dimensional image you must have several views.
- Third, the development includes the steps of creating a sketch and directly modeling. Asynchronicity of these processes leads to a huge investment of time.

Thus, none of the most common ways of creating images makes it impossible to obtain a spatial image of a flat figure, bypassing the manual model and without using of additional views of objects [2].

We hypothesized that the development of automated methods of converting flat images into the spatial ones and implement it in hardware and software system will not only combine the processes of drawing and modeling, to provide visual information to a qualitatively new level, but also leads to fully automation of the model creation process.

## 1 The purpose of the investigation

Development and implementation of hardware and software method of construction in the image space, represented in the plane.

## 2 Method of the investigation

At the first stage of the project was to develop methods of converting images. Sketch as a preliminary sketch, can operate only two coordinates, which does not allow obtaining information about the spatial shape of the object. We came up with the way in accordance with that to convert flat images in bulk, for each object of the original image it is necessary to add special markers. Depending on the type and its position, the markers will install the missing parameters of the object (i.e. height / length / width, depending on the projection type).

The second phase of the project - implementation techniques in software and hardware complex «IMPOSS!BLE Box».

In the program, the user is using the tablet creates a spatial image on the basis of the developed technique. In order to convert the image, the program recognizes and selects its component parts, assigns pointers and objects, processes the received data. The finished result can be seen both on screen and on the volumetric display.

We created the display that lets you view the object shown by all sides and gives us the opportunity to provide information to a qualitatively new level. For convenience, the device is equipped with interactive controls gestures.

## 3 Main results

As a result of the work, various ways of creation a spatial image have been studied. The analysis has shown that none of them has the possibility of combining the processes of drawing and modeling, as well as the possibility of spatial imaging of the plane, with a basis of only a flat picture. We have developed the technique of converting flat images into spatial, representing an entirely new way of working with spatial imaging, that allows you to represent almost any object in space out of a flat drawing.

The developed method is embodied in a hardware-software complex «IMPOSS!BLE Box».

## 5 Conclusion

Thus, the developed complex combines the processes of drawing and modeling can represent almost any object in the space out of a flat figure, which confirms our hypothesis. Having analyzed the opportunities created by the hardware-software complex we can summarize that the goal is reached.

## References

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# Intelligent robot system based on network and local interactive control for application of patrol and cleaning in community

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## 1. Introduction

Nowadays, labor shortage and human cost increasing become more and more serious in China. Especially for young people don't want to take boring and hard work. It's difficult to hire a patrol or a cleaner now. Therefore, this paper designs an intelligent robot system to take place of patrolman and cleaner for community. At the same time, in order to realize the online monitoring of community environment and remote control of the robot, this paper adopt network in robot control area.

## 2. Design

The intelligent robot system, which based on network and local interactive control for application of patrol and cleaning in community, consists of an intelligent robot, network, managing terminal, path recognition module, etc. Under the command of the owner or preset program, the intelligent robot may adjust its speed adaptively, cleaning garbage, moving objects, patrol community, upload video information. Network connect robot with managing terminal by WI-FI, optical fiber, or ADSL, etc., and provides value-added services, such as education, medical treatment, etc. Managing terminal is a computer that may receives video information, send command to robot by network, and help robot to deal with difficult things. Path recognition module identifies the location of robot, and control the route of robot.

## 3. Implementation

Intelligent robot consists of control module, execution module, communications and video module. Control module is the core of the robot, which control the action of robot according to the instructions or preset program. Executive modules includes walking, handling, cleaning and other customization executive components, which takes the main functions of the robot; Communications and video module includes video collection and communication, such as IPAD. Network connects robot with its owner. Managing terminal may be a computer, notebook or IPAD, which send instructions to robot and receive message via internet.

## 4. Results of the experiment

Fig.1 shows an intelligent robot. Fig.2 shows the owner watch community video and control the robot. Fig.3 shows the robot on duty of community patrol, sweeping rubbish, moving objects. The robot is controlled in remote and local modes. Its speed is adjusted according to battery performance and could be moved step by step.

Control screen

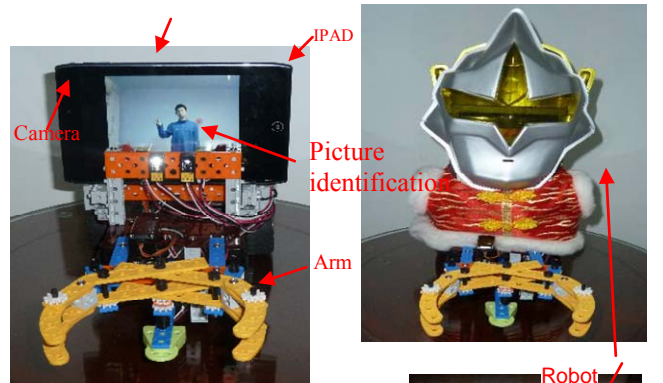


Fig.1 Intelligent robot



Fig.2 Control of robot via internet



Fig.3 A patrolling & cleaning robot

## 5 Conclusion

This paper present an intelligent robot system based on network and local interactive control for application of patrol and cleaning in community, that may patrol community, clean trash, move object, upload information. Owner may online control the robot, and the interaction control of robot from network or in local way is realized.

# Information technology in a controlled system

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## 1. Introduction

Our project consists of a modular software application which is designed to support the development and testing of controlled systems and a controlled system itself which controls a ball on a tiltable plate. The input consists of a Microsoft Kinect depth picture from which the ball position is calculated. The Computer then calculates the necessary tilt of the plate to control the ball as desired and instructs a microcontroller to control servomotors correspondingly. To assist in development and testing a simulation was created.

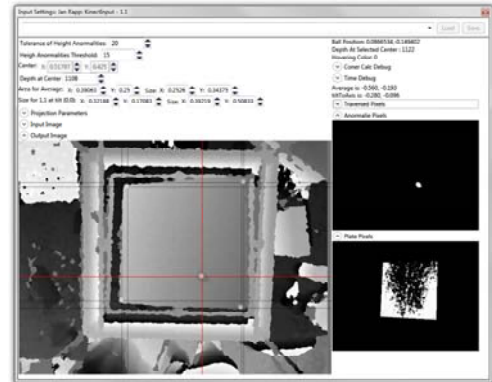


Fig. 2 Kinect Input

## 2. Software Application

The software application has a modular design, which consists of four components: The Input (which recognizes the data), the Output (which controls the actuators), the Preprocessor (which does some basic calculations for the Juggler) and the Juggler itself, who controls the system. The modules are depending on each other as specified by type arguments and interfaces and can be independently exchanged in the UI. The application was designed to be user friendly and to allow easy calibration.



Fig. 1 Interaction between the modules of the software

## 3. Simulation

A Simulation has been implemented to allow testing one's Juggler algorithms even if the physical system is not available. To simplify the calculation, there are two simulations, one assuming the ball is always on the plate and the other assuming the ball is always in the air or the ball is reflected by the plate. Both simulations are calculated numerically in several Updates.

## 4. Input and Output

The plate position in the depth image is calculated with a perspective projection from the known corners of the plate. The image is searched for anomalies from the expected plate distance which are caused by the ball.

The Output consists of four servomotors, which are controlled by a microcontroller with a PID controller.

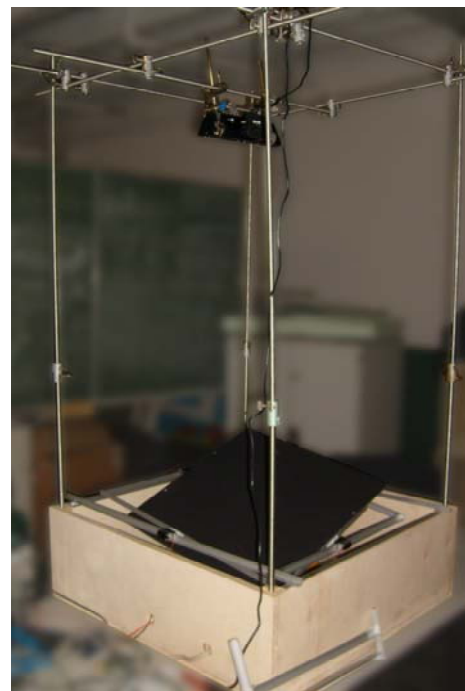


Fig. 3 The real construction of the controlled system

## 5. Preprocessor and Juggling

The Preprocessor is supposed to ease the implementation of the Juggler by encapsulating frequently used functionality (e.g. calculating the velocity and acceleration from the current and past ball positions and their delta times). The Juggler balancing the ball is a PD controller. Another Juggler tilts the plate based on the input of an acceleration sensor in a Wii Remote or mobile phone and allows the user to be the controller.

# MODULA: A new approach to database modeling in web applications

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## 1 The purpose of MODULA

The motivation to develop an online shop and the ensuing disillusion with the inflexibility of conventional solutions has led me to further investigate modern web application frameworks like Zend Framework, CakePHP and Symfony. After some experiments I came to the conclusion that despite their high level of sophistication, the way in which they represent the underlying database still can be enhanced. Thus, this work is supposed to provide an alternative to conventional database modeling techniques. In order to demonstrate the capabilities of these new concepts a light-weight PHP/MySQL framework named MODULA was developed. I used it to construct an online shop system and a collaborative blogging platform.

## 2 The method of MODULA in comparison with other solutions

The vast majority of web applications are based on relational databases (e.g. MySQL). In MODULA they are represented in the following way: Every relation is an instance of the `Module` class, which provides basic CRUD functionalities. In turn, every `Module` instance contains as many instances of the `Property` class as it has columns. Since `Property` is an abstract class, the developer can choose from a number of `Property` subclasses, each representing a different type of column (e.g. email, foreign key, small string etc.). Furthermore, every `Property` object encapsulates the functionality of validating data, parsing data that was retrieved from the database and modifying data before it is inserted into the database. It also contains information about its relation to other `Property` objects (i.e. foreign keys).

Especially in larger frameworks like Zend Framework or Symfony the deficit of encapsulation is reflected in a great number of large files compromising the overview. In frameworks like CakePHP that also defines its validation data separately [1, p. 303ff.], inconsistencies can emerge that lead to data deemed valid by the PHP script being rejected by the database.

In result, the comprehensive definition of all columns greatly improves the robustness of the overall application und reduces the need for configuration files.

Another issue is the communication between application and database. Symfony and CakePHP extensively use object-relational mapping (e.g. Doctrine) that provide an object-oriented access to the database. The downside is the large overhead that ORM entails - compromising the entire application's performance, because their bottleneck mostly lies in their databases [3]. Although bound to a Data Access Object, MODULA is capable of simulating the behaviours that would otherwise be implemented by ORM classes [2] by creating subclasses of `PropertyBehaviour`. Judging by its structure, this class can be best compared with the database-oriented classes of Zend (e.g. `Zend_Auth`). Both solutions do not use real ORM, but instead require the developer to manually pass the appropriate columns needed to execute their logic (like columns for username and password). Since `PropertyBehaviours` are based on `Property` objects, which already contain sufficient information to execute multiple-table queries, they are more flexible than Zend's components. This plays a role in normalised tables, where for example a user's data is split across two tables.

## 3 Result

Due to its extensive encapsulation techniques, the concepts behind MODULA introduce a clear and transparent class structure. By using a different software architecture MODULA can retain the advantages of ORM, without being plagued by its overhead. Interestingly, the class that allows this, `PropertyBehaviour`, is fully decoupled from the context in which it is used and thus can be published as an independent, loosely coupled component (like in Zend) – in opposite to the classes generated by ORM. Provided that this alternative database modeling technique becomes popular, a compilation of different `PropertyBehaviour` subclasses can be published that describes frequently used application logic.

## References

- [1] B. Porebski, K. Przystalski, L. Nowak, "Building PHP Applications with Symfony, CakePHP and Zend Framework", Wrox, 2011.
- [2] <http://www.agiledata.org/essays/mappingObjects.html>
- [3] <http://stackoverflow.com/questions/7334287/disadvantages-of-object-relational-mapping>



# Intelligent reconnaissance robot for replacing dangerous human tasks

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## 1 Introduction

Robotics incorporates aspects of many disciplines including electronics, engineering, mechanics, mathematics, optimization and IT software development. The field of robotics is closely related to artificial intelligence. It is required for robots to be able to handle such tasks as object manipulation and navigation, with sub-problems of localization, mapping and motion planning. The greatest advantage of using robots is that they can be applied in dangerous situations as well. For example after a catastrophe, an area can be different from the original status and also dangerous conditions can occur, so that it is important for the rescue team to know the real condition of the area of the disaster. The up-to-date map and information could be useful for example after fire, earthquake or flood events.

## 2 Problem definition

My goal was that to develop a robot that can explore a field of which we have no exact information. The robot has to change the map, if differences are found between the environment and the input data set, and also sending information about this to the computer is required.

## 3 Solution strategy

First of all a robot was built at the beginning of my work using the LEGO Mindstorms set, which was able to move and collect information from the environment.

In the next step a computer program with artificial intelligence was developed in order to determine the controller module of the vehicle. This program can keep a copy of a map in the robot's memory about the environment (or a labyrinth), and the goal of the computer program is to calculate an optimal route from the starting point to the destination and back. Finding the optimum is based on a breadth-first search graph algorithm.

During its way the robot checks whether the map of the environment is correct or not. If some wrong map information is found, the robot corrects the mistakes, and tries to find another way to reach the destination point. The robot takes a look around in the surrounding of the inaccurate map field increasing the probability to find a shorter way.

Moreover, the robot can also send some information about the mistakes found during its operation to the server program via Bluetooth. Based on this data set the server application can correct the mistakes of the map. In case the robot is destroyed the rescuers will have some up-to-

date information about that part of the area, which the robot has visited so far.

The program running on the robot is controlled by an artificial intelligence decision-maker component. This part is responsible for the correct decisions when the level of energy of the robot, the distance from the current location to the destination, the probability of the correctness of the map, and the distance of the return route are taken into account. If the decision-maker component finds the probability of reaching the destination too low, then it makes the robot return to the starting point. The controller program was written in Java using LeJOS program environment.

## 4 Results

Several sample environments have been built during my work, which have helped the testing phase of the program development. In the end of the work my robot was able to rove numerous labyrinths, send information about the environment and it was able to make right decisions, so I can assert that I managed successfully my project. The whole project consists of more than 1500 program lines.

## 5 Future work

In the future I plan to extend the number of the sensors of the robot. Further sensors, for example temperature, radioactivity, smoke sensor, or a motion-picture camera could be applied improving the precision and the reliability of the data sent by the robot to the server application.

## References

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# Wayang rebooted

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## 1. Introduction

*Wayang* is a unique form of theater employing light and shadow originating from Indonesia and has played a major role in Indonesian culture. The significance of *wayang* in the world of culture was recognized by UNESCO on November 7, 2003 when it was designated as a Masterpiece of Oral and Intangible Heritage of Humanity.

However, in recent years there has been a decreasing interest in *wayang*. Many young people of today do not find *wayang* appealing. But we all know that *wayang* stories contain high moral values that can be used in everyday life.

Today, young people are fascinated by the advancement of technology. A viable option to combine modern technology and the traditional art of *wayang* is the creation of a *wayang kulit* visualization game. The creation of this game would make *wayang* more appealing to a modern society.

## 2. Content

### 2.1 Purpose of the investigation

The purpose of this research is to create a *wayang kulit* visualization game, called the Wayang Rebooted as a means of re-introducing wayang to kids and teens through technology.

## 2.2 Investigation Methods

The design of this study is an experiment to create a *wayang kulit* visualization game. We analyze the data obtained throughout the duration of the research in a descriptive manner.

## 2.3 Results of the Experiment

After completing our game and taking a survey from users at school, most of them have stated that this game should be further developed, meaning it has potential.

## 3 Conclusion

The process of creating a *wayang kulit* visualization video game are making a concept → formulating a design → gathering materials needed → assembly → testing. After “Wayang Rebooted” is successfully constructed, this game can be applied into educational activities. This game facilitates users to understand the *Ramayana*. With the creation of this game, more people will be attracted to the traditional art of *wayang kulit*

## References

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- [2] Anggriawan Saputra, Derrys Novy. 2010. *Membangun Aplikasi Plane Fighter Menggunakan Flash*.
- [3] R.M. Poespaningrat, Prameojoe. 2005. *Nonton Wayang Dari Berbagai Pakeliran*. Yogyakarta : Kedaulatan Rakyat.

# Error-Free test result processing using mobile phone technology

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## 1 The purpose of the investigation

Scoring the exam answer by Short Message Service with assist from Internet Modem.

## 2 Method of the investigation

### 2.1 Equipment

1. Laptop
2. Internet Modem
3. Mobinil USB Application
4. SMS Server Application
5. Microsoft Excel
6. Hand Phone

### 2.2 Procedure

1. First, prepare the excel file sheets, fill the sheets with participants name, number of GSM/CDMA cards as the data of participants,
2. Give the GSM/CDMA cards to the participants follow the data of participants.
3. Participants sending the answer from SMS with hand phone with format: NIS\*CLASS\*THE ANSWER EVERY NUMBER OF QUESTION.
4. Internet modem will receive SMS from participants and scoring by SMS Server Application and Microsoft Excell.

### 2.3 Data Processing

Processing data with application Microsoft Excel should use the fixed function. The fixed function are:

1. =SUM(...)  
The function is for do the addition.
2. =AVERAGE(...)  
The function is for search the average grades.
3. =MID(...;...;...)  
The function is for take the text from the fixed residence with some fixed characters.
4. =IF(...;...;...)  
The function is for checking.

## 3 Results of the experiment

We were successfully processing exam answer-question by short message service using SMS Server and Internet Modem. It can calculate the answer questions from students automatically, quick, and accurate.

## 4 Conclusion

The score is more accurate. There is no missing score.

## References

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- [2] <http://cyberions.blogspot.com/2009/11/pengertian-modem-internet-dan-cara.html>
- [3] [http://belajar-sendiri.com/2009/10/apa-itu-sms-dan-bagaimana-cara-kerjanya/\(http://wss-id.org/blogs/rizky\\_anggraeni\\_sby/archive/2007/09/24/mengenal-fungsi-fungsi-dalam-microsoft-excel.aspx](http://belajar-sendiri.com/2009/10/apa-itu-sms-dan-bagaimana-cara-kerjanya/(http://wss-id.org/blogs/rizky_anggraeni_sby/archive/2007/09/24/mengenal-fungsi-fungsi-dalam-microsoft-excel.aspx)



# Saman dance revolution

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## 1 Introduction

Saman dance is one of the world's cultural heritage comes from Indonesia. Rapid movements and danced in a groups is characteristic of this dance. Unfortunately the preservation of this dance is less and less over the times and technological developments.

## 2 Content

### 2.1 Research Objectives

The purpose of this research is to try to make the game of Saman dance using pattern recognition that provided in Camspace software and combined with a flash game.

The interesting thing about this research is, the researcher presented a new way of studying the Saman dance in the form of the game. By using pattern recognition technology (Camspace Software) combines with adobe flash. So that, learn while preserving the Saman dance becomes easier and more enjoyable.

### 2.2 Methodology

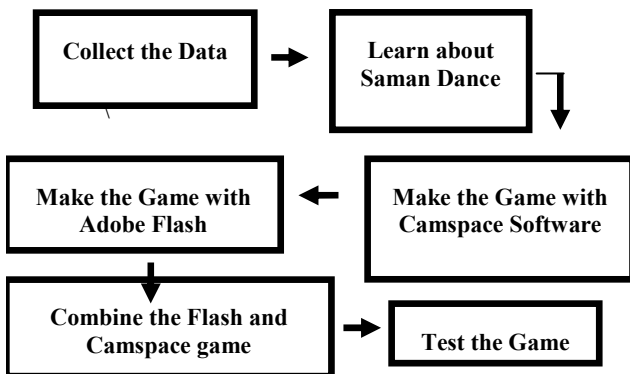


Fig.1 Interface in Camspace



Fig.2 Interface in Flash Game

## 3 Conclusion

1. The researcher conclude that the uniqueness of art culture should be packaged with recent technology. So that the interest of the society to learn the culture will be high. With the technology, the society will be able to learn culture will be more easier.
2. This game was very simple and easy to make, The components in this game was very simple too. The useness of gesture recognition technology in this game was very simple too.

## Reference

1. Hidayatullah, 2011. *Membuat Mobile Game Edukatif Flash*. Penerbit Informatika. Bandung

# The Flying Dutchman

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## 1. Purpose

Oceanographic research requires large, polluting and expensive ships. The goal of my research was to develop a cheaper, less polluting alternative to these research ships. I have designed and built an autonomous control system that changes a sailing vessel into a sailing robot. Since robot ships can be smaller and do not require human operators they are much cheaper. They use the wind as their main source of energy and therefore they can be self-supporting for a very long time.

The sailing robot should be capable of following a pre-defined route, and should react to its environment, like the wind and the waves. My research was threefold. First I wanted to investigate the minimal requirements for a fully functioning autonomous sailing robot. Second to build this ship and write all the necessary software. Third to test whether this ship is fit for the purpose it was designed for: independent sailing.

In my project I have combined theoretical and practical insights from different scientific fields such as electrical engineering, signal processing, control theory, informatics and last but not least: sailing.

## 2. Method

To be autonomous, the sailing ship must have information about three essential variables: wind direction, position and heading. This information is supplied by sensors and is processed in the on-board computer. This computer controls – through actuators - the rudder and the sails of the ship. The software “translates” the information from the sensors into commands that control the vessel

1) In order to control the position of the sails, the on-board computer must know the wind direction. The wind direction is determined by means of a wind vane. In a graph, every wind direction has its own position of the sails. This position is transferred to the sail actuator [1]. Because a sailing ship cannot sail against the wind, the information about the wind direction is also used for the planning of the route.

2) In order to plan the route, information about the current position of the boat on earth is required. This information comes from a GPS module. The on-board computer uses this information to calculate the path, a rhumb line, to the next waypoint of the current predefined route. In case the boat needs to sail too close to the wind, the route will not be a straight line but the boat will follow a zig-zag pattern. Sailors call this beating. To accomplish this, I investigated several algorithms that calculate a beating pattern [2]. Then I developed my own version of such an algorithm, to make it suitable for implementation on my low-end hardware and improve the efficiency of the boat.

3) In order to keep the boat on course the on-board computer needs to know the current heading of the boat. The current heading is measured by a tilt compensated digital compass. The information from the compass is filtered by a Butterworth low pass filter to remove the noise from the signal. Then this filtered signal is fed into a PID controller. This PID controller uses the error between the current heading and the heading to the next waypoint to calculate a rudder position.

All information from the sensors is combined in the on-board computer, a mbed (an ARM lpc1768 development board). A couple of times per second the on-board computer processes this information and combines it with the predefined route to calculate a new rudder and sail position. To accomplish this I created C++ software to run on the mbed microcontroller.

## 3. Results

The result of my experiment is a ship that can sail autonomously and make decisions on its own. My tests show that it reacts to wind and waves to sail any route optimally. All necessary intelligence is located on-board and therefore it can function without any contact with the shore. This makes it a true autonomous sailing robot.

## 4. Conclusion

I succeeded in creating a proof of concept of an autonomous sailing vessel for only €350. Since the boat lacks solar cells, it is not self-sufficient yet. A modified version could serve as an alternative to full size research ships and costs €600 (\$785) only.



Fig.1 Picture of the sailing robot *The Flying Dutchman*

## References

- [1] Ross Garrett (1987). *The Symmetry of Sailing*. Adlard Coles Nautical, 2nd edition.
- [2] Tobias Pröll Roland Stelzer (2007). *Autonomous sailboat navigation for short course racing*. Elsevier Journal of Robotics, 56 (7):604–614.

# Biometrical voice authentication system for computer networks

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## 1 Introduction

The way of authenticating a person by his login and password, which is traditionally used in computer networks, does not always provide a high safety level. The reason for that are such disadvantages as: a need to remember difficult passwords, a possibility of stealing the password phrase and losing private data. The idea of this project is using an alternative way for verification the personality of user – biometrics (person identification by his unique biological parameters like fingerprints, retina patterns etc.). The system developed during the project work uses voice recording, because this method seems to be the most cheap and convenient among all possible biometrical systems.

## 2 Purpose of the work

The work of the method is based on the uniqueness of the voice of every person. Humans can easily identify their partners while listening how they speak. Purpose of the work is to find out, if computer systems could be taught to do that.

## 3 Voice biometrics

Every burst of the voice signal can be represented as a phoneme – a basic element of a given language, from which words in that language are analyzed as being built up.

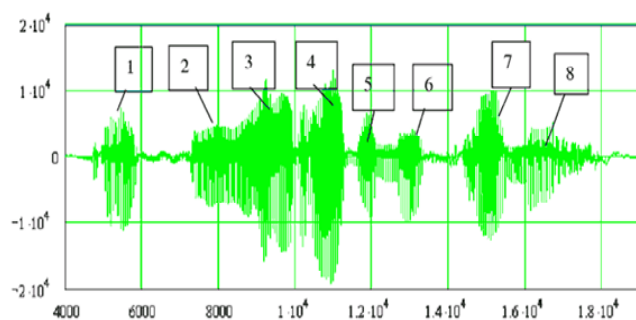


Fig.1 The recording of a sample phrase

This graph shows 8 bursts in the recording of voice signal

In analysis we can use only phonemes representing vowels can be used for verification process, because they allow to extract easily the main unique voice feature – frequency. Consonant have a more noisy structure, that is why they are not suitable for biometric process.

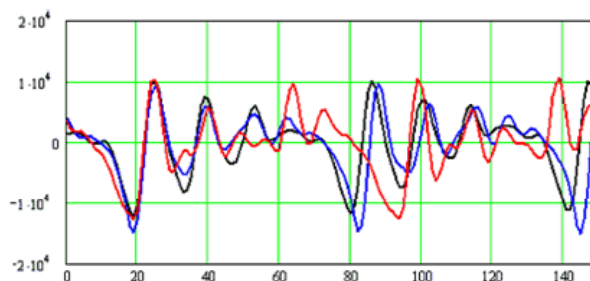


Fig.2 The recording of a sample phrase done by 2 speakers

The graph on figure 2 shows the differences of phoneme structures recorded from different speakers.

## 4 The algorithm of verification

After a recording a phrase prompted by system, the algorithm extracts vowel phonemes by searching the burst in the signal, that have specified characteristics. After that, we apply a several numbers of filters (like normalizing, sound muting etc.) on every extracted phoneme, and then compute Fast Fourier Transforms in order to extract the voice frequency. That frequencies are compared to the so-called “voice passport” of the user applying the correlation analysis method.

## 5 The use of the system

The developed system is designed to be used by web developers. To use it on your web-site, you should install a special Javascript code to your web page, after that an authorization form will appear. Not registered user should create a voice passport with a help of special master, which asks him to read digits from 0 to 9 to the microphone. Users, who already have an account, should just print their login and read 4 prompted digits.

# Time machine for Google android

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## 1 Introduction

Modern computers and mobile devices are used in a large number of critical areas. For instance, in medicine any bug can have very serious consequences. Therefore, bugs detection and fixing is the problem of great importance. Unluckily, in many cases debugging requires considerable effort as some bugs have very irregular nature and are hardly reproducible. E.g. some bugs can depend on state of a battery, server timings etc. Such debugging process is mostly done intuitively, without proper instruments.

## 2 Objective

My objective was to develop a tool, which helps to find and fix rarely occurring errors.

## 3 Materials and methods

The tool being developed, Time Machine for Android, allows remembering program states, and then playing them back in order to find a state of the program which lead to crash. To effectively perform this, I needed to change the operating system (Dalvik Virtual Machine). The implementation of Time Machine included two main units: Writing the information about programs interactions with an external environment into a file, and also recovery (emulation) the given interaction from the file. In most cases, when I used Time Machine, the decrease in programs performance was insignificant; therefore the project can be widely used during beta-testing.

## 4 Result

My tool allows to considerably simplify the detection of program's errors, to enhance their quality and also to significantly reduce the time of writing beta-testers reports (approximately 70%).

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# The OVF mode and its applications

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## 1 Introduction and the problem

All of the modern cryptographic ciphers are made of two parts: the mode of operation and the main algorithm. Every mode that is more used is simple, and made of a few basic operations, while the algorithm is mostly kept complex. The effectiveness of the cipher depends on the mode, but the algorithm itself is mainly responsible for the security of the cipher. Although standards change and technologies progress rapidly, both the modes and the algorithms are combined to work with the keys and blocks of fixed length. Therefore, not many ciphers last more than about 20 years. The problem is that these ciphers are not flexible enough to accept higher standards. That is why I have decided to create something that is.

## 2 What I have done

I thought that solution to the problem should be based on a mode of operation itself. The mode I made will accept blocks of any length, and their length will not affect the security and the effectiveness of the cipher. Also, the secret key size is equal to the plaintext size. The only purpose of the algorithm is to combine the feedback arguments that mode is giving (they are derived from a hash function) with the key, so that it can be broken only by the brute-force attack. The result of that is that none of the encryption's blocks can be decrypted without the entire ciphertext and the entire secret key in posses. Moreover, the mode does not have effectiveness shortcomings – ciphertext size is equal to the plaintext size, and both ciphering and deciphering processes can be parallelized. I decided to name my mode OVF (Outside Variable Feedback).

My project is based on presenting the OVF mode, along with the PFA (Parallel Feedback Algorithm), the symmetrical block cipher that is based on it. The PFA is originally my creation and it has been developed by me exclusively. It only stands as an example of what an application of the OVF can look like. Also, the advantage of the OVF-based ciphers is that time and space complexity for breaking the ciphers increases polynomial, not just when increasing the block size, but also when increasing the plaintext size and, at the same time, the key size.

## 3 How I have done it

The result of preparations for ciphering in the OVF mode considers two variables (marked X1 and X2 on Fig.1). Both are obtained from the  $n$ -block key as a one-way function results of the same, and are some polynomial function of  $n$  long (e.g.:  $\frac{1}{2}n^2$ ,  $n^5$ ...), depended on a hash function that is used. The original function I use to get them I shall keep for myself, but any hash function will do as long as it is one-way. Here is how the OVF mode looks like in algorithm

Fig.1:

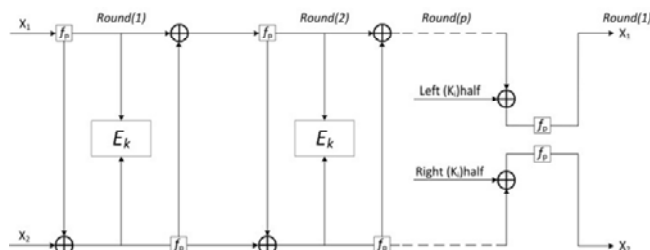


Fig.1, The basic OVF mode

The function marked  $f_p$  (permutation function) in Fig.1 is a symmetrical function that shuffles the bits of the every byte of a variable that is given. That means:

$$Fp(x) = x', Fp(x') = x \quad (1)$$

Besides going through these functions, the variables also do XOR with each other. This happens constantly and they will return to their initial values at some point. The time complexity before X1 and X2 again have their initial values is a **period**, and it is exactly three rounds long. I have proven the period's length in practice (with the simulator application) and in theory (with the mathematical induction). At the end of Fig.1 there is an OVF extension that happens after every  $p$  round, as shown in the same figure ( $p=3$  in PFA). The extension applies XOR to the X1 and X2 blocks and the secret key blocks used in the round before, while the result remains in the X1 and X2 variables.

## 4 The conclusion

DES (Data Encryption Standard) is a good example of what was said at the beginning. It has been 10 years since it was considered unsecure because of the “small” constant 64-bit block and even “smaller” 56-bit key. Almost 30 years ago, when it was first published, there was no alternative and it has become the most used cipher in the world, but later, the technological improvement excelled it. In my opinion, the opposite is held for the ciphers that use non-constant length keys, or, like in the OVF-based ciphers, the ones that use a key which length depends on a plaintext. But still remains the question – Is the potentially too long key a worthy price for perfect security of the basic messages? The question can be answered only by the future users of the OVF-based and similar ciphers that are to come.

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# Application of digital image processing in medicine

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## 1 Introduction

Information technologies have burst into our life with a tremendous speed and medicine is not an exception. Nowadays there is a very big variety of the diagnostic methods. For example, using photos of the iris we can get information about the general state of our health. Unfortunately, in Ukraine the level of diagnostic medicine is quite low, that is why we choose to study methods of the digital image processing that can be used for automatization of blood analysis.

First of all, **the purpose of our work** is to create the algorithm that allows us make digital processing of the blood analysis automatically.

**Our main goal** is to create cheap and easy-to-use hardware-software complex which will allow people to take blood analysis themselves.

## 2 Research procedure

### 2.1 The start of our research

The first step of our research was visiting the General Hospital №5. We were really surprised that the blood analysis was made by counting the number of the blood cells by the analyst. This process requires a lot of time and patience of the analyst that is the reason why we decided try to automate it.



Fig.1 Analyst, who counts the number of cells

### 2.2 Choosing the method of image binarization

We started creating of the program with studying methods of the digital image processing. We reviewed five methods of the binarization of the images such as Bernsed, Niblack and Otsu's methods, the last one we used in our program, because it fast and provides qualitative results.

## 2.3 Algorithm of our program

As the result of our research is the program that works in a such way:

1. Loading the image.
2. Binarizing the image and choosing the threshold.
3. Threshold filtering (with chosen threshold).
4. Cellular automaton:
  - 4.1. Numerating the black pixels with sequential natural numbers, the white pixels should be marked as a zero.
  - 4.2. Replacing the value of each pixel in the algorithm cycle with the biggest number of neighbour pixels. Once the image is invariant to this transformation, we obtain an enclosed areas inside each one of those all pixels have the same number.
5. Selecting the region, finding their limits and area. Counting the number of cells.  
The picture below is the screenshot of our program.

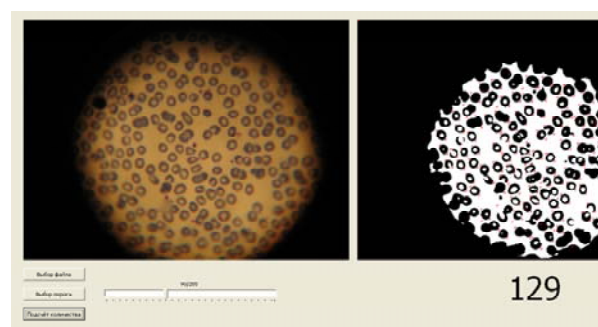


Fig.2 Screenshot of the program

## 3 Conclusions

**The result** of our research is the program which allows automatically count the number of red cells. Our studies can be continued by improving the program. We are planning to create an affordable hardware and software system that would automatically carry out quantitative analysis of blood. There is also possible to use the program for processing of other images, for example - pictures of bacteria or any other, where objects have enclosed borders.

## References

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# ECOLOGY



Radboud University Nijmegen  
The Netherlands 2012

# The development of 3G cellular communications technologies as one of the causes of honey bee colony collapse

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## 1 Introduction

The first signs of the mysterious disappearance of bees occurred in China, and now in some provinces they have completely disappeared. Then the USA beekeepers sounded the alarm, the first mass death of bees was recorded in autumn 2008, now it has spread throughout the states. In 2010 about 60% of the bee population on the west coast and 70% on the east coast were killed. Then the syndrome of a sudden collapse of the colonies spread over Europe. Germany, Switzerland, Spain, Portugal, Italy and Greece suffered most of all.

## 2 The aim of the research

The aim of this research is to analyze the influence of cell phone electromagnetic radiation and various communication technologies on the state of honey bees and other insects; to find out whether cell phones affect insects; to investigate the interaction of the bee colony collapse with the development of cellular communications technologies, basing on well-known scientific facts and our own experiments.

## 3 Method of the research

3G modems of Life Corporation, ZTE working on the 3G+ protocol and HUAWEI which uses the high-speed HSDPA protocol, were connected to the computer with the 3 meter extension. Both modems, as well as the 3G technology, operate in the frequency range of 450 MHz and use code division.

## 4 Results of the experiments

When these modems were connected to the Internet, the bees began to behave aggressively after a large video file was started to download. With an active Internet connection normal state of the bees replaced by a state of anxiety: the bees began to buzz very actively and not in a natural way, to thump on the vessel walls, to rush inside the jar. It depended on the speed of a connection and file downloading. While viewing web-pages and having installed low-speed connections the bees got less aggressive. When repeating the experiment many times in different locations with new bees this phenomenon occurred again and again.

## 5 Conclusion

Bee colonies located in areas with the greatest density of 3G coverage suffer most from various diseases. Bees with weak immunity cannot resist diseases and fly away.

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- [5] <http://bigafricanych.livejournal.com/6768.html>
- [6] <http://bees.by/index.php?id=41>
- [7] <http://www.bortnik-by.info/index.php>
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# The making of paper from natural fibers: Recycling and reusing at school

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## 1 The purpose of the investigation

To show the making of paper from waste natural fibers (*Cocos nucifera* fiber and *Musa sp* fiber) present in our region focusing environmental, social and economic aspects, strengthening preservation bonds through partnership with community association, private companies, state and city schools, and state government, presenting Environmental Education at school and around its boundaries providing dynamic and interactive ways which will surely decrease environment impact and make youth leadership possible towards sustainable development.

## 2 Method of the investigation (in comparison with known methods)

The methodologic process added an observation in the very site of the making and their problematic analysis around the school neighborhood, making speeches and on line courses, the making of paper from the *Cocos nucifera* fiber and *Musa sp* fiber with the aid of the Tecnokits environmental education kit, the usage of paper produced in daily school activities, a partnership with local government, private companies and community associations, performing and showing how to apply the recycling process in 20 city schools in Bela Cruz, CE - Brazil.

## 3 Results of the experiment

There was a great decrease in spending money in all 20 schools where the project took place. There has been a 10% economy in the budget to buy paper and its related matter. The recycled matter begets a feasible economy and substitutes other matter like A4-size paper, carton, 40 Kg paper, 60 Kg paper, double and EVA rubber during the process. In 2010, 150 state schools got the environment educational kit which was used to recycle paper. In 2011, 112 schools bought the kit, performing, however, an increase of 43%.

Kit acquisition by state schools in Ceará		
Year	Amount	Growth
2010	150	
2011	262	43%

Fig. 1. Kit acquisition by state schools 2010/2011

While performing this project, besides lowering the environment degradation, we could realize an increase of 50% in the environmental perception among the people

involved and we could add valueable partnership with institutions, environmental leadership, practical development of actions, making sure that all the people involved would keep in mind those achievement and also educational campaign. All the purposes we have discussed made the “Escola de Ensino Médio Professora Theolina de Muryllo Zacas” include a new subject to the students: Environment Education subject, making possible a new way of articulated teaching as it is demanded in our National School Parameters to High School.

## 4 Conclusion

Through brand new methodologic processes we realized we can contribute to save the environment , and above all, create alternative sources to make paper, willing to be used by our modern society as a way to promote sustainability. The usage of paper from natural fibers comes on the scene as a strong ally in Environmental Education process, to be lived inside and outside schools, working as a practical example to manage preservation and natural resources.

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# **Analysis of the application of such recycled glass wool filter medium to reduce the emission of particulate material originating from the combustion of fuel**

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Luciana Mascena Silva, José Flávio Rocha  
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## **1 The purpose of the investigation**

The objective of this study is to propose a mechanism to contain particulate matter from combustion, high efficiency and, above all, low cost, using as raw material recycled products. Particulate matter (PM) are, by definition, a number of pollutants consisting of dust, smoke and all sorts of solid and liquid material which remains suspended in the atmosphere. And pollute the environment, these materials constitute a major risk to the health of the population, especially children and elderly, which can cause allergies and respiratory diseases.

## **2 Method of the investigation (in comparison with known methods)**

The feedstock for performing the work is made of a metal, where combustion takes place with coal and oil, a metal tube as exhaust, attached to the container where the combustion occurs with epoxy glue and glass wool fibers with protection screens inserted at the end of the exhaust. To measure the degree of uptake of MP, we used the latest equipment, in collaboration with the Federal University of Ceará, as a scanning electron microscope equipped with a spectrometer dispersive X-ray imaging and identification of chemical elements and a spectrometer MicroRaman.

## **3 Results of the experiment**

As análises da fumaça com e sem o filtro utilizando escala de Ringelman apontam para uma redução na densidade de MP de 80% para 20% (redução de aproximadamente 75%). Todos os resultados obtidos apontam o uso da fibra de lã de vidro como um material eficiente na captação de MPs. The result was satisfactory, since we find a way to reduce the emission of pollutants in the atmosphere using a low cost mechanism, there is an improvement in environmental, social and economic.

## **4 Conclusion**

All results indicate the use of fiber glass wool as an effective material for uptake of MPs. Thus, we have an efficient, safe and feasible to reduce pollutants that very committed to air quality and population health.

## **References**

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# European beaver (*Castor fiber* L.)

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## 1 Reintroduction

We have been told that the European beaver (*Castor fiber* L.) have returned in Međimurje so we have researched the behaviour of the european beaver in the old backwater, of the river Drava near the village Otok in Međimurje county.

Date of relising	location	Number of beavers relised	Ratio of the sex M:F
30.10. 1997.	Legrad, rukavci Drave	2	1:1
13.11. 1997.	Legrad, rukavci Drave	8	4:4
4.12. 1997.	Legrad, rukavci Drave	5	3:2
23.12.1997.	Legrad, rukavci Drave	14	9:5
Totally		29	17:12

Table 1. Reintroduction of beavers in Legrad

## 2 Material and methods

### 2.1 Used material

Along with the field journal, we used the following equipment: keys to determine species, the field journal form, pencil, digital camera, meter (max. Length is 5 m), GPS Etrex, rubber boots.

### 2.2 Methods

We used the meter and then on the trees that were damaged by the beavers and we measured the height and the radius of the trees that were bited.

## 3 Results

The most bites were recorded on the black alder (52.34 per cent) and common willow (37.97 per cent). The number of bitten trees reduces as the distance from the shore increases, and the activity was recorded up to 17 meters from the shore. From all the recorded trees where the activity was noticed, three fifths were knocked down and two fifths were only damaged. On the basis of the age of the bites, we can conclude that the family was the most numerous in 2007/2008, because we have noticed the biggest activity on trees.



Fig. 1. The European beaver (*Castor fiber* L.)

## 4 Conclusion

from that period. European beavers (*Castor fiber* L.) especially like to bite young trees with the diameter from 6 to 9 cm. Bites on knocked down and damaged trees are mostly at the height of 30 to 70 cm. We have not found any dams in the research area.

## References

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# Fishes as bioindicators of water pollution of river Drava

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## 1 Introduction

Contamination changes quality of surface water and deteriorates living conditions of aquatic organisms. Fishes are suitable as biomonitoring organisms because they are at the top of the food chain in aquatic system and they can accumulate harmful substances which exist in their surroundings. In assessing the degree of pollution of aquatic ecosystems is necessary to apply such an approach that will provide information not only on the concentration of pollutants in water, sediment and/or biota but also on their possible influence on living organisms.

## 2 The purpose of the investigation

The aim of this study was to evaluate the impact of water contaminants on biological indicators (biomarkers) in liver and serum of two fish species, roach (*Rutilus rutilus*) and pike (*Esox lucius*), sampled at the Drava river upstream and downstream from the point source of water contamination, and thus confirm their usefulness for application in biomonitoring of water pollution. The content of liver enzymes aspartate aminotransferase (AST), alanine aminotransferase (ALT) and calcium in serum were used as possible biomarkers of liver damage, while the concentration of metallothionein in liver was used as specific biomarker of metal exposure [1]. The condition index was used as an indicator of general condition of fish.

## 3 Method of the investigation

Županijski channel, an influent of the river Drava which receives town's and sugar factory's wastewater and storm water from surrounding agricultural land, has been chosen as a potential water pollutant. Two locations, Vrbovka (upstream) and Sopje (downstream) from the confluence of the pollution, were chosen and water samples for analysis of physico-chemical parameters of water quality and metal level determination have been taken several times during sampling. Age, gender, biometric parameters and the condition index of caught fishes were determined and blood and liver samples for biochemical and biomarker analysis were taken. Data were statistically analyzed.

## 4 Results of the investigation

Except for nitrate, the values of the physico-chemical parameters in water samples meet the requirements for the 2<sup>nd</sup> category of surface water [2]. Mean values of dissolved K, Cu, Fe, Ni, Co, Mn, Ti, V and As were higher downstream of the confluence of the Županijski channel. Values of metallothionein also show an increase on the downstream location; and roach had a significantly higher value of metallothionein than the pike. Higher average levels of liver enzymes were observed in this study, if compared with some values found in the literature [1]. There were no differences in values of liver enzymes either among different species or locations of catches. Pike had significantly higher values of calcium. The condition index of both fish species studied was lower at the downstream location (Table 1.).

## 5 Conclusion

Water from river Drava downstream of the confluence of the Županijski channel maintained relatively good quality with respect to the measured physico-chemical parameters. However, elevated levels of some dissolved metals at the downstream location indicate that this point source significantly contributes to the exposure of aquatic organisms to metals, which was also confirmed by the finding of higher values of metallothionein as biomarker of metal exposure in both studied species. Slight decrease of condition index on the downstream location could also indicate a possible influence of contaminants, while the issue of higher average levels of liver enzymes remains open for further research. Thus, the results of this study suggest that the selected fish species and biomarkers may be useful for assessing the impact of water pollution.

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Sampling location	Vrbovka (upstream)		Sopje (downstream)	
Fish species	<i>Esox lucius</i>	<i>Rutilus rutilus</i>	<i>Esox lucius</i>	<i>Rutilus rutilus</i>
AST (U/L)	1222.4±822.5	1466.1±616.5	1010.1±552.2	1334.9±1196.2
ALT (U/L)	219.0±240.2	218.3±82.9	173.4±328.0	218.1±139.7
Calcium (mmol/L)	5.7±0.7*	3.1±0.5	5.8±0.7*	3.2±0.7
Metallothionein (µg/g)	176.6±35.5	368.1±89.7*	207.0±46.1	423.8±102.2*
Condition index (g/cm <sup>3</sup> )	0.8±0.1	1.37±0.2	0.7±0.0	1.27±0.14

Table 1. Mean values (±SD) of liver enzymes and calcium, metallothionein and condition index in fishes (\* p<0.05)

# Orchids of the area of Šibenik (Croatia)

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## 1 The purpose of investigation

The *Orchidaceae* family is regarded as a delicate group of plants in Croatia – 58 taxa are included in different categories of the Red Book of Vascular Flora of Croatia [1], and therefore the entire family is strictly protected by Croatian law [2]. According to the most recent floristic data 151 *Orchidaceae* taxa have been noted in Croatia and among them 40 taxa occur in the area of the County Šibenik and Knin [1]. With this research we wanted to give our contribution to the knowledge of distribution and ecology of the orchids in the wider area of Šibenik. The first aim of our research was to find new localities of orchid taxa on this area. The second aim was to investigate the duration of flowering for several orchid species on the „orchid island“ on the locality of Lozovac.

## 2 Methods

The research was performed during 2010 in the wider area of the town of Šibenik, situated on the Central part of the Croatian littoral. On the researched area we looked for localities and habitats on which orchids grew. On each locality we noted the following data: the name and precise coordinates (by Gauß-Krüger) of the locality, type of habitat, names of orchid taxa and the number of individuals for each taxa. We photographed the habitats and orchids. Identification of orchids was carried out using the suitable floristic literature [3, 4] and photographs which have been taken during our fieldwork. For some species we requested confirmation of the identification which was given by botanists from the Department of Botany in Zagreb. On the locality of Lozovac, on the same dry grassland we registered nine orchid taxa and we found it as the most suitable site for our research of the duration of the flowering period. Six orchid taxa with populations varying from more than 30 to more than 1000 individuals were selected for observation. In the period of March-June, every 3 to 4 days, we visited the locality of Lozovac. Each time we noted the date, orchid taxa in the flowering stage and the number of flowering individuals for each taxa. Accumulated data were used in the making of an appropriate graph. For each species we pointed out the beginning of the flowering (the appearance of the first specimen with at least one flower) the peak (the largest number of flowering individuals) and the end of the flowering (no flowering individuals).

## 3 Results

We found three new orchid taxa for the County of Šibenik and Knin: *Platanthera chlorantha*, *Orchis ustulata* and *Spiranthes spiralis* (Fig. 1). A total of 90 new localities for 17 of previously known orchid taxa for the County were recorded. The most important are the new findings for the taxa which have previously been noted only on 1-3 localities: *Aceras anthropophorum*, *Barlia robertiana*, *Ophrys lutea* ssp. *minor*, *O. x flavicans*, *Himantoglossum adriaticum* and *Orchis coriophora* ssp. *fragrans*. The most

of the new orchid findings were recorded on the dry grasslands and thorn scrublands (80,56%).

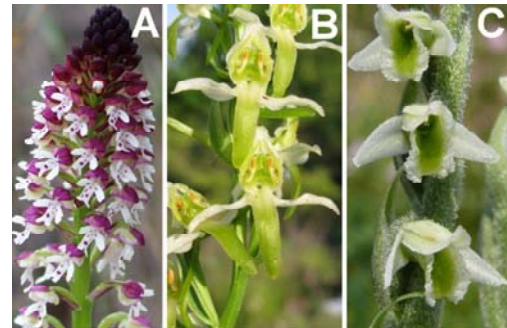


Fig. 1. New orchids for the County of Šibenik and Knin: *O. ustulata* (A), *P. chlorantha* (B), and *S. spiralis* (C).

The flowering period for six orchids observed on the locality of Lozovac lasted from the 18th of March to the 21st of June. The shortest period of flowering was noted for *H. adriaticum* (38 days) and the longest for *Ophrys sphegodes* ssp. *atrata* (50 days). The average duration of flowering for the observed taxa was 42 days. We found that the flowering of hybrid species *Ophrys x flavicans* (*O. bertolonii* x *O. sphegodes*) occurs approximately a month before the flowering of its parental species of *O. bertolonii*. According to literature [4] the early flowering and its adaptation to a specific pollinator are the most important isolating mechanisms that permit the independence of *O. x flavicans* from its parental species.

## 4 Conclusion

Three new orchid taxa for the County of Šibenik and Knin were found as well as 90 new localities for 17 of the previously known taxa. The most of the orchid taxa on the observed area are indirectly threatened because of the disappearance of its habitats caused by natural vegetation succession. Due to our research, the end of April and the beginning of May (when we can find the largest number of flowering species) is the optimal period for orchid observations in the area of Šibenik. It is necessary to continue the research of orchid flora, especially in the inland area of the County which is poorly researched. New findings can be expected so the total number of 43 taxa known after this research is not final.

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# Ecologic vs. Conventional agriculture – content of hazardous substances

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## 1 The purpose of the investigation

The purpose of this project is to describe the differences of ecologic and conventional agriculture because in nowadays people think that ecologic agriculture is healthier than conventional agriculture. The main purposes are find out: if the used phosphorus fertilizer contains permitted degree of cadmium, whether cadmium musters in the ground in higher concentrations, in which part of poppy (roots, stalk, leaf, seed) the lowest and highest degree of cadmium is piled up, if there are any differences between the contents of cadmium in seeds harvested too early to seeds harvested at the proper time.

## 2 Method of the investigation

Before practical activities I studied web sites and professional literature about ecologic agriculture. From these sources were selected information regarding to problems of application phosphorus fertilizers in ecologic agriculture and legislation. We mixed together 8 samples taken from the tested field. They were dried about the temperature 22°C. We prepared the samples and sent them to be analysed in the laboratory. Was bought bio poppy mark Sonnentor and exposed to the same analysis as conventional poppy.

## 3 Results of the experiment

In agricultural soil on the tested field cadmium was not piled up in over limited degrees. Phosphorus fertilizer Amofos does not contain over limited degrees of cadmium. Bio poppy contains over limited degree of cadmium compared to agricultural poppy. The highest degree of cadmium is accumulated in the roots.

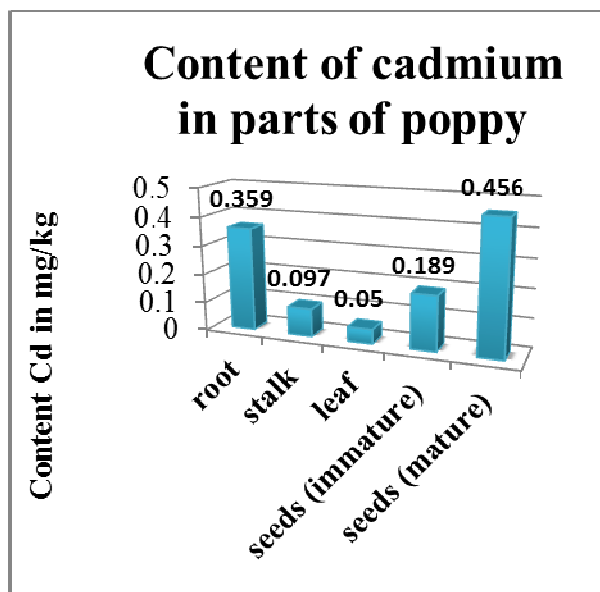


Chart 1: Content of cadmium in parts of poppy

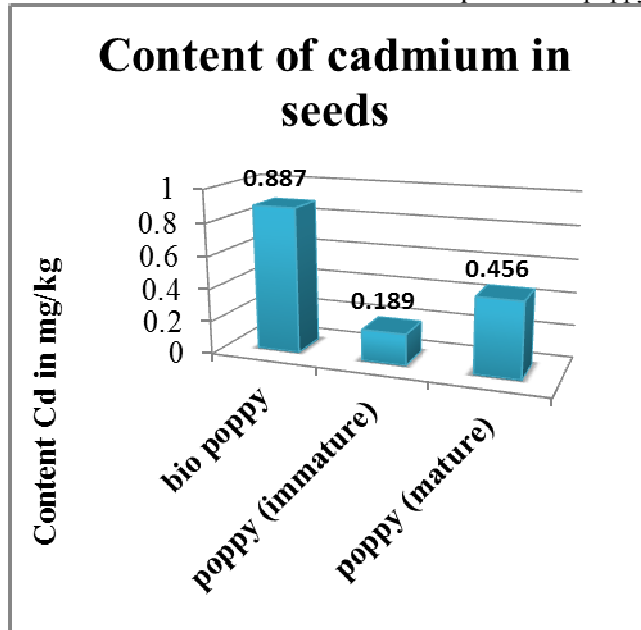


Chart 2: Content of cadmium in seeds

## 4 Conclusion

From these results is obvious that using phosphorus fertilizers on selected soil didn't cause increasing concentration of cadmium so much that it would not keep the decree valid in the Czech Republic. But literature states opposite. We can't explain that bio poppy contained so much cadmium in other ways that the soil where were the bio poppy grown were in past used chemicals or that bio farmers used chemicals.

## **Degree of pollution of soil and water purification**

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Acaroidea ticks are the permanent inhabitants of the soil. Their reaction to the environment pollution is very intense and thus they play the role of an indicator of the environmental pollution. Our observation is held on two different environments:

-Along the automobile route

-Besides the territory of cement factory and 15 kilometers from the factory.

As a result of the observation, we concluded that along with moving away from the automobile route, the composition of ticks in the upper layer of the soil is being increased, which can be seen as a sign of the gradual reduction of the automobile exhaust. When analyzing the area besides the cement factory, we can see that on the depth of 15-20 cm. in comparing to the upper layer the number of ticks in the rodent den is considerably higher, and this indicates that the area which is less polluted by the cement dust is less inhabited by the ticks. When measuring the territory 15 kilometers away from the factory, (Ialguji Valey) the number of acaroid ticks in both the soil and the rodent den is almost the same. By this finding we can infer that the influence of the factory is very low [1].

Arising from our experiment we can use acaroid ticks to measure the pollution level of the soil and environment. The process of the measurement involves extracting a mass of a soil, placing it in our device, which can identify the ticks within the soil. Using the device we can observe the ticks and conclude about the level of pollution of the soil.

Purification of the water is as important as the pure soil, because it helps to create living organisms, fosters their existence and development. We offer a device, which can become the favorite gadget for a tourist. In case of the lack of water while travelling, a tourist can easily purify this water for the use.

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# Bio-fuel vegetable oil, as alternative energy source

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## 1. Introduction

Vegetable oil is one of the most useful products all over the world. When already used oil is mixed with the flowing water, because it used oil consists of carcinogens, it causes ecological pollution of environment, which afterwards returns in our food, and appears in our organism and causes cancer (bosom [1], prostate gland [2], etc.) Because of oil's low density in compare with water, it covers water with thin membrane, which causes the damage of the aeration between atmosphere and water. Because of this the vegetable and animal plankton is doomed to death.

The subject of our study is how to clean already used oil.

## 2. Method

Our method is based on collecting used oil, filtrating, and dialysis of it, as a result we were able to clean the used vegetable oil from dangerous substances.

As the result we get second-hand used alternative fuel, which is free of carcinogens. The usage of it as bio-fuel doesn't damage environment. The difference between oil and our bio-fuel is that, it is only admixture of the carbonate chain, is free of lead additions, aromatic carbohydrates (which are poisonous), also sulfur admixture. Exactly the sulfur admixtures cause acid rains.

We found the new method of cleaning of the used vegetable oil.

It is possible to use cleaned vegetable oil in bio-diesel engine as bio-fuel.

With the use of our bio-fuel we will avoid some of global pollution sources, aeration between atmosphere-water, acid rains, polluting atmosphere with dangerous substances of smoke.

We can prevent cancer causing particles.

## References

The reference section should not be numbered (please use the style **Reference heading**). Leave a vertical space of 6 pt between reference entries. Citations in the text should be given by numbers enclosed in bracket [1]. Multiple citations should be written together, separated by commas [1, 2].

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# Synthesis of graphene

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## 1 Purpose of the investigation

The purpose was to find a new method for synthesizing graphene. Graphene is a very promising material for the future. I became fascinated by this material in 2010 when I read an article in the German science magazine "Spektrum der Wissenschaften" about the 2010 Nobel Prize for Physics for Andre Geim and Konstantin Novoselov. They were the first to describe the characteristics of graphene. Graphene is a nano-material, a one-atom-planar sheet of carbon atoms. Its characteristics are extreme conductivity and huge flexibility. Therefore it is an attractive material for solar cells, transparent displays and much faster and miniaturized transistors. But there is at present no effective industrial process for producing graphene. Therefore there are hardly any possibilities for intensive research into graphene and no possibilities to use this spectacular material in daily life. I decided to try to find a new process of graphene synthesis and to take part in the German contest for young scientists "Jugend forscht".

## 2 Method of the investigation

In the only known working, but not industrial-scale process of graphene synthesis adhesive tape is pressed on to a block of graphite. Afterwards it is applied to a silicon dioxide wafer. This method results in graphene pieces under 10  $\mu\text{m}^2$ . They are much too tiny for broader use. My investigation started from the hypothesis that it is much easier to get graphene indirectly from graphite oxide and graphene oxide. Scientists at the California Nanosystems Institute have reduced graphite oxide to graphene. However, an article of the magazine "Nature" suggested that it should be possible to exfoliate single sheets of graphite oxide to produce graphene oxide. It is much easier to reduce graphene oxide to graphene.

## 3 Results of the experiment

In a three-step process I was able to produce graphene. In the first step, the Hummers process was used to oxidize graphite and produce graphite oxide. The result was a solution made up mainly of graphite oxide. The remaining graphite deposited as sediment. In the next step ultrasonic sound was used to exfoliate the graphite oxide to graphene oxide. This process was described in a summary of an article in "Nature". For the next and decisive step, the reduction of the oxide atoms and of the OH-groups, no process currently exists and none is described in the literature. The graphene oxide is reduced in a solution and is dried on the surface of a carrier material. This requires a light reduction agent, in this case ascorbic acid. It is ideal because the resulting materials are graphene and water only. No waste product has to be extracted from the solution.

## 4 Conclusion

The evidence of graphene was provided by electric resistivity survey and by photography of samples with the help of a light microscope. The resistivity of graphene was compared to the resistivity of the base material. The resistivity of graphene differed according to the carrier material. Furthermore the resistivity of graphene was 400times lower than that of graphene oxide.

resistence R [k $\Omega$ ]	graphene oxide	graphene	$\frac{R(\text{graphene oxide})}{R(\text{graphene})}$
carrier material			
glass	2500	60	42
kitchen roll	2060	40	52
Rubber foam	2030	6,1	332
styrofoam	2017	9,0	224

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# Sweets pro and contra: Colouring agents and antioxidant content

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## 1 The purpose of the investigation

Healthy food and lifestyle are getting more and more attention these days. However, sweets still represent serious temptation. As several contradictory opinions can be heard about them I decided to conduct experiments and check facts and form my own opinion. Colouring agents [1] in chocolate candies type “M” and “S” have been investigated. The quantity of antioxidants in fruit and vegetable juices (lemon, white grape, red grape, grapefruit and tomato) and in my favourite sweets (lemon flavoured glucose, red currant jam, milk chocolates, dark chocolates and cocoa powder) have also been measured. I tried to get answers to the following questions: What kind of colouring agents are in the candies and are they dangerous or not? What is the antioxidant content of sweets compared to juices and each other? In addition, I wanted to know whether I have to eliminate sweets from my diet completely.

## 2 Methods of the investigation

I applied Thin Layer Chromatography (TLC) and High Performance Liquid Chromatography (HPLC) methods for investigating colouring agents. The basis of these procedures is that the mixture of different substances separates during elution. Using spectrophotometric methods one can identify substances based on their light-absorption spectrum. I applied this method for analysing colouring agents. The determination of the quantity of antioxidant is rather difficult because of their wide chemical variety. I used an indirect procedure which was published by Gianluca Farusi [2]. The basis of the method is that free radicals play an important role in the mechanism of the Briggs-Rauscher oscillatory reaction ( $H_2O_2$ ,  $KIO_3$ , malonic acid,  $MnSO_4$ ,  $H_2SO_4$ ) and no colour change can be observed until antioxidants neutralise them. Specifically, in my experiments the first blue colour was observed after 2-5 minutes in samples with juices and after 10-20 minutes in samples with sweets while in the case of the control sample it took only 10-14 seconds to change colour. The relative antioxidant contents of the samples were calculated by considering dilution. A calibration curve was determined by measuring the colour change for samples with different concentration of white grape

juice and these values were referred to Trolox, an artificial antioxidant compound.

## 3 Results

The blue candies from the „M” group are covered with artificial colouring, brilliant blue, while the yellow and brown ones contain natural colouring agents. I also identified beta-carotene in all samples. The antioxidant contents of the investigated juices are bigger by 20-22% than those of the white grape but they are well behind those of the sweets. In dark chocolate there is more antioxidant than in milk chocolate. Among the substances studied, cocoa powder has the largest antioxidant content (5500 times more than grape juice), which is almost the same as Trolox (Figure 1).

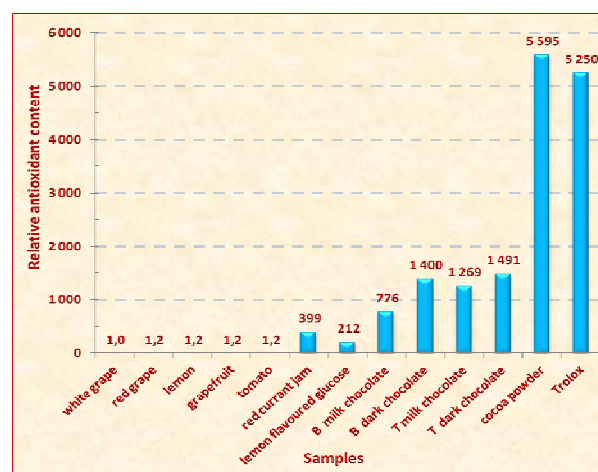


Figure 1. Relative antioxidant content of the investigated samples

## 4 Conclusion

Because of their antioxidant content sweets can be part of the healthy diet, but only in limited amount. Moreover, you should check all the ingredients in your food examining artificial additives such as colouring agents.

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# Plastic-Asphalt: Waste made useful

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## 1. Purpose of the Research

Plastic is a major problem the world is facing. It highly threatens the stability of the environment. It should not be littered or burned. It will also have lower quality the more it is recycled and in the end, it becomes a plastic bag. These bags are sometimes misused for the packaging of food in certain countries like Indonesia. That's why there is an urgency of another effective solution for this.

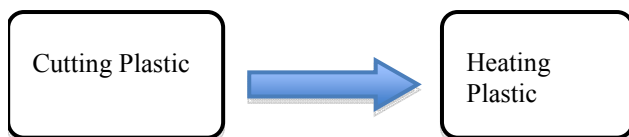
One of the most promising solution is by mixing it with asphalt, becoming asphalt modifier. Asphalt modifier is a substance that is able to mix homogeneously with asphalt usually to change it's characteristics and improve it's performance. Previous experiments[1] has been conducted using various types of polymers. This research utilizes plastic bags as the most dangerous form of plastic.

These days, roadways are crucially needed especially by developing country's which it's infrastructure depends heavily on road transportation. This solution will be highly demanded by developing country's indeed.

A few questions to find out whether this can be a solution are; can it work? If it works, what's the maximum proportion to achieve optimum asphalt performance, and what type of road does it qualify. These questions can be found out through the following methods.

## 2. Method

The experiment is done by comparing the performance of the widely used normal asphalt and plastic modified asphalt. The comparison is done in asphalt phase and asphalt mixture phase. Four parameters are taken for asphalt phase which are; ductility, penetration rate, softening point, and loss of weight. As for asphalt mixture phase, only marshall stability test is used. The samples production can be seen through the process below;



## 3. Results and Discussion

The mix shows a homogeneous result. The comparison of performance between normal asphalt and plastic asphalt can be seen from the table below.

Parameter	Method	Normal	Modified
Flexibility	Ductility test	>140 cm	20.75 cm
Binding Power	Penetration Rate test	63.4 mm	47 mm
Temperature Resistance	Softening Point test	48°C	60.2°C
Light Oil Content	Loss of Weight test	0.4%	0.0001%
Strength	Marshall test	50.33kg/mm	47.6kg/mm

Table 1. Performance Test Results of Plastic Asphalt

Results show that Plastic-Asphalt has less flexibility and strength but it shows higher resistance to temperature than normal asphalt.

## 1 Conclusion and Recommendation

According to the results, it is concluded that it works and may become a very promising solution to tackle the plastic waste problem. The best proportion is 4% of plastic weight compared to asphalt's weight and although it wouldn't fit for highways, it can still be used on provincial and local roads.

For the future, there should be discovered a new substance to improve the asphalt's flexibility so it would fit the criteria of a flexible pavement. There should also be found a way to dilute the plastic easier in asphalt since it takes a long process.

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# The Utility of *Salacca zalacca* Waste as Alternative Fuel

Adis Pranaya Yakin, Fransisca Romana Betty

*Stella Duce 1 Senior High School*

## 1. Introduction



Yogyakarta, Indonesia is widely known as the largest snake fruit production, so there will be many snake fruit wastes in every snake fruit season. But the problem is snake fruit has two kinds of parts, the first part is the wet part and the second part is the dry part. This research is used to investigate the best way to reprocess snake fruit waste so it can be useful for communities. Snake fruit that being used is snake fruit from Yogyakarta.

## 2. Content

### 2.1. Purpose

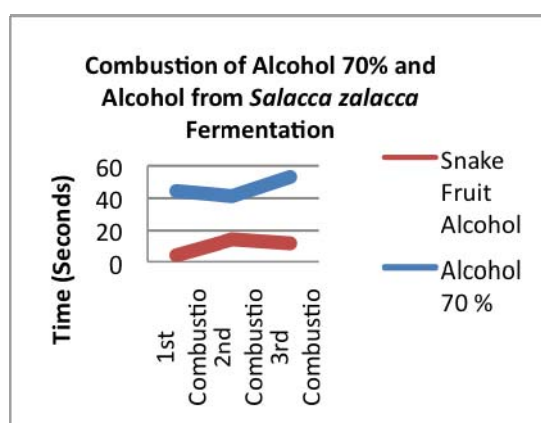
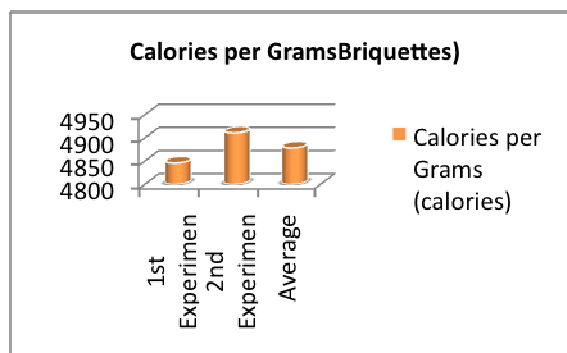
This Research is made to find out the best way to reprocess snake fruit waste in Yogyakarta. Based on the previous research, the products are still not qualified, so using this experiment people can know about snake fruit usages and use it directly.

This product is zero garbage product so it will not produce other waste.

### 2.2. Methodology

This research was done qualitatively and quantitatively, qualitatively by comparing the quality of the briquette, liquid smoke and also the bio-methanol from snake fruit waste with other products that can be used with the same function like this research's products. Quantitatively by comparing the result of respondent, time to stay flaming from briquettes and bio-methanol, and also the liquid smoke's contents.

## 3. Result



## 4. Conclusion

There are three kinds of methods that can be implemented to reprocess snake fruit waste, like using the pyrolysis machine to make briquettes and liquid smoke, and also making bio-methanol from fermentation process. But the best way to reprocess snake fruit waste is making it to be liquid smoke, because it is high economical value.

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# Photovoltaic efficiency of newly designed a dye-sensitized solar cell assembled with graphene/TiO<sub>2</sub> electrode

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## 1 Introduction

In order to enhance the photovoltaic efficiency, electrons, which are transferred from the LUMO of dye molecules, should be accepted easily and donated to the external surface of the semiconductor film. To promise electrode with good electron capturing and donating properties, this study therefore introduce graphene into the TiO<sub>2</sub> nanomaterial for application to DSSC. Graphene has high electron mobility and low resistance, so it may help to improve efficiency.

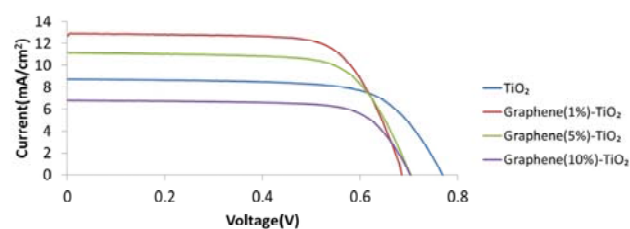
## 2 Materials and Methods

TiO<sub>2</sub> is synthesized using a common solvothermal method [3]. Titanium isopropoxide (TTIP) is used to main solute ingredient. Graphene is synthesized using Hummer method from Graphite [4]. To use as an electrode in DSSC, the graphene and TiO<sub>2</sub> were mixed physically. To prepare the graphene/TiO<sub>2</sub> thin film, a paste was produced by mixing 2.0 g of nanometer-sized TiO<sub>2</sub> powders and graphene 1, 5, and 10 wt% corresponds to TiO<sub>2</sub> weight with a mixture consisting of 5.0 g of  $\alpha$ -terpinol, 0.5 g of cellulose, and 20 ml of ethanol, after sonication for 24 h at 1200 Wcm<sup>-2</sup>. A graphene/TiO<sub>2</sub> film was fabricated by coating onto an FTO conducting glass plate using a squeeze printing technique. The film was treated by heating at 450 °C for 30 minutes to remove the additives. For DSSC manufacture, the prepared thin film electrode was immersed in a 3.0x10<sup>-4</sup> M N719 dye solution at room temperature for 2 h, rinsed with anhydrous ethanol and dried. A Pt-coated FTO electrode was placed over the dye-adsorbed graphene/TiO<sub>2</sub> electrode, and the edges of the cell were sealed with a sealing sheet (PECHM-1, Mitsui-Dupont Polychemical). The redox electrolyte consisted of 0.5 mol KI, 0.05 mol I<sub>2</sub>, and 0.5 mol 4-tert-butylpyridine as a solvent.

## 3 Results and discussion

Figure 1 shows the photocurrent-voltage curves of pure TiO<sub>2</sub> and graphen/TiO<sub>2</sub> films. The film thickness was in the range of 8.0 ~ 10.0  $\mu$ m and the unit cell area was fixed with dimensions of 5.0 mm x 5.0 mm. A DSSC assembled with pure TiO<sub>2</sub> had a V<sub>oc</sub> of 0.77 V and a J<sub>sc</sub> of 8.70 mAcm<sup>-2</sup> at an incident light intensity of 100 mW/cm<sup>2</sup>. The power conversion efficiency was 4.46% for the pure TiO<sub>2</sub> anatase structure, but increased to 6.03% in the DSSC made from 1.0 wt-% graphen/TiO<sub>2</sub> film, with a J<sub>sc</sub> of 12.89 mAcm<sup>-2</sup>. On the other hand, the efficiency was slightly reduced in the DSSC made with a graphene content > 1.0 wt-%, which

confirmed that graphene/TiO<sub>2</sub> is a better material in DSSC than pure TiO<sub>2</sub>.



Sample	V <sub>oc</sub> (V)	J <sub>sc</sub> (mA/cm <sup>2</sup> )	Fill factor	Efficiency (%)
TiO <sub>2</sub>	0.77	8.70	0.67	4.46
Graphene(1.0 wt-%)-TiO <sub>2</sub>	0.68	12.89	0.69	6.03
Graphene(5.0 wt-%)-TiO <sub>2</sub>	0.71	11.15	0.66	5.18

Fig. 1 Photovoltaic efficiency of DSSC assembled with Graphene/TiO<sub>2</sub> electrode.

## 4 Conclusion

Graphene/TiO<sub>2</sub> film was prepared to enhance the solar energy conversion efficiency. In comparing the performance with that of pure TiO<sub>2</sub>, the 0.1 wt-% graphene/TiO<sub>2</sub> DSSC showed superior solar energy conversion efficiency. This confirmed the easy electron transfer over the graphene/TiO<sub>2</sub> surface, the significant flow amounts, and the capability of the graphene/TiO<sub>2</sub> to enhance the photocurrent and powder efficiency of DSSCs.

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# Invasive plant (boxelder maple) EXTRACTS implications for NITELLOPSIS obtusa cells and test

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## 1. The relevance

One of the greatest contemporary threats to biological diversity is the penetration of alien species. Some species, was to become the new environment, it becomes invasive - resulting in severe ecological, economic problems. Alien plants are entering into a new environment quickly multiply and grow as stelbia indigenous plant species. Invasive plant species are changing species composition of plant communities.

## 2. Introduction

Global environmental change, including climate change and anthropogenic influence, to promote biological invasions. Aggressive species, potentially threatening the stability of the local ecosystem, including the first - boxelder maple (*Acer palmatum*).

Invasive species in ecosystems is physical and biological structure of the biogeochemical cycles of matter, nutrient metabolism. Together they form a competition to native species, especially black alder (*Alnus glutinosa*).

## 3. Hypothesis

Nitellopsis obtusa cells ecotoxicological test results show that invasive plant extracts more toxic than native plants.

### 3.1. The aim

Investigate Nitellopsis obtusa cellular processes change the effect of invasive plant extracts.

- Learn about plant invasiveness problem in Lithuania.
- Investigate Nitellopsis obtusa cells as a marker for invasive plant extract on.

### 3.2. Material and methods

Invasive plant species - the boxelder maple extract the effect of cell mortality Nitellopsis obtusa.

The aim of - the letaliąją concentration (LC50), which toksikanto (in our case, invasive plant *Acer palmatum* L. leaf extracts) concentration that produces 50% of testuojamų cell death.

### 3.3. Objects

Ekotoksigologinis maurabraginis algae bio indicators (Nitellopsis obtusa);

Invasive plant boxelder maple (*Acer palmatum*)

Native woody plant - black alder (*Alnus glutinosa*).

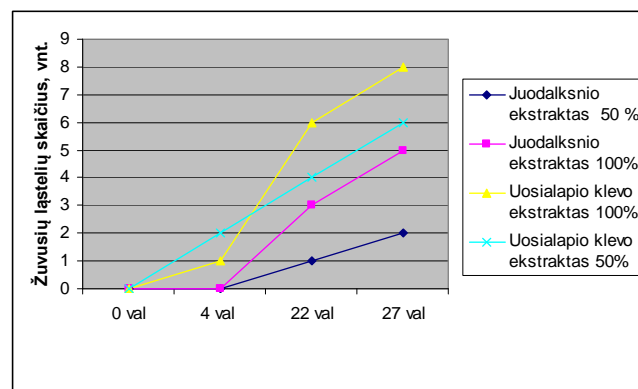
### 3.4. Preparation of leaf extracts

Mimic the boxelder maple and alder leaves leaves nuokritų access to natural water courses, laboratory tests were taken the water - the lake water Obelijos litoralinėje in conjunction with the built in mikroorganizmams. Phytoplankton and zooplankton were removed by filtering lake water through the tanks malūninių quadruple folded silk.

Leaf destruction of biological experimental studies carried out in three sealed 35 l containers: Option 1 - 20 l Obelijos lake water, version 2 - 20 l Obelijos lake water + 200 g of air dried alder leaf mass, Option 3 - 20 l Obelijos lake water + 200 g of air dried boxelder maple leaf mass. Biodegradation of extracts prepared by keeping containers in the dark for 90 days, maintaining the temperature at 11-12 ° C range. During the experiment a daily water all variants have been aerated. (~ 1.5 hours)..

## 3.5. Diagrame

All N. obtusa cells 27 hours-long experiment has gone through the control of artificial pond water, 50% of the extract on alder died only two cells, and boxelder maple 50% of the extract on six cells. From Table 7 and Figure 10 of the submitted data, the boxelder maple leaf extract has a potential impact on the algal cells. 100% of the boxelder maple extracts in 27 hours. 8 led to cell death, while over the same period, alder leaf extract on the same time killed 5 cells. Set LC50 alder leaf extract 100% of the daily, boxelder maple and 50% for the day.



## 4. The test findings

From the above results we can draw the general conclusion that the boxelder maple leaf extracts are more toxic than the local alder gėlavandeniam maurabraginiam Nitellopsis obtusa algae, which are bio indicators of pollution of waters.

Our hypothesis: Nitellopsis obtusa cells ecotoxicological test results show that invasive plant extracts more toxic than native plants, confirmed our proposed bio indicators Nitellopsis obtusa lethal toxicity of the test reflected the media.

## 5. Recommendations

Studies have shown that pasirinktosios methods are adequate to evaluate Nitellopsis obtusa cell processes change the effect of invasive plant extracts.

Nitellopsis obtusa cells ecotoxicological tests have shown that invasive plant extracts more toxic than native plants. The proposed bio indicators Nitellopsis obtusa lethal toxicity of the test reflected the media and is suitable for freshwater toxicity assessment.

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# Crystal Pyro-Carbon

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## 1 Introduction

In our world today, agriculture is getting more advanced in so many ways. Agriculture is mostly found in rural areas. Agriculture pollutes the river in the rural area with animal faeces. The faeces will eventually increase the biological oxygen demand and chemical oxygen demand. The project called 'crystal pyro-carbon' that had been created can solve the problem.

## 2 Purpose of investigation

The purpose is to help the rural area to overcome the problem they face with the effects of. It is also to inform farmers on how to manage the waste product from their agriculture activity. Moreover, it is used to clean the polluted environment to make it a better place.

## 3 Method of investigation

Crystal pyro-carbon can reduce biological oxygen demand and an experiment is conducted. The manometric method is used. The sample is kept with a substance that absorbs carbon dioxide in a sealed container. It also can reduce chemical oxygen demand. The COD test is to measure the amount of organic compounds in the water. Potassium permanganate ( $\text{KMnO}_4$ ) is used to measure COD. Significant COD of the polluted water is needed for the experiment. Total suspended solid can also be reduced. A significant amount of TSS the polluted water is needed for the experiment. TSS of a water sample can be determined by pouring a carefully measured volume of water through a pre-weighed filter of a specified pore size. Then, the filter is weighed again after drying. A dry weight measure of the gain particulates present in water, all of it is filtered by manipulating before and after.

## 4 Results

Based on the experiment, crystal pyro carbon is used in treating polluted water from a pig farm. The experiment is conducted to investigate the effect of pyro-liquid as shown in Fig. 1 if super activate carbon is immersed in the water treatment. Super crystal carbon that is immersed with pyro-liquid is more effective in reducing the pollution of water.



Fig.1 Pyro-liquid

When crystal pyro-carbon is used, biological oxygen demand (BOD), chemical oxygen demand (COD), and total suspended solid (TSS) is reduced. The water pollution level drops drastically when super active carbon as shown in Fig. 2 is immersed with pyro-liquid. It is about 54% drop in difference. For TSS, crystal pyro carbon is 56% more efficient than super active carbon. It will be more positive reading in larger scale.



Fig.2 Super active carbon

## 5 Conclusion

In conclusion, we have observed that if super active carbon is immersed with pyro-liquid the result will be increase to 50%. The hypothesis is accepted if crystal pyro carbon is used, then BOD, COD and TSS can be reduced.

# Birds of Prey affected by deforestation

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## 1 Introduction

Taking into consideration that up to the mid-nineteenth century in Fizeş Plain there were nested species such as: *Gyps fulvus*, *Aegypius monachus*, *Aquila heliaca*, *A. crysaetos*, *Falco peregrinus*, *F. vespertinus*, *Neophron percnopterus*, *Bubo bubo*, *Strix uralensis*, *Glaucidium passerinum* and that these species do not exist any more due to the anthropogenic impact that the ecosystems suffered in the area, this study will help prevent the extinction of birds of prey which are now present in Fizeş Plain.

## 2 The purpose of the investigation

To prevent the extinction of the birds of prey which can be found in Fizeş Plain due to the anthropogenic impact.

## 3 Method of the investigation

In order to achieve the objectives of the project, several different activities were accomplished. In addition to the documenting activities, the birds of prey from Fizeş Plain were monitored during October 2010-May 2011. The experimental work of the project involved laboratory investigation of *Athene noctua* and *Asio otus* ingluvies.

## 4 Result of the experiment

The research revealed that from 1870 until now, 7 species of day birds of prey from the Fizeş Plain and 3 species of night birds of prey have disappeared.

This is due to the massive deforestation that led to the fragmentation of forests, lakes transformation in ponds, the spreading of agricultural lands, the use of pesticides and not least poaching. Located in the top of trophic pyramid and also being indicators of biodiversity, the ingluvies of night birds of prey allowed us detailed appreciation of the food consumed. In the ingluvies that were analyzed, we found 30 skulls of rodent mammals, limb bones, feathers, hair, chitin. The maximum number of skulls found in one ingluvie was four.

## 5 Conclusion

At the end of this study we concluded that conservation activities in Fizeş Plain should be improved. Following the project, the collaborators from „Babeş Bolyai” University contacted the authorities and at the end of May, Fizeş Plain was declared Nature Reserve.

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# The level of carbon dioxide in classrooms

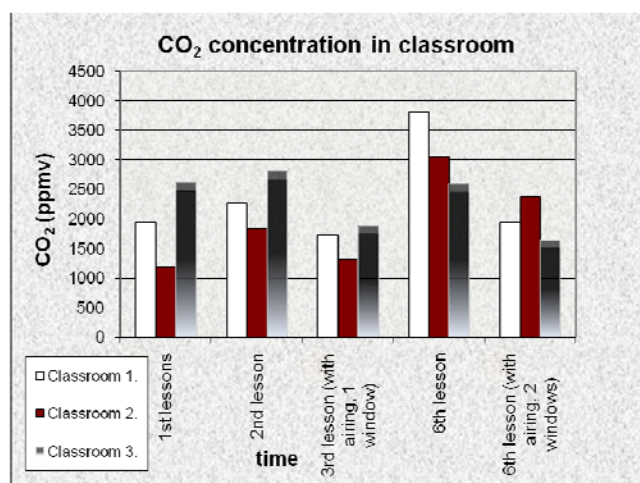
Jánosi Zsuzsa-Anna, Kovács Zsolt  
*Apáczai Csere János High School*

## 1 The purpose of investigation

It is a well-known fact that carbon monoxide is a hazardous gas, because it hinders the body's oxygen intake and supply. But only a few know that carbon dioxide can also be harmful. As students, we spend most of our time sitting in the classroom. In many cases, there are more than 25 children crammed into a room. If we do not air the room, the carbon dioxide concentration is gradually increasing. The purpose of our investigation is to prove how important it is to air the classrooms. As a fact, we know that carbon dioxide colourless and odourless gas, which is component of the air, it contributes to global warming and it can also be dangerous to our body since it reduces neuronal function, it makes us sleepy, and in larger quantities it causes headache, dizziness, acceleration of respiration, unconsciousness. Starting from this, we decided to measure the carbon dioxide level in different classrooms and then to compare the results. We spend 80 percent of our lives in enclosed spaces. According to American statistics, the maximum carbon dioxide concentration in an enclosed space is 1000 ppm. Ppmv is an abbreviation for parts per million volume, a subunit of ppm that is used for parts of volumes like milliliters per cubic meter ( $\text{ml}/\text{m}^3$ ).

## 2 Method of investigation

For the investigation, first we bought six jars with identical caps. Then, we made a hole in each cap, so we could plug a cork into it. We insulated the hole, so when we put the probe into the jar, there was no loss in carbon dioxide. We made several measurements in different classrooms, and on different floors and at different times. During each measurement we placed an open jar into the room/corridor/yard, and after an hour we closed the jar. After that, we measured the carbon dioxide level with the help of an GLX Xplorer (made by Pasco), which showed the carbon dioxides level in the jar. Finally, we compared all the obtained results and summarized them in tables and diagrams.



## 3 Conclusions

Several conclusions were drawn:

- The open air carbon dioxide level depends on the weather and the period when the measurements took place. In the morning, the carbon dioxide concentration is higher, because most of the people go to work or school by car or public transport. These vehicles emit carbon dioxide which significantly affect the quality of the air. In cities the carbon dioxide concentration level is higher than in the countryside (in cities 900+ ppm, in the countryside 500-600 ppm).
- Airing can improve the air quality of closed spaces only if the outside carbon dioxide concentration is lower than the inside concentration. So the best way it would be to have an energy-saving approach.
- Based on the indoor measurements, it can be said that it is necessary to ventilate every two or three ours, otherwise it may lead to the reduction of our intellectual performance, which we can experience during Maths, Chemistry and Physics classes.

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# An Eco-Building functioning plan

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## 1 Introduction

The aim of the research paper *An Eco-Building Functioning Plan* is to show the assembly of modern technology in a building. With some small adjustments this type of building can very easily be used for settling a new planet.

The biggest advantage of this building is that it is viable when it comes to energy and utility needs and can provide housing for a large number of people, 3600-4600 inhabitants, in the narrow space of 250m x 250m. Within the building, apart from the residential area, there will be shopping malls, recreational centers, as well as state institutions, emergency clinic, educational centers...

All these characteristics embody the perfect building of the future since the earth is becoming overpopulated and we need a solution for the comfort of a large number of residents in a small space (it is estimated that by 2050 there will be more than 9 billion people on the earth).

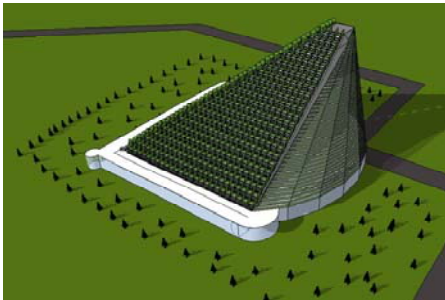


Figure 1 - East view of Eco-building

## 2 Method

For this project I needed thorough data processing. The eco-building consists of several smaller facilities. While designing the project and layout of the building, I had to make sure it looked modern, could perform the given function and that its construction would be feasible. As the building is ecological, it must have renewable energy sources (in this case I have opted for solar power because Malta was chosen as the place for the construction and data processing) and must not contain any polluting and potentially dangerous substances.

## 3 Results

These projects are very ambitious, expensive, but also profitable. However, my project is far more feasible, as it is of a smaller scale and less expensive. The construction would cost about \$1,4 billion, the profit would be 10% and up (profit is calculated according to the market value of m<sup>2</sup> in Malta). Due to the large number of solar collectors and

photovoltaics the building will be a power plant and heating plant as well. During the day, the building will produce more electricity than needed for consumption, and the excess energy will be sold to the city electricity network, and when the sun goes down, the electricity will be purchased from the network.

For managing these operations I have chosen a central computer in the building which has subunits in every facility within the building. The computer controls the power consumption. At any time the user can check the consumption and will be able to see if it exceeds maximum and how much electricity is sold / purchased.

In addition, the installed system would control protective systems (alarms, entrance surveillance...). The biggest advantage of the analyzed system is the reduction of electricity consumption, as it is also connected to the lighting. Lights are turned on by the sensors when someone enters the room, and are turned off when everyone goes out. The system would be connected to the heating bodies as a kind of protection since it would turn them off in case of overheating. Apart from that, the system would control the room temperature. Heat pumps pump hot/cold water in the pipes depending on the need for heating/cooling (the pipes would be located in the walls, which is healthier and more efficient). If all the facilities devices and equipment were connected with this system, an incredible amount of energy would be saved and the building would be even "greener". In addition to all the ecological components, I had to take care of the regular security systems and anti-fire systems and fire stairs, which would be located at every 50 meters. Safety is always in the first place.

Apart from that, each flat would have its own garden (40m<sup>2</sup>), so the residents could stay in touch with the nature.

## 4 Conclusion

Projects price is high, but their cost effectiveness and all the benefits they offer are incredible. They can improve the quality of life for years to come. All this is aimed at preserving the environment for the future generations.

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# Synthesis of new acceptor materials for organic photovoltaics

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## 1 Purpose

Nowadays, the rapid depletion of conventional energy resources, such as fossil fuels, population, and increasing energy need, has led renewable energy resources to produce. The necessity of research in the use of renewable energy as gained center stage due to world's future energy problems. In addition to wind, rain, tides and geothermal heat; sunlight is a natural resource generating energy. Active layer of organic solar cell (or organic photovoltaic) (OPV) converts light to electrical energy directly. Despite the inorganic materials, organic materials are abundant, easily handling, low cost and easy to be produced. In this project, It is aimed to synthesis of a new n-type organic molecule based on perylene diimide with high electron withdrawing cyano moieties for OPV applications and fabrication of OPV with this new photo sensitizer. According to the purpose:

- Determination of organic matter synthesise
- The synthesis of organic matter
- Synthesized in an organic solar cell made with organic matters.
- AFM surface morphology of organic solar cells with the measurement of each stage of production
- Measurement of electrical properties and the calculation of the efficiency of organic solar cells produced
- P3HT organic solar cell production with a second
- Organic solar cells made with the synthesized substance, was to compare the electrical properties of P3HT solar cell.

## 2 Method

Material derivative of the first stage diimide perylene (cPDI) were synthesized in three steps. In primary care, perylene-3,4,9,10-tetracarboxylic acid in sulfuric acid bisanhydrit / oleum mixture is made in the bromination reaction. In the next step, obtained from 1,6,7,12-Tetrabromoperilen-3,4,9,10-tetracarboxylic acid and propionic acid bisanhydrit imitlenme reaction was performed using a microwave. Finally, from the second step, N, N'-di (2-ethylhexyl) - 1,6,7,12-Tetrabromoperilen-3,4,9,10-tetracarboxylic acid in DMF and cyano groups with bisimide perylene diimide derived material was obtained.

Then, the solar cell applications heterojunction structure and volumetric solar cells produced was started. Al / LiF / P3HT (Poly (3-hexylthiophen-2,5-diyl)): PCBM (C61-phenyl-butyric acid methyl ester) / PEDOT (poly (3,4-ethylene dioskitiofen)): PSS (poly (stirenesulfonade)) / ITO and Al / LiF / P3HT (Poly (3-hexylthiophen-2,5-diyl)): cPDI / PEDOT (poly (3,4-ethylene dioskitiofen)): PSS (poly (stirenesulfonade)) / ITO configuration, solar

cells are manufactured under the same conditions. Post-production, films, surface analysis and performance analysis of photovoltaic solar cells, respectively, AFM (atomic force microscope) and the solar simulator (AM 1.5) is made with. According to the analysis of photovoltaic performance obtained, is used as a standard P3HT: PCBM solar cell with an active layer of 1.33% of yield, while the P3HT: cPDI with an active layer of the solar cell is The yield of 0.89%.

## 3 Results

The comparison of photovoltaic performances of both devices, PCBM and Perylene diimide, is demonstrated. The illuminated current-voltage characteristics demonstrate that no failures are made in contacting the devices with the probes, and both are working obviously. The extracted power conversion efficiency of the device with P<sub>3</sub>HT: PCBM is 1.33 %. This result is the highest obtained efficiency for all our devices which is also due to the large FF factor of 41 %. However devices with perylene diimide have smaller FF of 35 % and also a poor power conversion efficiency of 0.89 %. For comparison, these values are summarized in table 4.1

Sample	Isc [mA/cm <sup>2</sup> ]	Voc [mV]	FF	Efficiency [%]
P3HT: Perylene	3,78	680	0,35	0,89
P3HT: PCBM	4,4	750	0,41	1,33

Table 1. Comparison of photovoltaic performance of P3HT: PCBM and P3HT: cPDI

## 4 Conclusion

Organic solar cell made of two. Post-production, films, surface analysis and performance analysis of photovoltaic solar cells, respectively, AFM (atomic force microscope) and the solar simulator (AM 1.5) is made with. According to the analysis of photovoltaic performance obtained, is used as a standard P3HT: PCBM solar cell with an active layer of 1.33% of yield, while the P3HT: cPDI with an active layer of the solar cell is The yield of 0.89%.

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# Effects of technologic devices to Ozone

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## 1 Purpose

Today, mankind with the developing technology has negative effects on the world. The most vital thing of these are climate change and global warming. These technological developments affects the ozone layer negatively. In this project we aimed to inform people by investigating the harmful ozone produced by technology now used in many electrical appliances to be used more consciously. To do this, we obtained information about ozone, ozone layer and ozone types, searched benefits and harmful effects of ozone and detected ozone-emitting electronic devices respectively. In order to detect harmful ozone produced by devices, we prepared a solution using Sodium Iodide and distilled water. The filter papers were dipped in to solution which we have previously prepared and later the filter papers were placed near electronic devices periodically and the color changes were observed. We aim to raise awareness of community about the thinking of the future of our world with our work when using electronic devices.

In this project, we intended to determine bad ozone emitting technological tools and wanted to inform people for a more conscious use of many electrical appliances. We needed to perform an experiment to determine the effect of these technological tools to the ozone layer. Later we have set a hypothesis before the experiment.

The most radiation emitting three technological tools which we expect in our hypothesis are:

1. Desktop PC
2. Mobile Phone
3. Microwave.

## 2 Method

A saturated solution was prepared by mixing Sodium Iodide and distilled water. For this, Iodide was added into the distilled water in soluble amount.

Mixture was cooled and sedimentation of a small amount of sodium iodide was observed.

Previously prepared Filter paper was dipped into saturated solution obtained.

Wet filter papers were placed next to the specified electronic equipment and the color changes of dry filters were observed at 10-20-30-60 minutes respectively.

Observation notebook was noted, photos were taken.

Tables were prepared according to the observations.

## 3 Results

We observed the filters at 10, 20, 30 and 60 minutes and noted our observations.

To avoid from the negative effects of technological devices:

- Technological tools can be used within a shorter period of time.
- Television and other remote controlled devices should be turned off using their own on/off buttons.
- Television and other watching devices should be watched from a long distance.
- All the electronic equipment should be pulled off when not in use.

## 4 Conclusion

Long-term use of electronic devices which emit radiation produces harmful ozone around themselves. This ozone causes air pollution and creates greenhouse effect. It also has a negative influence on human health. Therefore, these devices should be kept in off mode and they should be used for in a limited period of time.

The most ozone producing devices to their environment:

1. Desktop Computer
2. Microwave
3. Mobile Phone

## References

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# Toxicity evaluation of oil polluted soils by sensitive test reactions of fitoremediants

Borsuk Halyna

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## 1 Introduction

A problem of oil contamination is one of the most pressing and major nowadays. Complexity of the problem is not only in the scale of oil spills, but also in development of criteria of estimation and methods of liquidation of consequences of this inconstant, of its structure, pollution. Priority researches are the ones on finding test systems that will provide an opportunity to estimate combined influence on environmental pollutants on human health and biota. On this behalf plant test systems have significant advantages opposite to devices, they are cheap, easy to reproduce, multiply rapidly, have the typical reaction to the impact. Plants can be considered the most convenient objects for biomonitoring of soils. Simplicity of account of effects and interpretation of results, their sensitiveness and producibility makes the use of plant test systems for the diagnosis and assessment of toxicity of oil polluted soils appropriate [1,2].

## 2 Research procedure

### 2.1 Purpose

The aim of this project is the studying of sensible reactions of fitoremediants for the actions of pollution of soil by oil with further prognostication of efficiency of their application for renewal, fitoindicacion of muddy oil soils territories.

We put some tasks:

- To investigate the influence of oil on likeness of seed and morphometric indexes of plants *Vicia faba* L.
- To learn sensible reactions of test of *Carex hirta* L. and *Vicia faba* L. at influence of contamination of soil by oil: parameters of growth of plants, state of stomating apparatus leaves, symptoms of damage and other like that.
- On the basis of the obtained data, to estimate efficiency of application of plants for fitomonitoring of muddy oil territories.

**Objects of the researches :** *Carex hirta* L., *Faba bona* Medic. (*Vicia faba* L.), *Ginkgo biloba* L., *Avena sativa* L., *Linum usitatissimum* L.

### 2.2 Methods of work

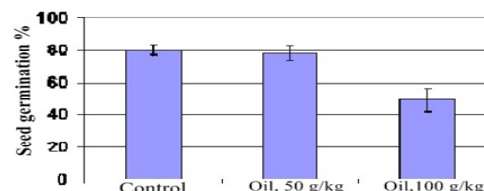
Experiments were held in laboratory and field conditions. In bowls with soil oil in an amount 50 and 100 g of oil brought in crude oil on 1 kg of soil. We landed vegetative plants of *Carex hirta* L. and *Vicia faba* var. Minor after 4 weeks of bringing of oil in soil, we wet *Vicia faba* var. Minor in water for 15 hours. Control - plants are grown on an environmentally clean soil. We determined seed germination over 10 day and in *Carex hirta* L. After 50 days we: determined seed germination, growth indicators, breathing apparatus, system, symptoms of leaves damage.

## 3 Results

For the first time the impact of oil on the nature of the upper leaf pubescence of *C. hirta*: in oil-contaminated areas the forms with smooth and not pubescent leaves with glossy upside, and in control areas – leaves are pubescent and have a matte upside; and in experimental plants of *C. hirta* the anomalies in the formation of breathing apparatus (merger of two-three breathing apparatus) were observed, while in the the leaves of *V. faba* such anomalies were not observed.

During the oil contamination of soil (50 g / kg) the number of breathing apparatus on the side of the leaf of experimental plant increased, particularly in *V. faba* almost 43% increased, and in *C. hirta* - 13% in relation to control. However, during the action of strong oil contamination (100 g / kg soil), the decrease of the amount of breathing apparatus per unit of the leaf area was observed: in *V. faba* by 18% in *C. hirta* – by 15% in relation to control.

A direct relationship is found between the quantitative value of oil in the soil (50 and 100 g / kg) and growing rates of plants *C. hirta* and *V. faba*: the height of upper ground part, the root length, the size of the cabbage plates of experimental plants directly proportional to decreasing with increasing concentration of oil in the soil. For the actions oil contamination of soil the growth parameters plants of *Ginkgo biloba* L., *Linum usitatissimum* L., *Avena sativa* L. went down in 2-4 times accordingly in relation to control.



## 4 Conclusions

Investigated test reactions fitoremediants (seed germination, growth indicators, breathing apparatus system, symptoms of leaves damage) should be used when fitoremediation of oil polluted areas, and plants *C. hirta* and *V. faba* - to restore the oil polluted soils. But plants: *Ginkgo biloba* L., *Linum usitatissimum* L., *Avena sativa* L. are proof to petroleum contamination, that we can not recommend them restore soil.

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# Investigation of caffeine sources in surface waters in urban areas (on a base of Kharkiv city example)

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## 1 Abstract

Caffeine is a natural substance that presents in such plants as cacao tree, tea, matte, and many others. On other hand it is very popular substance among people - caffeine-contained products are consumed mostly at every home.

But what its presence in environment and namely surface waters can tell about? What are main urban source of caffeine in surface waters?

## 2 The purpose of investigation

To consider caffeine as one of the indicators sewage pollution in large cities and to analyze its major urban sources.

## 3 Theoretical part

- Literature analysis on the research topic with special attention on potential man-made sources of caffeine in surface waters in urban areas.

## 4 Experimental part

- Identification and systematization of natural and man-made sources of caffeine in surface waters in urban areas on the example of Kharkiv city.
- Analysis of caffeine-contained products consumption in urban areas on the example of Kharkiv city (questioning)
- Assessment of caffeine contamination of urban rivers on a base of experimental data.

## 5 Method of the investigation

Comparatively-descriptive method, experimental method

## 6 Results

Map of caffeine sources for surface waters within Kharkiv city has been design on a basis of identification of all possible sources of caffeine. Among main sources of rivers pollution are population, industry and hospitals.

The annual average level of caffeine consumption in Kharkiv region is 4000 gm per person, means it is quite high.

Kharkiv city rivers annually receive 50 mg of caffeine from sewage systems. Since caffeine is one of the best indicators of domestic sewage pollutions the results are interpreted as that Kharkiv surface waters are significantly polluted.

## 7 Discussion

Perspectives of environment contamination by caffeine for evaluation of general level of pollution by domestic sewage.

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# LIFE SCIENCE



**Radboud University Nijmegen**  
The Netherlands 2012



# Deactivation of the hormone IGF-1 of bovine milk

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## 1. Introduction

This paper is the actuation analysis of the treatment of sodium hydroxide and elevated temperature as deactivators of the IGF-1 hormone in bovine milk. This deactivation is necessary due to the high protein content in the milk, that by accumulating in the human being bodies, by ingestion of dairy products, stimulates an increased cells proliferation and apoptosis inhibition, causing the appearing of cancer cells [1, 2, 3].

## 2. Method of the investigation

Using as independent variables the sodium hydroxide, that acts as denaturing agent of some proteins, the temperature, as reaction auxiliary [4], and two brands of milk, three dependent analysis where analyzed: the hormone deactivation, treatment applicability in industrial scale and the modification of the milk properties after the treatment. Using as samples UHT milk, type C, integral, the sodium hydroxide concentration ranged from 4 g.L<sup>-1</sup> and 4 µg.L<sup>-1</sup>, and temperatures between 20 and 190°C. The reaction of deactivation employed can be seen in FIGURE 1.

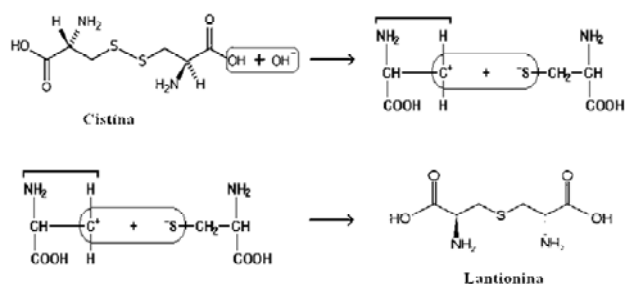


Fig. 1 Reaction of deactivation of the hormone IGF-1

Reference: ABRAHAM, L. et al.. Tratamentos estéticos e cuidados dos cabelos: uma visão médica (parte 2), 2009.

## 3. Results of the experiment

A deactivation of 99,35% was found, through radioimmunoassay, using the treatment with 3,5 mg.L<sup>-1</sup> of sodium hydroxide and temperature of 130°C. After that, the properties of the milk after the treatment were analyzed. The pH was measured, as well as dry extract, sensory properties and others, and none of them showed significant changes. In the analysis of industrial applicability of this method, it was possible to assess that, for its simplicity, this treatment would cost less than \$ 0,01 per milk liter.

## 4. Conclusion

Through of the obtained results, it is possible to conclude that the indicated treatment is efficient in the hormone deactivation, does not modify the milk properties and has easy and cheap industrial applicability. If applied, this project will influence in the decreasing of the overall mortality of human being by several types of cancers and will help, significantly, in the minimization of the expenses with the public health, considering the high consumption of dairy products around the world.

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# Analysis Report of Questionnaire on How much the secondary and university students know the earthquake self-help knowledge

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## 1. Introduction

China, one of the world's most earthquake-prone countries, experiences an average 145 magnitude-4 earthquakes on the mainland annually.

The 2008 Sichuan earthquake, magnitude 7.9 Mw, occurred at 14:28:01.42 CST (06:28:01.42 UTC) on 12 May 2008. Sichuan earthquake death toll exceeds 12,000.

On April 14th, residents of China's remote Yushu County, located on the Tibetan plateau, were awoken by a magnitude 6.9 earthquake. In the sparsely populated villages and the larger town of Gye gu, thousands of wood-earth buildings collapsed and many larger structured heavily damaged or destroyed.

Japan was struck by a magnitude 7.9 earthquake off its northeastern coast on March 11, 2011, shaking buildings in Tokyo for several minutes and prompting a tsunami warning.

With the occurrence of Wenchuan Earthquake, Yushu Earthquake and the Japan Fukushima Earthquake, how to save ourselves during the earthquake has been a hot spot. Most of the schools have taught students self-help knowledge. Then we have to ask: Is the knowledge school taught us all correct? How much do the students remember after the universal education of the earthquake self-help knowledge? Therefore, I handed out the questionnaire.

We can learn form the data that , most of the students know how to protect themselves during the earthquake. However, there are still some questions students don't know the answer clearly.

## 2. Overall Plan

Most of the schools have taught students self-help knowledge. In order to know if the schools taught us all correct, and how much the students remember after the universal education of the earthquake self-help knowledge, I handed out the questionnaire. The investigation total provided questionnaire 230 , took back 228(return rate was 99.1%). Knowing how much the secondary and university students know the earthquake self-help knowledge , so that the schools can arrange the next teaching program accordingly . Find out the mistakes in the teaching, and tell schools to correct them. I want more students to know the correct way to protect themselves during the earthquake .

I asked lots of friends and relatives of mine to help me hand out the questionnaire. Issuing location includes Beijing(Beihang University, The High School Affiliated To Beihang University, Beijing Bayi High School , The

Second High School Affiliated To Beijing Normal University) and Changsha.

The respondents of this survey are secondary and



university students, so I divided them into three parts including 12~15 years old(junior high school students),16~19 years old(senior high school students) and 20 years old and

beyond(university students).

## 3. Summary

1. Most of the students know how to protect themselves during the earthquake pretty well. It shows that since the occurrence of Wenchuan Earthquake, Yushu Earthquake and the Japan Fukushima Earthquake, earthquake self-help has received considerable attention. The work of Schools and society to teach people the knowledge about earthquake self-help has got a good result.

2. Most of the people don't have a Disaster Supplies Kit at home, it's quite dangerous during the earthquake. Schools and society should enhance the propaganda, and tell students the importance of have a Disaster Supplies Kit at home.

3. Most of the students don't know how to protect themselves in the classroom during the earthquake, it is related to the education we received.

4. Most of the people don't know the correct way to protect themselves during the earthquake. In my view , so many people choose the wrong answer, mainly because schools and society haven't taught the students. They didn't pay enough attention on this part, or even overcome it

## 4. Conclusion

With the occurrence of Wenchuan Earthquake, Yushu Earthquake and the Japan Fukushima Earthquake, how to save ourselves during the earthquake has been a hot spot. China is situated between two major earthquake belts — the “Pacific Ring of Fire and “Eurasia Earthquake Zone”, China's seismic activities are quite frequent. So, we have no reason to overcome the earthquake self-help. we should tell more people about the knowledge of earthquake.

# A new type small air cleaner

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## 1. Introduction

Last year, my house was renovated, and the quality of the air was very bad, a bad smell of the lacquer filled the air. The formaldehyde content of the air was so high that it was not fit for live in, and many reports had said that many people caused leucocythemia because they had inhaled too much toxic air. Therefore I came out an idea of making a machine which can clean the air quickly and efficaciously.

## 2. Design

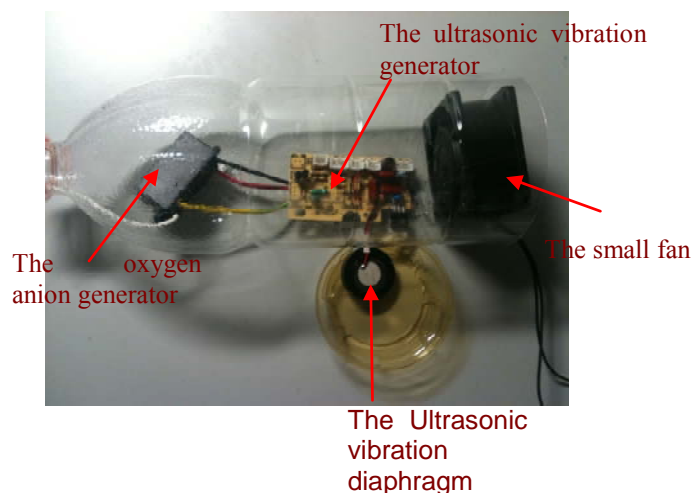
First, I found some kinds of the air-cleaned machines that many people use, but if you forget to clean it, the harmful waste will come out through the air outlet. So, if you stay in this surroundings, you will feel sick soon. So I thought, is there any machine that can only clean the air and without brings any waste? Then I found a matter which is called the “negative oxygen ion”. The winner of Nobel Prize in Medicine, the German Physiological chemist Dr. Schonbein thought it can clean the air and it’s also good for health. And I also find the oxygen anion generator which is a machine that can only produce and transmit the negative oxygen ion without accumulate residue. That is actually what I want. Then I bought an oxygen anion generator, but after a day’s test, the air was so dry that it was very uncomfortable. So I thought could I add a humidifier? But the humidifier that market sells is so big and expensive, so I found out the principle that humidifier works—it’s just an ultrasonic vibration generator that put in the water. Then it can atomize the water. So I bought an ultrasonic vibration generator and made a small humidifier. But strangely, it was not very efficaciously, I was confused so I look up the literature and finally find out the negative oxygen ion will be absorbed if the humidity in the air is high. At last, I changed the area of the ultrasonic vibration generator diaphragm in order to reduce the humidity of the air.

## 3. Implementation

The negative oxygen ion will come out through the oxygen anion generator, and the small fan will blow the negative oxygen ion out. The water vapour will be produced by the ultrasonic vibration generator.

## 4. Results of the experiment

The picture shows the complete machine.



## 5 Conclusion

Through the study this time, the most important thing I have learned is never give up. This is the only way to success. Second, I have learned a new matter and its’ principle. Finally, I have more ways to solve problems.

# Treatment and prevention of children's flat foot

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## 1 The purpose

The goal of this work is to highlight the importance of proper foot arch in case of children. The main part of this project is a proposal of five sets of exercises for children aged 4 to 7 years. These exercises are designed primarily to prevent deterioration of the state modified or healthy arch of the foot, and then secondarily to entertain children and not to become a boring duty. Furthermore, meeting both of these criteria, will be at least partially verified in practice. Lastly, the aim is also to create a manual which presents these sets to the public.

## 2 Experimental methods

Work progress is divided into the following steps:

Step 1: Collect data and information from the literature concerning types of flat foot, its diagnosis, prevention and treatment; anatomy of the foot; phylogeny of leg and ontogeny of foot.

Step 2: Choose exercises that are suitable for the treatment or prevention of flat feet especially in case of children aged 4 to 7 years. Add sets of exercises focusing on proper posture and correct walk – both of these factors are closely related with this diagnosis. Choose exercises not only from books and manuals, but also from own experience – exercises of yoga, thai-chi and qigong. The primary criterion is to organize a set of exercises that will improve the quality of walking and strengthening the arch, the secondary criterion, is to make children enjoy the exercise and not to take it as an obligation.

Step 3: After consultation with a specialist of what exercises to choose, create five sets of exercises suitable not only for children with a diagnosis of flat feet, but also for healthy children - as a preventive exercise of developing this disease.

Step 4: Test sets not only from the purely medical point of view, but also from the point of attractiveness for kids. Consult the effectiveness of exercises with a physiotherapist Mrs. Dagmar Ševcová. Verify the fact that sets are really entertaining in Kramolna kindergarten, where children try to practice these sets.

## 3 Results

Consultations with Mrs. Ševcová were mainly addressed to the suitability of the exercises, which were selected to sets and their probable physiological effects on the child's flat foot. In the final version of this work therefore there are exercises that have been approved by the Expert.

Exercising with children from kindergarten Kramolna was done on 24<sup>th</sup> January 2012. Children practiced exercises with me and the teacher sometimes helped. With the teacher Koubková we ran the same conclusion - exercise is suitable for children. In terms of complexity and attractiveness and fun. The set entertained the children. They had tried to do it very carefully. However, it is important to note that a very important success factor is the motivation of the instructor.

## 4 Conclusion

Exercises have been approved from both perspectives. The sets are suitable for the treatment or prevention of children's flat foot, they are also attractive for children.

# The Dead Sea

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## 1 The purpose of the investigation

This project compares the Dead Sea water, amniotic fluid and Float spas 'salt water. The hypothesis is that the density of liquids helps the fetus to float in the amniotic fluid and humans in the Dead Sea and the Float spas. Next goal is to introduce the Dead Sea and find out people's awareness of the Dead Sea and so called Float spas.

## 2 Method of the investigation

Firstly, I the density of The Dead Sea water and the float spas 'water was measured and the results were evaluated. The density of the amniotic fluid for the project was measured in the University Hospital in Hradec Králové. All the data collected about the amniotic fluid and the Dead Sea were also evaluated.

The project includes a questionnaire with results, measurement graphs, the Dead Sea photographs, photographs of the Masada fortress and the Dead Sea cosmetics. Expert articles about amniotic fluid and the Dead Sea are also a part of the paper together with the float spas leaflets.

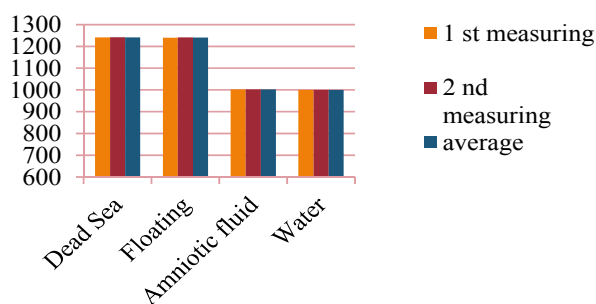
## 3 Results of the experiment

The results of measuring of densities can be seen in the graphs. The rest of the project is rewarding of people's knowledge understanding and images of the Dead Sea and Float spas.

	1 <sup>st</sup> measuring	2 <sup>nd</sup> measuring	average
The Dead Sea	1241 kg.m <sup>-3</sup>	1242 kg.m <sup>-3</sup>	1241,5 kg.m <sup>-3</sup>
Floating	1240 kg.m <sup>-3</sup>	1241 kg.m <sup>-3</sup>	1240,5 kg.m <sup>-3</sup>
Amniotic fluid	1002 kg.m <sup>-3</sup>	1002 kg.m <sup>-3</sup>	1002 kg.m <sup>-3</sup>
Water	1000 kg.m <sup>-3</sup>	1000 kg.m <sup>-3</sup>	1000 kg.m <sup>-3</sup>

Table 1. Measuring of densities

Measuring of density in kg.m<sup>-3</sup>



Graphic 1. Measuring of densities

## 4 Conclusion

The Float spas 'water has the same density as the Dead Sea water and it helps humans float in these liquids. The density of amniotic fluid is similar to the density of water and fetus is floats in the amniotic fluid. People have more information about the Dead Sea than about the Float spas.

# Experiments for the chemistry lessons

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## 1. The aim of the project

The aim of the project is to create educational material in form of videos and photos. These would show the chosen experiments which could in the practice make the education of chemistry at primary schools and lower levels of secondary schools easier, more interesting and also safer.

## 2. Work process

Videos and photos of the chosen experiments were made in the chemistry laboratory of PSJG HK and the private laboratory of the project leader.



Fig. 1. Retardant ammonium dichromate



Fig. 2. Burning of hydrogen bubbles

## 3. Results

The result of the work is two educational DVDs which show videos and photos of chemistry experiments. These are processed in the computer programme called Windows Movie Maker. These DVDs can be used by chemistry teachers during their lectures. The students and the professors see the use of these DVDs as a very good didactical resource.

## 4. Conclusion

The educational DVD could in practice make the education of chemistry easier, safer and could illustrate the topic better. Also the use of videos saves time compared to the practical demonstration of an experiment.



# Mucus of fish as antimicrobial agents

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## 1 Introduction

Fishes are notoriously known for its ability to survive in severe conditions, such as polluted and contaminated waters. There have been speculations to how these fishes are able to survive under such conditions. One part attracts this research is the fish epidermal mucus, because fish owners from all around the world have observed how the damage of fish epidermal mucus stresses the fish. Thus the purpose of this experiment is to see whether fish epidermal mucus works against pathogenic bacteria and understand the underlying mechanism behind it. The fishes used in this experiment are *Mystus gulio* and *Clarias gariepinus*.

## 2 Content

### 2.1 Purpose of the Investigation

To understand whether fish mucus will be an effective antimicrobial agent and if so, how it works.

### 2.2 Method of the Investigation

The experiment will first use a standard antibiotic test methodology; this will yield the lengths of the zone of inhibition, which will be used to determine the efficacy of the fish mucus extracts ranging from 50%, 25%, and 12.5%. The controls used in this experiment are water (negative control) and 100mg/ml ampicillin (positive control). The second thing to do is to find out whether the fish mucus extracts works bacteriostatically or bactericidally. To do this, bacteria is smeared over the agar using the swab technique, then cylinder cups are placed to contain the fish mucus and to localize it. After a period of incubation, the zones of inhibition in the agars are cut and transferred to a new petri dish. If growth exists on the new petri dish, then the extract works bacteriostatically, but if there's no further growth, it works bactericidally.

## 3 Result of the Experiment

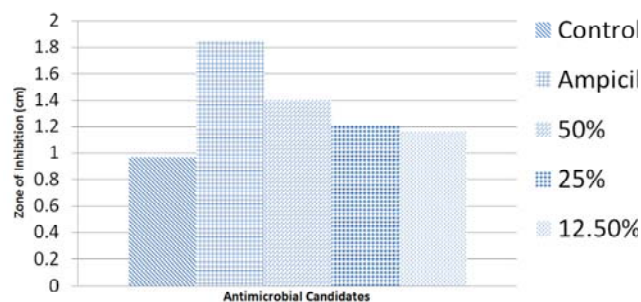


Fig. 1. Results from the experiment

The second experiment proves that both fish mucus extracts works bacteriostatically.

## 4 Conclusion

From the experiment, it is proven that fish mucus match the ampicillin if the concentration is to be increased. It is also proven that the fish mucus works bacteriostatically, which just inhibits the growth of a bacteria, but does not necessarily kill it. It is unknown though, whether the fish mucus will work bactericidally in higher concentrations as one of the experiment's limitations is the inability to use higher concentrations of the mucus due to the viscosity of the mucus.



# Chitosan defies death

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## 1 Introduction

Diabetes Melitus is one of the diseases common in Indonesia. Diabetes Mellitus, often simply referred to as Diabetes, is a group of metabolic diseases in which a person has high blood sugar, either because the body does not produce enough insulin, or because cells do not respond to the insulin that is produced.

Gangrene is the death of tissue of certain parts of the body. In Indonesia, people who suffer from Diabetes will also often suffer from Gangrene, which usually affects a patient's feet. The medication for it is not affordable for everybody.

I have chosen the Horseshoe Crab, simply because it's known widely in Indonesian and can be found easily. Also, due to the fact that, among all crustaceans, the Horseshoe Crab contains the highest levels of Chitin. By using the Chitin found in the shell of the Horseshoe Crab, I shall endeavor to heal the Gangrene of Diabetic Patients.

## 2 Content

### 2.1 Purpose

The research aims on finding an affordable medicine for gangrene of diabetic patient from waste. With over  $\frac{3}{4}$  of the Indonesian territory are water territory, there are a lot seafood waste, especially crustacean waste. So we're using the shell of Horseshoe crab, one of the horseshoe crab which is easily found in Indonesia and it's waste we're a lot.

### 2.2. Methodology

After obtaining the shell, the shell was soaked in Sodium Hydroxide for 2 days for demineralization process. Then soaked in HCl for 1 day for deproteinization process. After 1 day, it is then dry under the room temperature. It took 5 days for the shell to fully dry under the room temperature. Then the shell are boiled with Sodium Hydroxide for 4 hours for deacetylation process. Which after this process, the shell are now chitosan. It is then crushed to powder using blender and was measured and add with acetic acid with the ratio of 1:100 (1g chitosan with 100 ml of acetic acid). We can now obtain the gel.

## 3 Treatment

### 3.1 Procedure

Before applying the gel, the gangrene of the patient must be cleaned with either NaCl or Alcohol. Then it is covered with gauze which has been poured enough gel to cover the gangrene. (in this case 2 tsp). The gel was changed twice a day.

### 3.2 Result

The gel then was applied on the gangrene of diabetic patient with this Biodata:

1. Name: Kayu Ting Ting (initialized)
2. Age: 70 yrs old.
3. Time duration of gangrene: 3.5 yrs
4. Blood Sugar Contents : 396 mg/dl.

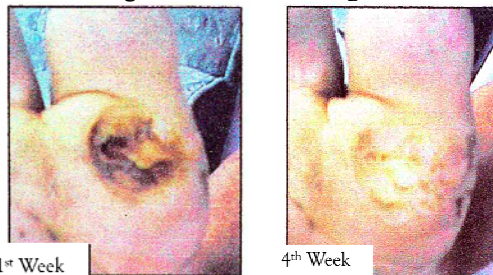


Figure. Before & After Treatment

## 4 Conclusion & Suggestion

### 4.1. Conclusion

The shell of the Horseshoe Crab's Shell which is considered as waste in Indonesia can be use to make Chitosan Gel which has successfully heal the gangrene of Kayu Ting Ting.

### 4.2. Suggestion

Further Research is needed on the combination of chitosan with other materials for patients with diabetic gangrene.

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# Mathematical approach of RNase P RNA applying knot theory and phylogenetic analysis

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## 1. Introduction

RNase P RNA is a ribozyme that processes 5' end of tRNA and activates it, and has been attracting researchers' attention as initial life form at the earth. Especially, since every known species has RNase P RNA, many researches have been conducted to find out the information of evolution and speciation from RNase P RNA [1]

However, preceding studies failed to draw out meaningful phylogenetic result because there are too many structural features of RNase P RNA. No research has ever suggested an optimal way to consolidate different structural features and connect them with current taxonomic knowledge well.

New approach of analyzing RNase P RNA is demanded, and here, we suggest a novel mathematical approach applying knot theory.

## 2. Main Purpose

By suggesting a new method of analyzing RNA using mathematical knot theory, we tried to prove various phylogenetic meanings and unrevealed fundamental of evolution.

## 3. Procedure (simplified)

- ① Design a mathematical representation for secondary structure of RNA as a corresponding singular knot. (Fig 1)
- ② Modify state model of Kauffman bracket to represent the singular knot as a corresponding polynomial. (Fig 2) [3]
- ③ Get secondary structures of RNase P RNA of various species from web DB ([www.mbio.ncsu.edu/rnasep/](http://www.mbio.ncsu.edu/rnasep/))
- ④ Represent RNase P RNAs of 53 different species in the DB as a polynomial by the method we designed.
- ⑤ Organize the polynomials as a table, and analyze for phylogenetic significance.

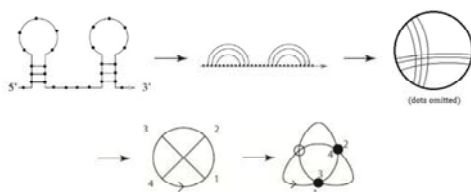


Fig.1 Linear representation of RNA secondary structure as a singular knot diagram (simplified)

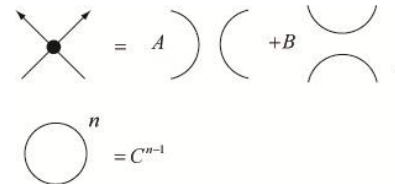


Fig.2 Modified state model of representing a singular knot diagram as the corresponding polynomial  
A singular knot with virtual crosses(black dots) can be spliced and eventually become a polynomial.

## 4. Result

We found out there are only 5 common factors when we factorize the polynomials. By examining degrees of the common terms, we got three significant results.

**1. Different Evolution of 3 Domains** (A) Bacteria : It's proved that the structure and function of ribozymes are important and maintained as bacteria evolve. (B) Eukarya : Because more proteins are produced, ribozymes become simpler as they evolve. (C) Archaea : Diverse polynomials suggest that the direction of evolution is various and different because of extreme living environment.

**2. Support Endosymbiosis** Degrees of factors in eukaryotic nuclear RNase P RNA are distinguished from those in eukaryotic plastid RNase P RNA. Eukaryotic plastid RNase P RNA polynomials are very similar to those of bacteria or archaea. It directly supports the idea of endosymbiosis that plastids came from archaeal or bacterial species.

**3. Comparing with Phylogenetic Trees** It proves the direction of evolution of archaea is not random; it is similar to that of either eukarya or bacteria depending on each phylogenetic branch.

## 5 Conclusion

We suggested a new approach of RNA applying knot theory, and proved its effectiveness by finding out strong phylogenetic meanings from gotten polynomials numerically and systematically. The result helped us to get closer to the fundamental of evolution.

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# Characterization of vacuum-mediated *Agrobacterium* infiltration for virus-induced silencing of *Arabidopsis* genes

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## 1. Introduction

Virus-induced gene silencing (VIGS) is an effective gene silencing technique for functional study in plants [1]. In this technique, *Agrobacterium* harboring expression cassette for plant viral genome can be infiltrated into plant leaves either by syringe or vacuum. In this study, we applied the vacuum-mediated infiltration of *Agrobacterium*, used in the plant *Aquilegia* [2], for VIGS in the *Arabidopsis* model plant. We used the tobacco rattle virus (TRV)-based system for a VIGS system and the phytoene desaturase (PDS) gene to monitor effective gene silencing.

## 2. Objectives

Here, we characterized the effect of plant growth stage in VIGS based on vacuum-mediated *Agrobacterium* infiltration. We also investigated the extent of the plant tissues where VIGS occurred, and performed the quantitative analysis of the gene suppression level by VIGS.

## 3. Methods

**Plant Culture and agroinfiltration** Wild-type *Arabidopsis thaliana* ecotype Col-0 plants and competent cells of *Agrobacterium* strain GV3101 were used.

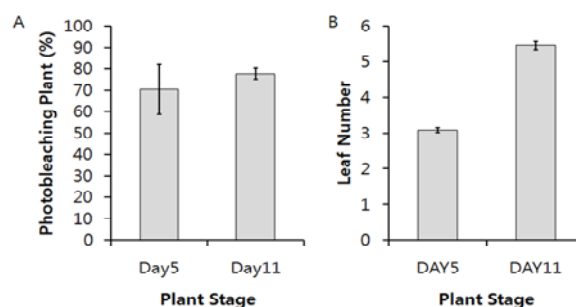
**Plasmids** TRV-based VIGS vectors, pTRV1 (Genebank ID: AF406990) and pTRV2-MCS (Genebank ID: AF406991), are transformed into *Agrobacterium*.

**Real-time PCR analysis** Total RNA was extracted from the leaves of *Arabidopsis* plants after VIGS application. cDNA was then synthesized from the extracted total RNA by using ImProm reverse transcriptase and random primers. Real-time PCR was performed with TRV and PDS primers in annealing temperature of 54°C for 39 cycles.

## 4. Results

*Phytoene desaturase* (AtPDS) gene which induces photobleaching when repressed is used to characterize vacuum-based agroinfiltration. We applied agroinfiltration of *Agrobacterium* with vectors carrying AtPDS gene to the seedlings with 2 true leaves (Day5) and with 4-5 true leaves (Day11). Photobleaching was observed on experimental groups 7 days after agroinfiltration. When photobleached Day11 plants were grown, their cauline leaves, silique, and reproductive organ also showed photobleaching.

Photobleaching was observed in 70~80% of *Arabidopsis* plants. VIGS efficiency was largely independent from the plant stage (Fig.1A). We also checked tissues where the gene was silenced. We counted the rosette leaf first showing photobleaching. Photobleaching was observed only at new leaves even though vacuum-infiltration applied vacuum for the whole plant tissues (Fig.1B).



**Fig.1 Efficiency of vacuum-based agroinfiltration depending on plant stage.** A, The number of plants showing photobleaching. B, The rosette leaf first showing photobleaching (n=100 for four trials).

The PDS gene expression at photobleached leaves was decreased about 20 folds. Even in the same viral infected seedling, photobleached leaves showed decrease in AtPDS transcripts, while unbleached leaves did not show any decrease in AtPDS transcripts.

## 5 Conclusion

Our results indicate that vacuum-mediated infiltration of *Agrobacterium* is applicable in various growth stages of *Arabidopsis* plants. Effective gene silencing appears to be seen only in new leaves and subsequent plant organs formed after VIGS application. As vacuum-infiltration is easy, rapid and efficient, we expect this technique useful for massive functional study of *Arabidopsis* genes.

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# The study of phytoncide features of indoor plants

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## 1. Relevance

The air quality of urban areas is far from ideal. In addition to the usual dust, indoor air often has a higher content of chemical substances, produced by building materials, furniture, cleaning agents. Compliance of hygiene standards in housing and classrooms do not fully solve the problem of presence in the environment of bacteria, unicellular organisms that cause diseases which lower the activity of systems and organs of human body. We are interested in the activities of Phytoncides, their influence not only on other plants, but also on the human environment. We decided to find out more about the volatile aromatic substances, the conditions under which they are produced and their greatest impact on the environment.

## 2. The purpose of the research

Empirically determine the impact of phytoncides on microorganisms vital functions.

Objectives of research:

1. Identify plants which produce Phytoncides in the classroom.
2. To prove empirically that usage of phytoncides can have a detrimental effect on the microorganisms.

## 3. Introduction

### 3.1. Phytoncides

Phytoncides are antimicrobial volatile organic compounds derived from plants and may reduce the growth of bacteria, fungi, protozoa and certain viruses or kill them. Phytoncides (which means from the Greek word "Fiton" - plant and the Latin "Zeredathah" - to kill) play a protective role in the body. Some plants give off very active substances which prevent them from rotting or being eaten by some insects and animals. The chemical nature of Phytoncides is different. This is usually complex compounds- glycosides, terpenes, tannins, secondary metabolites as non-major classes of natural compounds- proteins, proteins, carbohydrates and fats.

### 3.2. Methods

Phytoncide activity of indoor plants was determined by usage of bioassay. This study was carried out in the school laboratory. In the experiment, we used cultures of protozoa (Infusoria), which were obtained under laboratory conditions, according to the methods described by Tokin B.P., 1980, Fedorova A.I.,

Nikolskaya 2000. We evaluated empirically the juice of indoor phytoncides plants. We used the extract obtained from the pulp of the leaves. The pulp was prepared by crushing and grinding the leaves in a mortar with pistil just before the work. We placed a small ball of soil in a glass (50 - 100 ml), added water and mixed it. Then we took a drop of water from a glass with a pipette and put it on a microscope slide. We examined the preparation in the small and large increase. Added under the cover slip a drop of plants' juice. We observed the movement of protozoa. With the help of stopwatch we noted the time on the following parameters of the reaction to Phytoncide plant: At the slowdown time of the unicellular. At the death time of the unicellular. Observations of the unicellulars and phytoncide functions of indoor plants were carried out with the school microscope at 120 times magnification.

### 3.3. Equations

$$A = 100: T$$

### 3.4. Table

Type of plant	slowdown time, min:	death time of the unicellular, min:
1. Chlorophytum	4	7
2. Chrysanthemum	4	5
3. Coleus	4	4,50
4. Dieffenbachia	4	5
5. Fuchsia	3	6
6. Scindapsus	3	11
7. Pelargonium	4	8
8. Sansevieria hahnii	2	4
9. Kalanchoe	2,5	3,30

## 4. Conclusion

All the investigated indoor green plants have phytoncide activity. The power of phytoncide production and phytoncide activity is different in plants used for the experiment: Kalanchoe, sansevierii, koleus, chrysanthemums and dieffenbachia have high phytoncide activities. The following plants have less phytoncide activities: fuchsia, pelargonium and Chlorophytum and finally is very low in Epipremnum. Most useful plants, for growing in school classes to improve the environmental situation in order to disinfect the air and visual purpose, should be recommended Kalanchoe, sansevieria, coleus, chrysanthemum, dieffenbachia and fuchsia.

# The analysis of the quality of drinking water

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## The actuality of the problem

We have decided to begin to research the quality of drinking water, because we were interested to come to know what water there is in pipe-lines, if it is useful for a man, what water is more qualitative: filtered or pipe-lined. Is it worth buying filtered water?

### 1 The tasks of the research

To perform chemical analysis of water. To compare the quality of filtered and pipe-lined water.

### 2 Hypothesis:

Filtered water is more useful and better than pipe-lined water. Is it worth buying filtered water?

## 3 Practical work

### 3.1 Samples of water

1. Water from our school canteen;
2. Drinking bottled water "Zalia giria";
3. Water refined with a simple filter;
4. Pipe-lined district water;
5. Water from the bare-hole in the settlement of Rudomina;

### 3.2 The smell of water

100 millilitres of water were poured into a retort 150-200 millilitres with a wide neck. This retort was covered with a cork, then it was shaken with a rotating movement, then the cork was removed and then we quickly defined the character and the intensity of the smell of water.

In all the samples of water the smell was absent.

### 3.3 Colouring

We examined water on the background of a white sheet of paper in the day light. Water is considered to be colourless, without any colours.

### 3.4 Hydrogen indicator

pH was defined with the help of an universal indicative paper, comparing its colouring with the scale.

pH of water in all the samples hesitated from 6 to 7. It meant that the water was neutral.

### 3.5 The discovery of the organic substances

2-3 drops of 1% solution of potassium permanganate ( $\text{KMnO}_4$ ) were poured into 1-2 millilitres of the examined water. The disappearance of the colouring of potassium permanganate ( $\text{KMnO}_4$ ) or its confusion by examined water indicated that there were organic substances.

In all the samples organic substances were not formed.

### 3.6 The definition of chlorine ions (Cl)

3 drops of the solution of nitro-silver ( $\text{AgNO}_3$ ) was added to 5 millilitres of the examined water. The contents of chlorides (Cl) was defined by the fall-out or dullness. In samples 1 around 4 there was big dullness, it indicates the presence of ions chlorine (Cl). In samples 2,3,5 ions of chlorine were not found .

### 3.7 The definition of 5 chlorine ions (Cl)

0,5 millilitre of the solution of hydrochloric acid (HCl) (1:5) and 2 millilitres of 5% solution of barium chloride ( $\text{BaCl}_2$ ) were added to 10 millilitres of the examined water and everything was mixed. We defined the contents of sulphates ( $\text{SO}_4$ ) by the character of the fall-out. If there was no dullness – the concentration of sulphate ion ( $\text{SO}_4$ ) was less than 5mr/l. If dullness is weak and appears not at once but in a few minutes – 5-10 milligrams/litre. If the dullness is weak and appears at once after adding barium chloride ( $\text{BaCl}_2$ ) 10-100mg/l. Big (strong) falling out dullness indicates about high contents of sulphate ions ( $\text{SO}_4$ ) (more than 100mg/l). Weak dullness appeared in samples 1,3 and 4 after 5 minutes, it signifies that there is sulphate ions ( $\text{SO}_4$ ) in water. Sulphate ions ( $\text{SO}_4$ ) are absent in samples 2 and 5.

### 3.8 The definition of carbonate ions (CO<sub>3</sub>)

5-6 drops of phenolphthalein (C<sub>20</sub>H<sub>14</sub>O<sub>4</sub>) were added to 10ml of the examined water. If the colouring doesn't appear, it is considered that carbonate ions (CO<sub>3</sub>) are absent in the sample. In all samples carbonate ions (CO<sub>3</sub>) weren't found.

### 3.9 The discovery of ions of copper (Cu)

3-5ml of examined water were poured into a china (porcelain) cup, this water was completely dried and a drop of concentrated solution of ammonia (NH<sub>3</sub>) was placed on the outside part of the stain. The appearance of intensive blue and violet colouring indicated that ions of copper (Cu) were present there. In all other samples ions of copper (Cu) weren't discovered.

## 4 Work out table

	1	2	3	4	5
Smell	Not definite	Not definite	Not definite	Not definite	Not definite
The intensity of smell	Colourless	Colourless	Colourless	Colourless	Colourless
Colouring	Clear	Clear	Clear	Clear	clear
pH	pH=7	pH=7	pH=6	pH=6	pH=6
The rigidness of water	Neuter	mild	Mild	Neuter	mild
Organic substances	-	-	-	-	-
Chloride ions	10-50mg/l	Absent	Absent	10-50mg/l	absent
Sulphate ions	10-50mil./l	Absent	Absent	10-50mil./l	Absent
Carbonate ions	-	-	-	-	-
Cooper	-	-	-	-	-

## 5 Conclusion

Our hypothesis was confirmed as a result of chemical analysis, we proved that filtered water and water from bore-whole is more qualitative than pipe-lined water. Filtered water and water from a bore-whole is milder and it does not contain chlorine.



# *Peperomia pellucida* Future cure for Gout

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## 1 Introduction

Gout occurs when uric acid content in the blood exceeds 7.5 mg / dL. This factors leads to excessive production of uric acid in the body and less efficient excretory system that causes uric acid to remain in the joints of the body. A symptom that may be encountered by patients with gout is pain in the joints, especially the big toe joint. Joints also become red, swollen and hot. In addition, patients will suffer from fever. *Peperomia pellucida* is believed to be able to effectively treat gout.

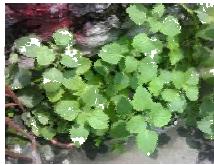


Fig. 1 Picture of *Peperomia pellucida*

## 2 The purpose of investigation

Gout has caused a lot of problems and discomfort to humans especially to the elderly. We are determined to find a solution to this problem for the sake of others. Our main objective is to find herbs that could cure gout. The usual medications in the market have come with a lot of side effects, so herbs are recommended to solve the problem.

## 3 Method of investigation

In this experiment, we would like to see the results of reactions between extract of *Peperomia pellucida* with uric acid. Before the first test we provide experimental material samples and extract of uric acid *Peperomia pellucida*. In the calculation of uric acid, we used the urine of patients with gout. Uric acid can be found in the urine of patients with gout because uric acid dissolves slightly in water. We provide four specimens; two is the control and two more a test specimen. First four glass slides prepared and labeled with A, B, C and D. Glass slides A and B are dropped with concentrated urine using a glass rod. Two drops of distilled water is then dropped. Two specimens will be the control specimens. Then cover the glass drops of urine. Slides C and D are also dropped with 2 drops of the concentrated urine. Extract of *Peperomia pellucida* is then added to slides C and D. The 2 specimens which are C and D are prepared to observe the reaction of extract *Peperomia pellucida* on uric acid in the urine. After that, two types of glass slides can be viewed under a microscope. Observations for the four glass slide are recorded.

## 4 Results of the experiment

Glass slides	Observation
A	a lot of sharp crystal was formed
B	a lot of sharp crystal was formed
C	a few crystals was formed
D	a few crystals was formed

Table 1 Results from the experiment

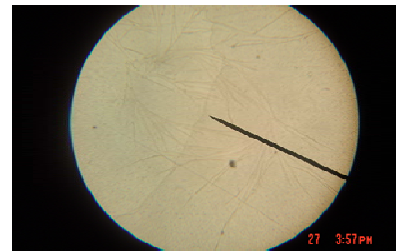


Fig. 2 Uric acid crystals viewed under the microscope

After conducting this experiment, we found that there was a high content of uric acid on slides A and B which contain urine of patients with gout because uric acid crystals will only formed when the concentration of uric acid. Then, *Peperomia pellucida* action on uric acid can be seen by adding extracts of urine of patients with gout. After the mixture of uric acid and *Peperomia pellucida* had been observed under the microscope, there was significant difference in the average amount of uric acid crystals in the urine is much less in slides C and D. Then in slides A and B. This means there is a positive reaction in the average amount uric acid crystals that causes gout to decrease after being mixed with *Peperomia pellucida*.

## 5 Conclusion

Findings indicate that *Peperomia pellucida* has the potential to treat gout. So this species can be commercialised in various ways such as making *Peperomia pellucida* in the form of tablets or capsules. This can reduce the use of more expensive drugs and prevent side effects. *Peperomia pellucida* can also be commercialized in the form of a health drink or tonic. Besides that this plant can also be processed in the form of dried concoction for brewing and drinking. Therefore, hope that this study is to be given its due consideration due to its high potential.

# Chewing for a high grade

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## 1 The purpose of the investigation

The purpose of this graduation project was to find out the influence of chewing gum on stress and on cognitive functions and ultimately to change the chewing gum ban within our school.

## 2 Method of the investigation

To test the influence of chewing gum on stress six test subjects ranging between the ages of 16-18 were chosen. They all wore a heart rate monitor for two days, one day while chewing gum, the other day without gum. Each day, six saliva samples were taken from the subjects, at approximately 09.00 am, 10.00 am, 11.00 am, 12.00, 13.00 pm and 14.00 pm. The circumstances on both days were kept equal as much as possible so that the chewing of gum was the only variable. The test subjects had the same meals and performed the same activities on both days. Their saliva was collected in special tubes. The collected saliva was then analyzed in the laboratory of Leiden University for two stress indicators: cortisol, a stress hormone which has a circadian rhythm, and alpha-amylase, a digestive enzyme. The amount of cortisol and alpha-amylase increases when stress increases.

To test the influence of chewing gum on cognitive functions, the students from three grades of our grammarschool were chosen. Each grade was divided into two groups. One group had chewing gum and the other half did not. All students had to do the same Latin test. They had ten minutes to learn twenty Latin words, after which they had to reproduce ten words out of the twenty within in ten minutes. This test was repeated, this time the situation was reversed. A different set of words was used the second time. [1,2,3,4]

## 3 Results of the experiment

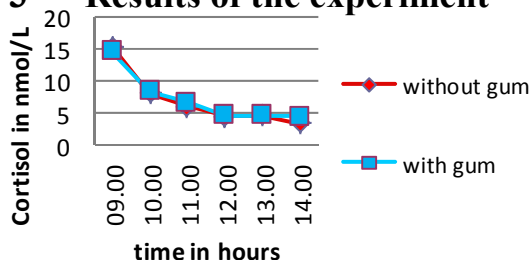


Fig. 1 The average amounts of cortisol in multiple saliva samples of the test subjects

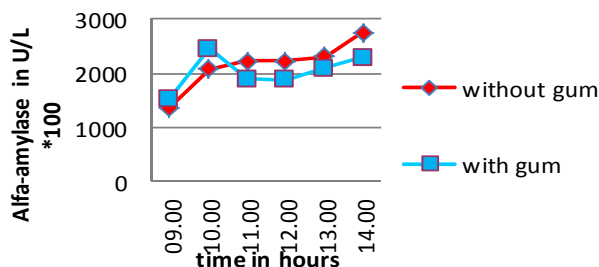


Fig. 2 The average amounts of alfa-amylase in multiple saliva samples of the test subjects

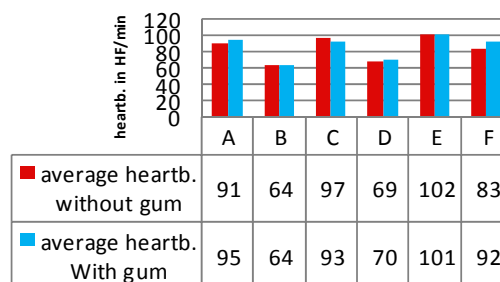


Fig. 3 The average heart rate of the test subjects throughout the day, with and without chewing gum

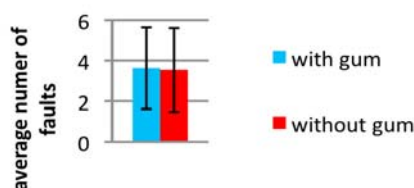


Fig. 4 The average amount of mistakes made in the Latin test, throughout the day

## 4 Conclusion

The results of the experiments show that the amount of cortisol is higher while chewing gum. However, literature tells us that it should be lower. The amount of alpha-amylase increases when exposed to a stressor. Based on these results it can be said that the amount of alpha-amylase decreases after 11.00 am. However, due to minimal differences between the test results, a conclusion cannot be drawn on whether chewing gum lowers the heart rate or not. Multiple studies show that chewing gum improves cognitive performance, but based on these results said conclusion cannot be drawn, for the results did not differ significantly. [1,2,3,4] Overall no definite conclusions can be drawn, which is due to the fact that too few test subjects were available. Nevertheless: 'no result is often the best result'. And in the end, the chewing gum ban was changed and chewing gum during exams is no longer prohibited!

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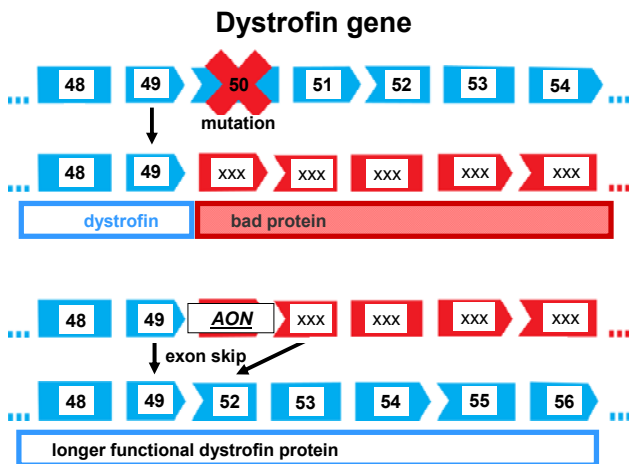
# Duchenne muscular dystrophy; a medicine within a hand's reach?

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## 1. Duchenne muscular dystrophy: the disease, the *dystrofin* mutation and the cure

Duchenne muscular dystrophy (DMD) is a fatal muscle disease affecting young boys, caused by a mutated *dystrofin* gene. Progressive muscle weakening causes wheelchair dependency in adolescence and death before 30 years of age [1].



Exon-skipping during mRNA splicing by antisense oligonucleotides (AONs) to increase functional dystrofin protein levels is claimed as a potential therapy for DMD patients [2]. To assess if AONs will become available as medication for Duchenne patients I performed a literature review and completed 2 research projects.

## 2. Research 1: Does 'exon-skipping' of *dystrofin* work in human muscle cells?

### 2.1 Purpose

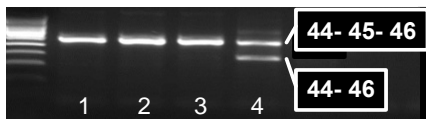
To test if antisense oligonucleotides (AON) against dystrofin exons induce 'exon-skipping' in mRNA in muscle cells.

### 2.2 Methods

I used PRO045, aimed at exon45 of the dystrofin gene, to treat human muscle cells. I isolated mRNA from cultured myotubes treated with PRO045. After PCR of the exon 44-45-46 fragment from the cDNA I separated the products by gel-electrophoresis and visualised them by EtBr staining.

### 2.3 Results

In lane 4 PCR products of cDNA from myotubes treated with PRO045 show skipping of exon 45 (low band). In untreated myotubes (lanes 1-3) only intact exon 44-45-46 is present.



### 2.4 Conclusion 'exon-skipping' experiments

Dystrofin exons can be skipped in mRNA by AONs.

## 3. Literature review: 'exon-skipping' medicines for Duchenne's disease

PRO051 and AVI-4658 are AON-based, investigational medicines for DMD. PRO051 is most advanced. Laboratory evaluation of PRO051 in cultured DMD myotubes and in a DMD mouse model showed exon51 skipping, increased dystrofin protein levels and better muscle function. Animal studies showed no major side-effects, normal fertility and normal juvenile development. Phase I/II clinical trials with PRO051 in DMD patients showed improved muscle performance, exon51-skipping and increased dystrofin levels.

## 4. Research 2: Will Dutch healthcare pay for DMD 'exon-skipping' medication?

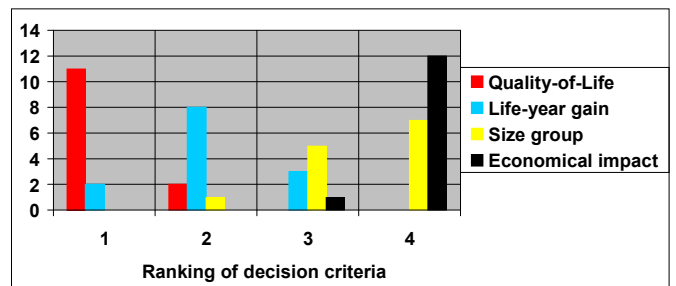
### 4.1 Purpose

Assess the reasons of Dutch healthcare to pay for PRO051.

### 4.2 Methods

I interviewed 13 participants (neurologist, pharmacology professor, Ministry of Health, insurance company, pharma, parents) by online questionnaire. I asked for ranking of 4 criteria measuring efficacy of life-saving interventions [3].

### 4.3 Results questionnaire



Respondents also felt that costs up till €94.000/year would be acceptable, if PRO051 showed clear patient benefit.

### 4.4 Conclusion 'Dutch healthcare payment'

'Quality-of-Life' and 'Life-year gain' are the most important to decide on PRO051. Costs of €94.000/year was acceptable.

## 5. Overall conclusion and discussion

PRO051 is an effective medicine for DMD. Before it can be used for Dutch patients, sufficient gain in 'Quality-of-life' and 'life-year gain' must be proven in phase III clinical trials.

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# Lifestyle in the chronic respiratory disease patients

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## 1 The purpose of the investigation

Unhealthy lifestyle represents an important risk factor for chronic respiratory diseases [1]. Also, lifestyle habits may significantly affect the course of the lung disease and may influence the outcome of the treatment. The aim of this study was to investigate lifestyle habits of chronic respiratory disease patients and their influence on the course of the disease.

## 2 Method of the investigation

The study has encompassed 100 patients diagnosed with a chronic respiratory disease at the Institute for Lung Diseases and Tuberculosis of the Clinical Centre of Serbia. All patients answered a questionnaire consisted of questions divided in four groups: demographics, basic anamnesis of the disease, lifestyle, and disease severity.

## 3 Result of the experiment

Among 100 study subjects there were 29 with bronchial asthma, 23 with chronic obstructive pulmonary disease, 10 with aspergillosis, 18 with tuberculosis and 20 with bronchitis. There were 58 men and 42 women and average age of the study subjects was 58 years. Three main parameters were investigated as important indicators of lifestyle: smoking, knowledge of disease and physical activity.

### *Smoking*

There were 50 smokers and 50 nonsmokers among study subjects. Among smokers, there are more men than women (72% vs. 28%), while among nonsmokers the ratio is more balanced (44% vs. 56%). More than half of smokers (56%) suffer of disease for no more than 6 years. Smokers suffer from dyspnea more often than nonsmokers (68% vs. 36%). Smoking status did not significantly correlate with the type of cough and the changes in the course of the disease.

### *Knowledge of disease*

Older patients are less informed about disease than younger patients, with middle-aged patients, between 40 and 60 years of age, being best informed. Among patients least informed about their disease, 64% are 60 years and older. Patients who suffer of the disease for a long time are much better informed on their disease than patients who were diagnosed recently. The best knowledge of the disease was observed in patients with bronchial asthma.

### *Physical activity*

In this study, physical activity was considered to be walk longer than 30 minutes at least twice a week. Majority of recently diagnosed patients are not physically active (88%). Lack of physical activity was also associated with episodes of wheezing (63%). Among patients who experienced disease worsening 86% are physically inactive, while significant portion of physically active patients (55%) declared that they felt improvement. Physical activity did not correlate with type of cough or type of respiratory disease.

## 4 Conclusion

Results of the questionnaire taken by 100 patients with chronic respiratory disease confirm that unhealthy lifestyle in most cases leads to lung disease worsening [2]. Educating patients on their disease helps that they understand the benefit of healthy lifestyle and take measures that can lead to improvement of their quality of life.

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# Angelman syndrome diagnosis: FISH analysis of chromosome 15 microdeletion

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## 1 The purpose of the investigation

Microdeletion on chromosome 15 in the region q11-q13 causes Angelman syndrome (AS), a genetic disorder characterized by severe mental retardation, microcephaly, macrostomia, maxillary hypoplasia, ataxia and epileptic seizures with specific EEG abnormalities [1]. Patients with this disorder have a happy and excitable personality [2]. The purpose of this investigation was to analyze the presence of microdeletion in the region 15q11-q13 in an individual suspected of suffering from Angelman syndrome.

## 2 Method of the investigation

The method used for detecting microdeletion in the region 15q11-q13 was Fluorescent *In Situ* Hybridization (FISH), a useful tool for diagnosing microdeletion syndromes that would otherwise be difficult to detect using standard cytogenetic methods.

FISH method consisted of three steps:

1. Denaturation of fluorescently labeled probes (double stranded DNAs complementary to DNA sequences that are being detected) and cytogenetic sample made from peripheral blood of the patient (chromosomes)
2. Hybridization of complementary parts of DNA probes and chromosomes during cooling
3. Detection of fluorescent probes hybridized to chromosomes under a fluorescent microscope

## 3 Result of the experiment

In the analyzed sample green signals (control signals for the region 15q22-q24), blue signals (control signals for the region 15p11.2) and red signals (signals for the region 15q11-q13) were clearly seen on both copies of chromosome 15 (Fig.1). Therefore, the presence of both copies of 15q11-q13 region on tested cytogenetic sample was confirmed and the microdeletion in the region 15q11-q13 is not present in the analyzed individual.



Fig.1 Detected hybridized probes for chromosome 15

## 4 Conclusion

Results obtained by analyzing cytogenetic sample of the individual suspected with Angelman syndrome by FISH method showed that there was no microdeletion in the region 15q11-q13. Although the microdeletion was not detected in this individual, a possibility remains that he has Angelman syndrome. To exclude this possibility, further analysis should be done to detect abnormal methylation by DNA methylation analysis and to detect paternal uniparental disomy by DNA polymorphism testing [3].

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# Adhesion strength of butterfly pupae

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## 1. Introduction

When the caterpillar is fully grown, it makes a button of silk to fasten its pupa to a leaf or a twig. There are two types of pupae, suspensi (A) and alligatus (B) (Fig 1). Most pupae are attached to a surface by a velcro-like arrangement, which consists of two parts. First, a silk pad is spun by the larva and is usually cemented to the underside of a perch. Second, the cremaster, a hook-shaped protuberance at the tip of the pupal abdomen, is fixed to the silk pad (Fig 2).

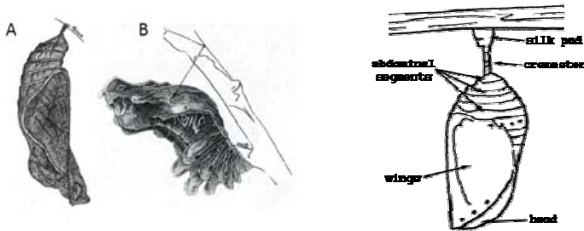


Fig. 1. (left) Two types of pupae: suspensi (A) and alligatus (B)  
Fig. 2. (right) Structure of a pupa

## 2. Motivation

This research is to know the major factors that contribute to the durability of a butterfly pupa. The following are the aims of this study: the carrying weight capability of a pupa, the morphology of cremaster, the connection between larva adhesion force and pupa attachment, the connection between silk pad and cremaster structure of larva protopads.

## 3. Methods

Eight common species are chosen. The morphology of larva protopoda and cremasters is observed under the microscope. Pupa of each species are tested by weights to understand the adhesion strength (Fig 3). Velcro was used as the simulation of silk pad and cremaster. By changing the shapes and the numbers of hooks on a velcro, the durability of the velcro is measured. The larva adhesion ability is also tested to understand if it has any correlation to the pupa durability.



Fig. 3. Pupa weight test

## 4. Results

If the hooks are easier to observe in the larval phase, then the grip strength is higher for the larva, but it has no

correlation with the pupa adhesive strength.

For the 8 species, *Papilio memnon* has the most adhesive pupa which carries 358g while its pupa is only 1.971g. Silk pads with different shapes have different adhesive ability and the order is: number eight > circle > crescent.



Fig 4. Three shapes of pupae's silk pads

The bigger a cremaster is, the more adhesive a pupa is. The numbers of hooks in a cremaster vary in different pupae. Based on the Velcro experiment test, a saturation effect is found. Below the saturation density, the more dense the hooks are, the more adhesive a pupa is.

## 5. Conclusion

- (1) The larva adhesive strength has no correlation with the pupa durability.
- (2) The shapes of the silk pads indeed affect the durability.
- (3) On the same shapes of silk pads, the larger the area is, the higher the durability is.
- (4) On a fixed area, there exists the saturation point for durability; the adhesive strength does not get larger with the increase of hook density.

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# The research of pollen type and chemical components in bee pollen at Te-Pa research station

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## 1 Introduction

Bees are social insect that can be found almost everywhere. They play important role in pollination of flowering plants as they are pollinated during the bees try to get their nectar and pollen. In addition to honey, bees feed pollen to their youngs. Pollen are thought to be the source of protein and other nutrient necessary for the growth of larvae. It is important that researcher on pollen chemical compositions, including protein, fat, fiber, humidity and ash, should be carried out.

## 2 Purpose

- 2.1 To study flowering plant diversity around Te-Pa research station
- 2.2 To compare pollen found in bees with those of flowering plants near the research station
- 2.3 To compare percentages of components in plant pollen found with the bee to those of *Mimosa invisa*

## 3 Methods

### 3.1 Flowering plant diversity surrounding Te-Pa research station

Plant specimen around 3 kilometers radius of the Te-Pa research station were collected. Pollen were studied after they were separated from flowers using standard acetolysis technique.

### 3.2 Pollen comparison

Pollen were collected from 5 beehives twice a day, first in the morning between 8 a.m. to 10 a.m. and in the afternoon between 2 p.m. to 4 p.m.; twice a month between November 2009 to January 2010. Standard acetolysis method was used to prepare pollen for the morphological study. Pollen shape, aperture, surface, and size were recorded and compared to those studied earlier in Section 1.

### 3.3 Chemical component comparison

Pollen from the the most common plant species were chosen to study their chemical compositions, including fat, protein, fiber, moisture, and ash.

## 4 Results

There are 4 species of flowering plants commonly found around in the radius of 3 kilometers from the Te-Pa research station, including *Elaes guineensis* Jacq., *Cocos nucifera* L., *Cucurbita moschata* Decne, and *Mimosa pudica* L. Pollen from *Elaes guineensis* are boat-shape and elliptic with trisyncolpalte aperture. *Cocos nucifera* has

perprolate shape pollen with monocolpate aperture. *Cucurbita moschata* has spherical shape pollen with periporate aperture. *Mimosa pudica* has tetrad pollen type with spherical shape and colporate aperture.

Pollen from the bees that were studied by standard acetolysis method (Figure 1) are light brown in colour with trisyncolpate aperture and boat-shape-elliptic in shape show similarity to *Elaes guineensis* pollen (Figure 2).



Figure 1. Pollen from bees



Figure 2. Oil palm pollen

The percentage of chemical components in plant pollen found with the bees, *Elaes guineensis* and those of *Mimosa invisa* pollen are in Table 1.

Chemical component (%)	<i>Elaes guineensis</i>	<i>Mimosa invisa</i>
protein	21.24 ± 1.50	39.13 ± 0.28
fat	1.93 ± 0.06	1.58 ± 0.19
humidity	17.53 ± 0.47	15.24 ± 0.14
ash	3.95 ± 0.06	3.14 ± 0.06
fiber	0.99 ± 0.41	0.08 ± 0.01

Table 1. Comparison of chemical components in pollens between *Elaes guineensis* pollen and *Mimosa invisa* pollen.

## 5 Conclusion

The percentage of protein in both pollen species is very different so we cannot conclude that *Elaes guineensis* pollen, gathering from Te-Pa research station, has the same properties as *Mimosa invisa* pollen. But this project can be used as a database for other research in the future.

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# Roles of amino acid transporter system L on cholangiocarcinoma cell proliferation

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## 1. Introduction

Cholangiocarcinoma(CCA) is malignant tumor derived from bile duct epithelial cells, which is associated with liver fluke (*Opisthorchis viverrini*) infection. CCA is the major cause of death from cancer in Northeastern area of Thailand. Resistance to chemotherapeutic drugs results in poor prognosis of CCA cases. Therefore, searching for new therapeutic targets is needed. There are various amino acid transporters on cancer cell membrane including an essential L-type amino acid transporter 1 (LAT1). Cancer cells have much more LAT1 compared to normal cells. Therefore, the purpose of this study is to determine the effect of 2-aminobicyclo-(2,2,1)heptane-2-carboxylic acid (BCH), an inhibitor of LAT1, on cholangiocarcinoma cell proliferation. Expectedly, LAT1 is proposed to be a new therapeutic target for cholangiocarcinoma treatment.

## 2. Objectives

To study the role of LAT1 on cholangiocarcinoma cell proliferation.

## 3. Methods

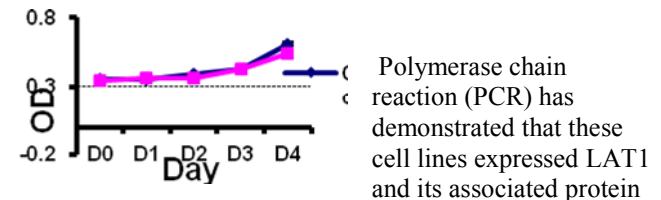
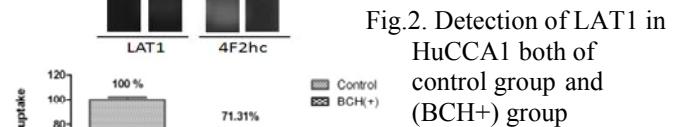
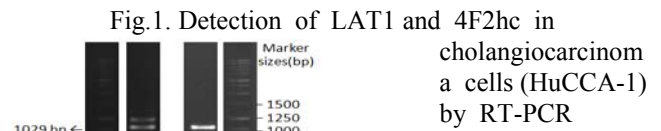
This study includes 4 main sessions: maintaining cell culture, checking expression of LAT1, amino acid uptake experiment and determining the effect of LAT1 on cell viability. For cell culture, HuCCA-1 (Human cholangiocarcinoma 1) was used. HuCCA-1 was cultured in HAM F12 growth medium containing 10% FBS (Foetal bovine serum) and incubated in 37°C and 5% CO<sub>2</sub>.

To check the expression of LAT1, total RNA was extracted from cancer cells. cDNA generated from the extracted RNA were amplified by RT-PCR (reverse transcription polymerase chain reaction). The expression of LAT1 in genomic level was determined by gel electrophoresis technique.[1]

Acid uptake experiment was performed to assess the function of LAT1. First, cancer cells were divided into two groups. The first one was the control group without BCH and the other one is the group treated with BCH. Then, <sup>14</sup>C-LEU was fed to both groups and its uptake level was determined.

For cell viability, cancer cell is also divided into two groups; the control, and BCH-treated group. The number of cancer cells in the two groups was counted by MTT assay.

## 4. Results



4F2hc. In these cell lines, LAT1 mediated [<sup>14</sup>C]L-Leucine transport and was inhibited by system L selective inhibitor BCH (2-aminobicyclo-(2,2,1)heptane-2-carboxylic acid). In MTT assay, the inhibition of LAT1 by BCH reduced HuCCA-1 cell growth.

## 5. Conclusion

Cholangiocarcinoma cell proliferation was determined by testing the insistence of LAT1 RNA by PCR. The function of LAT1 was determined by the uptake of radioactive substance <sup>14</sup>C-LEU. The effect of inhibiting LAT1 on the proliferation of cancer cells was assessed by MTT assay. According to the result, LAT1 expression in HuCCA1 was detected at the RNA level. The inhibition of LAT1 by BCH reduced cancer cell proliferation. Therefore, LAT1 is the main essential amino acid transporter protein in the cancer cells tested. For future study, the differential response to BCH between cancer cells and normal cells should be assessed since the treatment might help decrease the proliferation of cancer cells but has less effect on normal cells.

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# The influence of magnetic field ( $B = 3.2$ mT) on the mealworms (*Tenebrio obscurus* Fabricius) growth

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## 1 Introduction

How magnetic field (MF) effect living things? We do not clearly know. Basic knowledge tells us that MF can induce ions to move in the same direction. We then could imagine that if organisms are put in strong MF, the movement of large amount of ions inside their bodies may be disturbed. This speculation led us to hypothesize that the ion transportations inside living organisms under strong magnetic field could be faster and thus could effect their growth rate. In this project, we investigated the influence of strong magnetic field (MF), which is 100 times stronger than the Earth's magnetic field, on the growth of mealworms (*Tenebrio obscurus* Fabricius).

## 2 Objective

To study the growth of mealworms under magnetic field of 3.2 mT and to compare the results with those without magnetic field influence.

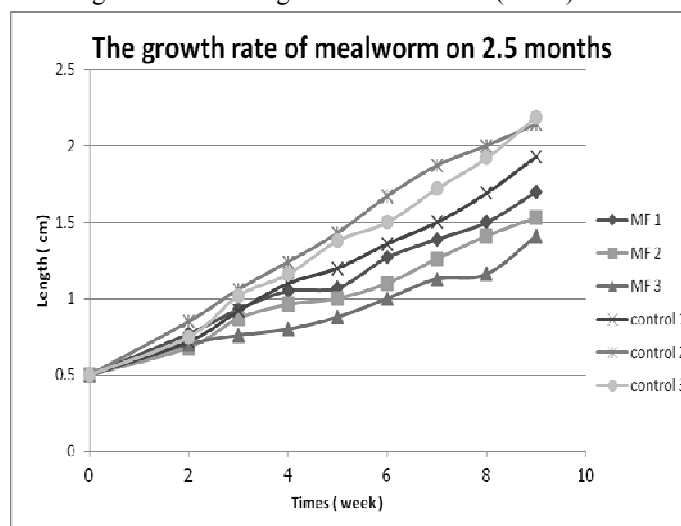
## 3 Methods

This study consists of two parts: the magnetic field generation and the studying of the mealworms growth under influence of the magnetic field. For the magnetic field generation, MF was created using a double-coil of Cu. Each coil had 74 rounds and 28 cm in diameter. The gap between the circular coils was 10 cm. The coils were supplied with 5V from D.C. stabilized power supply. The MF strength from this circuit was 3.2 mT stronger than the Earth MF 100 times. For the studying of the mealworms growth, 90 mealworms of the same generation with the length around 0.5 mm were selected. They are put into six different plastic boxes ( $6.5 \times 9 \times 4.5$  cm), each with 15 mealworms, and fed with 50 g guinea pig food. Three boxes were set in control condition and the other three boxes were set in the MF condition. We observed and record the growth (length) of these mealworms once a week. We use ANOVA to compare their length in different conditions.

## 4 Results

The experiment was carried out for a period of 2 months and a half. The mealworms in the control groups had an average length of 2.19 cm with 0.28 cm SD ( $n=39$ ) and a death rate of 13.33 %. The mealworms in the MF had an average length of 1.61 cm with 0.33 cm SD ( $n=28$ ) and a death rate of 37.77 %. The mealworms in the MF groups were on average 5 mm smaller than those in the control groups and with 22.21% higher death rate. The experiment was continued for 4 months. We found that all of the mealworms in control groups became adult and produced many new generations of larva. In MF groups, we

found that only 6 of 27 mealworms became adult, with an average 2.35 cm in length and 0.34 cm SD ( $n=21$ ).



## 5. Conclusion

The mean lengths of mealworms from two groups were compared using ANOVA. We found that the numbers differ significantly ( $p < 0.05$ ). The mealworms in MF groups were considered significantly smaller than the mealworms in the control groups. We concluded that strong MF can retard the growth rate and the metamorphosis of the mealworm. Since this experiment employed simple population growth model we therefore cannot explain how the strong magnetic field can retard the growth of mealworms, which have complex biological mechanisms. However, results from this experiment could lead to other more thorough investigations that could yield possible applications of MF to benefit human living quality, such as using MF to retard the growth rate of pests.

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## Acknowledgement

I gratefully thank Dr, Decha Thapanya for his advice in this investigation. I also thank the Biology and the Physics Department, Chiang Mai University, for providing rooms and equipment for mealworm cultures and magnetic field measurement, respectively.

# Thai chillies (*Capsicum frutescens* L.) can inhibit the growth of colon cancer (SW620) and gastric cancer (KATO-III)

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## 1. Introduction

Recent report shows that there are about 12 million cancer patients worldwide and around 7 million of them die each year. According to the National Cancer Institute of Thailand, the lowest percentage of cancer patients in Thailand is in the Southern region, where most people have unique consuming behaviour of spicy foods. The fact led me to extract active compounds from fresh and dried chillies and apply them against the antiproliferation of two cancer cell lines: gastric cancer cells (KATO-III) and colon cancer cells (SW620).

## 2. Objectives

To determine the antiproliferative activity on colon and gastric cancer cell lines from fresh and dried chillies in the form of crude extract and in the form of partially purified substance.

## 3. Methods

Fresh and dried chillies (*Capsicum frutescens* L.) (1 kg of each) was used. To prepare dried chillies, fresh chillies were dried at 50 °C for 7 days. Each of the samples (90 g) was separately grinded and extracted by 400 ml of 100% hexane. The extract was named as crude hexane extract (CHE). The pellet was further extracted with dichloromethane (CH<sub>2</sub>Cl<sub>2</sub>) and methanol (MeOH). The fractions were named crude dichloromethane extract (CDE) and crude methanol extract (CME) respectively. Later, all crude extracts were tested for the antiproliferation against KATO-III (human gastric carcinoma, ATCC No. HTB 103) and SW620 (human colon adenocarcinoma, ATCC No. CCL 227) by MTT assay.

Cancer cells were cultured in RPMI 1640 media containing 5% fetal calf serum and incubated at 37 °C with 5% CO<sub>2</sub> for 3 days. DMSO was used as control. The percentage of cell viability was calculated by the formula:

$$\% \text{ of cell survival (PS)} = (\text{Abs test} \times 100) / (\text{Abs control}).$$

Where Abs control is the absorbance of cells treated with DMSO and Abs test is the absorbance of cells treated with any crude extract. Then, the inhibition concentration at 50% (the concentration presenting the 50% of cell viability) was calculated by drawing a graph with an X-axis indicating the concentration and a Y-axis indicating the PS.

The active crude extract was further purified by adsorption chromatography. By Thin Layer Chromatography (TLC), fractions providing the same pattern of chemical compounds were pooled. The antiproliferation of all pooled fractions was again tested by MTT assay as mentioned previously.

## 4. Results

It was shown that crude hexane extract of fresh chillies (HFC), crude dichloromethane extract of fresh chillies (CFC) and crude dichloromethane extract of dried chillies (CDC) could have the antiproliferative activity on both cell lines. The HFC fractions no. 4, 5, 6, 7, 8 and 9, the CFC fractions no. 4, 6, 7 and 8, and the CDC fractions no. 7 and 8 could have the antiproliferative activity on both KATO-III and SW620 cell lines. The table below shows the result of the IC<sub>50</sub> value experiment.

fractions	KATO-III	SW620	fractions	KATO-III	SW620
CFC-F4	>200	117	HFC-F4	145	139
CFC-F6	10	7.25	HFC-F5	>200	200
CFC-F7	50.45	48	HFC-F6	117	72.5
CFC-F8	13	15	HFC-F7	12	8
CDC-F5	>200	161	HFC-F8	20	12
CDC-F7	>200	180	HFC-F9	90	117.5
CDC-F8	45	88			

Table 1 IC<sub>50</sub> values (µg/ml) of some CFC, CDC, HFC fractions on KATO-III and SW620 cancer cell lines.

## 5. Conclusion

Crude hexane extract of fresh chillies (HFC), crude CH<sub>2</sub>Cl<sub>2</sub> extract of fresh chillies (CFC), and crude CH<sub>2</sub>Cl<sub>2</sub> extract of dried chillies (CDC) could perform the antiproliferation against both KATO-III and SW620. Among all obtained fractions of three crude extracts, the fraction no. 6 of CFC presented the highest antiproliferative activity with the IC<sub>50</sub> of 10 µg/ml for KATO-III and of 7.25 µg/ml for SW620.

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# Antioxidant activity and phenolic content in butterfly pea (*Clitoria ternatea* Linn.)

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## 1 Introduction

Butterfly pea is a perennial herbaceous plant native to Asia. In Thailand, its flowers are widely used as medicine and food colouring mixture. In addition, its portions are known to be good source of antioxidants which help remedy various diseases. This fact led us to the study of antioxidant activity from extracts of butterfly pea.



## 2 Objectives

- 2.1 To determine antioxidant activity and phenolic content in butterfly pea.
- 2.2 To compare antioxidant activity and phenolic content between water extract and ethanol extract of butterfly pea.
- 2.3 To analyze active constituents of antioxidant activity by thin layer chromatography (TLC) method.

## 3 Method

The investigation consists of four parts – preparing the sample, determining antioxidant activity, determining quantity of total phenolic contents and analyzing antioxidant activity of each fraction of butterfly pea.

**Preparing the sample by extraction of butterfly pea.** 15 g of fresh flowers of butterfly pea was blended with 75 ml of water, and another 15 g was blended with 75 ml of 95% ethanol using blender machine. Each mixture was centrifuged at 5000 rpm, 4°C for 25 minutes to yield extracts of the flowers. After the supernatant layer, each extract was pipette and kept in appendrof tubes at -20°C

**Determining of antioxidant activity by DPPH scavenging activity method.** DPPH was added to the extract in appendrof tubes, then the mixtures were kept in a dark place for 30 minutes. Next, absorbance was measured using spectrophotometer at wavelength 520 nm, and converted to %scavenging (ability of antioxidant) using the following formula:

$$\% \text{Scavenging} = \frac{(A_{\text{DPPH}} - A_{\text{Blank}}) - (A_{\text{sample+DPPH}} - A_{\text{control sample}})}{A_{\text{DPPH}} - A_{\text{Blank}}} \times 100$$

Both ethanol and water extracts were diluted to ratios of 1:1 1:2 1:3 1:5 (v/v) and antioxidant activity was determined using aforementioned DPPH assay. IC<sub>50</sub> value was then analyzed by plotting a graph between %scavenging and

concentration. IC<sub>50</sub> is the concentration of the substance at which DPPH's color is reduced by half. The more IC<sub>50</sub>, the less antioxidant activity.

**Determining quantity of phenolic contents by Folin-Ciocalteu method.** A standard graph was drawn for 5 different concentrations of gallic acid. These concentrations were prepared by adding 0, 10, 25, 50 and 75 µl of 0.1 mg/ml gallic acid to each test tube and adjust the volume to 300 µl with water. The samples were prepared using 100 µl of each crude extracts and adjusting volume to 300 µl. Folin-reagent was added to each test tube. After 10 minutes, 1 ml of 7.5% Sodium Carbonate was added, and the tubes were allowed to stand for 2 hours. After that, 2 ml of water was added and absorbance was measured using spectrophotometer at wavelength 765 nm. The total phenolic contents were then calculated as mg/g gallic acid equivalents.

**Analyzing antioxidant activity of each fraction of butterfly pea by Thin Layer Chromatography.** Samples of ethanol and water extracts and gallic acid were spotted on TLC plate, then developed in TLC chamber using a mixture of ethyl acetate: isopropyl alcohol: water (1:3:1) as an eluent. After solvent moved to the top of the plate, the plate was removed from the chamber and UV absorbance was observed at 254 nm. Each fraction was scraped out and determined its antioxidant activity using abovementioned DPPH protocol.

## 4 Results

In the determination of antioxidant activity, we found that IC<sub>50</sub> of water extract was 75 mg/ml, while ethanol extract was 126 mg/ml. For the quantity of phenolic contents, we found the quantity in water extract was 30.80 µg/ml and ethanol extract was 26.47 µg/ml as gallic acid equivalents. In an analysis of active fractions, we found 4 fractions from butterfly pea extract at R<sub>f</sub> 0.77, 0.63, 0.51, 0.34 which are related to -6.04, 37.27, 2.81, 25.55 %scavenging respectively.

## 5 Conclusions

Water extract of butterfly pea contained higher antioxidant activity and quantity of phenolic compounds than those of ethanol extract. Gallic acid was separated as one of active components in butterfly pea, but provided least antioxidant activity.

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# Thrombin immobilized Alginate base medical product which reduce coagulation time; New generation band-aid

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## 1 Purpose

For centuries, deaths which based on blood loss has become one of the biggest fears of humanity. Most of the injured soldiers and civilians have lost their lives from loss of blood in wars. In our daily lives a small bleeding cut makes people anxious. Excessive blood loss as a result of serious injuries at traffic accidents and work accidents, stop the bleeding control has primary importance. To this end called out coagulation factors, optimized commercial and capable of stopping the blood products are in the markets. However, many herbal extracts or powders made from containing a variety of products.

The products which herbal extracts are used, when contact with blood, coagulation occurs. However, a lot of herbal extracts contain metabolites and may cause allergic reactions. The most important problem, when substance which provide activation of clotting factors use people who have excessive bleeding, it permeate vessel and stay there then continue coagulation in vessel. Possible conclusion the clot increasingly vessels which supplying the heart cause heart attack, stroke or death or plugging in any vessel cause of embolism.

To stop this kind of bleeding in vital, development of a new method is required. The purpose of this study, reducing the coagulation without creating permanent damage to person and achieve coagulation in the shortest possible time and create a new product which is biocompatible for reducing loss of life. For this aim, our goals are:

- Determination the biocompatible material which used for developed new product
- Rendering the product can be applied for internal bleeding and external bleeding
- Keep the duration of action of the product high
- Make the product is easy to prepare and low cost
- The implementation of this method is to enrich the world of science and medicine

## 2 Method

Coagulation factor plays very big role in the prevention of bleeding. When the extrinsic and intrinsic ways effect each other the consist coagulation. Determinant enzymes are stays on the intrinsic way. At the last step of the coagulation, thrombin enzyme effects fibrinogen and fibrinogen turns to fibrine and it cause blood clot than bleeding stops. In the end the matter is turning fibrinogen to fibrine so increasing thrombin enzymes' activity.

## 3 Results

As a result;

In our study, key enzyme of the clotting mechanism, thrombin, was covalently immobilized to sodium alginate gel beads in order to reduce bleeding time.

- ✓ Sodium alginate was chosen of support material cause of; it is a biopolymer, it isn't being caused of allergic reactions and it is using areas of health sector.
- ✓ The developed product shouldn't be caused of negative situation because, it apply to bleeding wound and it pursuit and in contact with open wound and blood.
- ✓ Sodium alginate's immobilization experiments with thrombin given successfully results and in vitro experiments have resulted in success.
- ✓ Rekalsifikasyon time is a test that might be a reference to bleeding time. Rekalsifikation time trials is determined by coagulation mechanism's intrinsic pathways' enzymes. Rekalsifikation time were reduced by half (%50) with the product.
- ✓ There is a second way for coagulation named extrinsic, extrinsic pathway doesn't effective to determine rekalsifikation time. Here the result to be removed, bleeding time will be reduced further when extrinsic pathway participation to coagulation. So our expectation, bleeding time decrease even more than %50.
- ✓ After storage stability, the product protect activity when it stored at +4°C in gel form according to other temperatures, was detected.
- ✓ Storage life is shorter cause of gel form contained water.
- ✓ The developed product was formed of a band-aid by applique to textile product.
- ✓ Band-aid's storage life is longer than gel form because band-aid doesn't have water.
- ✓ According to precedents in we use today, development product is economic and ecological because it is biocompatible, easily prepare and low cost.

## 4 Conclusion

Thrombin immobilized to calcium alginate beads for this objective. Result of optimization work on 5 calcium alginate beads: optimum pH 5, amount of EDC 3mg, starter thrombin activity 0,6 U, incubation time 1 hour, incubation heat 37°C was in calcium alginate beads activation with EDC. In the end of the research we have seen bleeding was %50 less. The extrinsic way in coagulation wasn't effective for determination of rekalsifikation time. Bleeding time decrease over %50 with participation of extrinsic pathway in rekalsifikation test. Rekalsifikation test results showed us developed product can reduce the bleeding time.

Our new product is better than the other similar product, because ; Our new product is biocompatible, easy to prepare and it is very economic

Our new product is very easy to use and this is very important for first treatment.

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# Investigation of the nutritional value of *Pleurotus Citrinopileatus* and *Dijamor* which has used different propositions of red pepper waste

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## Purpose

World's population is increasing and the food problem is increasing parallel with this increase. People are using fungi like food for years. In this project, more than most people are not recognized by the fungi, enriched in selenium content is intended to be made more favorable for human health. With this purpose, a certain amount of selenium is known to be beneficial for human health and recommended by dieticians to consume fungal organism that will serve a common purpose. As a result of this project high value added economic value to be achieved both for health will be made to achieve an important food item.

In recent years some medical researches with selenium are increased interests of people to selenium element. Especially in the west countries knows the lack of selenium effects to the human health. In human body selenium has too much biologic effect to the human health.

A lot of red pepper is growing in our country, and they are using in many applications. After get separate the fleshy part of the pepper unused portion of peppers are completely disposed as waste to disposal. Red pepper is known to their high nutritional value. This waste is suitable for use as a mushrooms composts.

In this project;

- The waste of red pepper which is not using in anywhere trying to added on cultivation area,
- The waste of red pepper has been used in the fungi which is not known in our country *Pleurotus dijamor* and *Pleurotus citrinopileatus* and trying to hear this types of fungi to our people,
- The waste of red pepper has given to the cultivation area of the fungi with different percents and trying to look at selenium rates of this fungi,
- Composts prepared in different proportions compared with the control group for selenium analyzing,
- *Pleurotus citrinopileatus* and *dijamor* grown up in different compositions of composts
  - Selenium
  - Protein
  - Total phenols
  - Anthocyanin analysis is intended to search increase the nutritional value.

## Method

Firstly wheats are washed and added water, after that they were incubated for absorption of water. The wheats which has absorbed the water sent to the autoclave device and sterilized. After I get the fungi micelles, *Pleurotus citrinopileatus* and *Pleurotus dijamor* micelles were added into the sterilized wheats. I added bran, plaster, straw and different percents of red pepper waste with control group. After substrates sterilization they have incubated in optimum humidity, temperature and light for to cover substrates. After vaccination of micelles, they have incubated for 25 days to cover substrates. After 25 days the packets, which is substrates are in that, are opened and incubated again 10 days for first fungi grows. I get the hat form of fungi which has finished the incubation.

From every try I get a sample and I use them in selenium content, antioxidant, protein and total phenolic content analysis. In LECO device I measured the protein contents, in spectrophotometer device I measured the total phenolic content content and in ICP-MS device I measured the selenium content of fungi.

## Results

Selenium Results	<i>Pleurotus citrinopileatus</i>	<i>Pleurotus dijamor</i>
Control	0.083	0.114
A	0.338	0.268
B	0.220	0.294
C	0.243	0.235
D	0.178	0.137
E	0.146	0.191
Protein Results	<i>Pleurotus citrinopileatus</i>	<i>Pleurotus dijamor</i>
Control	32.89	33.16
A	43.15	36.72
B	37.59	36.95
C	36.98	36.89
D	43.08	37.19
E	44.20	37.76
Total Phenolic Content Results	<i>Pleurotus citrinopileatus</i>	<i>Pleurotus dijamor</i>
Control	245,25	155,42
A	248,98	258,81
B	355,25	335,08
C	467,20	361,53
D	489,24	450,78
E	757,37	646,12

## Conclusion

In this study unused waste materials turned into a material that can show positive effects for human health in mushroom cultivation.

- Unused waste material in mushroom cultivation transformed into a product which would yield positive effects for human health.
- Composts prepared in different proportions than the control group increased amounts of selenium.
- *Pleurotus djiamor* and *Pleurotus citrinopileatus* which has grown in composts with different percents, their selenium content is higher than control group.
- Selenium is really necessary for the human health and we get Selenium from medicines. In that way, we will get Selenium from mushrooms.
- The idea of protein proportions in mushrooms is raised by red pepper waste is proven.
- Red pepper in compost, mushrooms phenol content increases, increased waste. In this way, anti-oxidant properties are increased of Fungi.
- A person which is consume beech mushrooms (the type of includes rich protein and phenol) will continue to lead a healthy life and will protect from cancer disease.
- Nowadays, animal protein products are really expensive. By producing high-value protein contained mushroom was provided to increase the purchasing power of people. Nutrient content of foods to be reinforced in this way is recommended by WHO(World Health Organization), so countries which is less developed and facing with famines can take advantage of that cheaper products.

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# Concentration of photosynthetic pigments in cybride transplastic plants *Lesquerella fendlerixBrassica napus* and their parent forms

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## 1 Introduction

Somatic hybridisation is the way of organism crossing that enables 1) the crossing of phylogenetically distant plant species (organisms); 2) the obtaining of asymmetric hybrids that carries the genes of one parent organism with some chromosomes, organelles and cytoplasm of the other; 3) the fusion of three and more cells; 4) the obtaining of hybrids with the both parent genotypes; 5) the obtaining of plants, heterozygote for extranuclear genes and others. This way the studying of the obtained in the result of somatic hybridisation cybrid plants development as well as the analysis their obtained cell organelles interacting and functioning appears to be important.

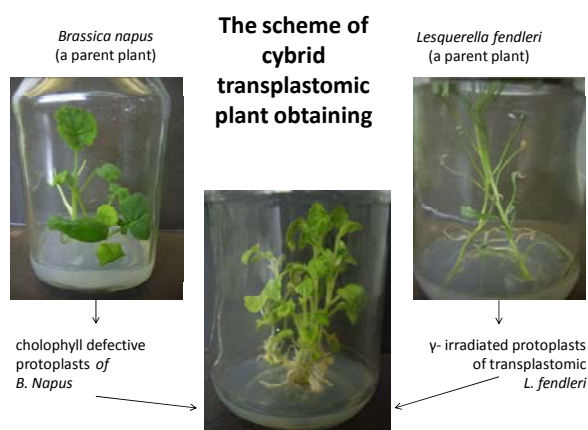
## 2 Research procedure

### 2.1 Purpose

The aim of our work was to analyse the obtained cybride transplastic plants of *Brassica napus* with chloroplasts of *Lesquerella fendleri*.

**Object of the research:** cybride transplastic plants of *Brassica napus* with chloroplasts of *Lesquerella fendleri*

The transplastic plants *Brassica napus* with chloroplasts of *Lesquerella fendleri* were obtained by fusion of chlorophyll defective *B. Napus* plants with  $\gamma$ -irradiated (for nucleous inactivation and cell division prevention before protoplast extraction) protoplasts of transplastic *L. fendleri* in Institute of cell biology and genetic engineering NAS Ukraine [1].



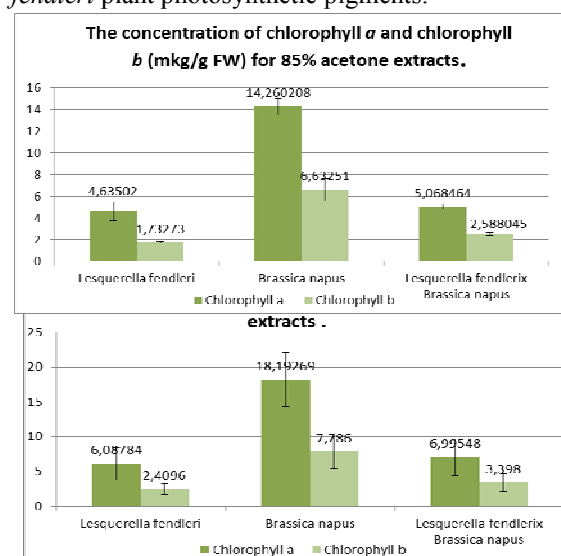
### 2.2 Methods of work

The plants *Brassica napus*, *Lesquerella fendleri* and cybrid transplastic plants were cultivated under the same light conditions at 24°C, 16-hour photoperiod. The pigment extracts of 1 and 2 leaf layer of *Brassica napus*, *Lesquerella fendleri* plants and cybrid transplastic plants (100 mg FW) were obtained in 96% ethanol solution and 85% acetone solution. The concentration of pigments in extracts

was counted basing the optic density data obtained by photoelectrocolorimeter measurement. The fluorescence intensity of the obtained extracts was measured by spectrofluorometer.

## 3 Results

The obtained cybrid may have similar features (the leaf plate form, the leaf plate size, the stem form etc.) and look like *Brassica napus* plants probably due to the nuclear genome effect on their development. When studying out the chlorophyll a and b concentration for cybrid transplastic plants *Brassica napusxLesquerella fendleri* and their parent forms the concentration of cybrid photosynthetic pigments was shown similar to the concentration of *Lesquerella fendleri* plant photosynthetic pigments.



The obtained results show the possible obtaining of *Lesquerella fendleri* chloroplasts by the obtained cybrid plants and these organelle tendency to their independent division.

## Conclusions

The concentration of photosynthetic pigments in cybride transplastic plants *Lesquerella fendlerixBrassica napus* is similar to the chlorophyll concentration in leaf tissues of *Lesquerella fendleri* compared with the original form of *Brassica napus* so that the cybride transplastic plants *Lesquerella fendlerixBrassica napus* probably received chloroplasts from *Lesquerella fendleri*.

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# Virtual screening of biological activity of derivatives of 3,4-dihydroisocoumarin

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## 1 Introduction

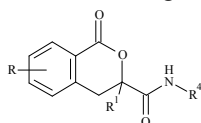
Isocoumarines are widespread in nature [1] and exhibit a wide range of biological effects on plants, animals and humans. Positive activity (antitumor, antibacterial, antiviral etc.) is known, so some of derivatives (mostly natural and semi-natural) was synthesized and some of them is used in medical practice.


Most of the methods used for isocoumarins synthesis are based on derivatives of homophthalic acid and Pd-catalytic reactions, which are too expensive for synthesis on a commercial scale. So we decided to use recently developed method of synthesis of derivatives of isocoumarin, which doesn't require high purity of reagents, special temperature mode or very expensive reagents. This method is based on Cu-catalytic reaction of arylation of unsaturated compounds with arenediazonium salts.

## 2 Research procedure

### 2.1 *In silico* screening of biological activity of isocoumarins derivatives

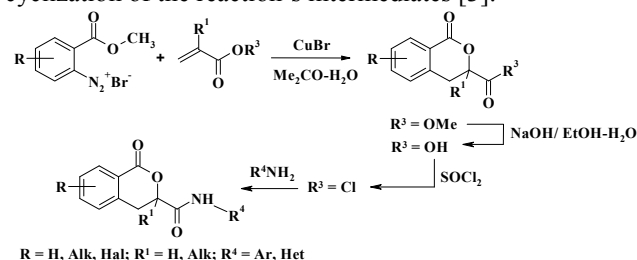
The *in silico* screening of biological activity of the 150 3,4-dihydroisocoumarin-3-carboxamides were carried out using web-service PASS [2]. As a result of the prediction, 15 compounds with the highest probability of detection of biological activity were selected among its. These compounds showed high Pa (probability to be active) in one or some types of biological activity – in range 0.78...0.92 and Pi (probability to be inactive) was lower than 0.01 for all compounds. We'd chosen 6 main types of biological activity for further *in vitro* screening:



R	R <sup>1</sup>	R <sup>4</sup>	Proposed activity
H	H	4-NH <sub>2</sub> SO <sub>2</sub> C <sub>6</sub> H <sub>4</sub>	Antiprotozoal
Br	H	4-NH <sub>2</sub> SO <sub>2</sub> C <sub>6</sub> H <sub>4</sub>	
Cl	H	4-NH <sub>2</sub> SO <sub>2</sub> C <sub>6</sub> H <sub>4</sub>	
H	Me	4-NH <sub>2</sub> SO <sub>2</sub> C <sub>6</sub> H <sub>4</sub>	
Me	Me	4-NH <sub>2</sub> SO <sub>2</sub> C <sub>6</sub> H <sub>4</sub>	
H	H	4-SCNC <sub>6</sub> H <sub>4</sub>	Corticotropin releasing factor antagonist
H	H	2,6-Cl <sub>2</sub> C <sub>6</sub> H <sub>3</sub>	Cardioprotectant
H	H	4-MeOC <sub>6</sub> H <sub>4</sub> CH <sub>2</sub> CH <sub>2</sub>	
H	Me	2-CH <sub>3</sub> C <sub>6</sub> H <sub>4</sub>	Anti-ischemic
H	Me	4-CH <sub>3</sub> C <sub>6</sub> H <sub>4</sub>	
H	Me	4-FC <sub>6</sub> H <sub>4</sub>	
H	Me	2,4-Me <sub>2</sub> C <sub>6</sub> H <sub>3</sub>	
H	Me		Treatment of acute neurological disorders
H	Me	4-NH <sub>2</sub> SO <sub>2</sub> C <sub>6</sub> H <sub>4</sub>	Dopamine agonist
Me	Me	4-NH <sub>2</sub> SO <sub>2</sub> C <sub>6</sub> H <sub>4</sub>	

### 2.2 Synthesis of isocoumarins derivatives

Selected compounds were synthesized by arylation reaction of unsaturated compounds (methyl acrylate, methyl methacrylate) with *ortho*-methoxycarbonylarenediazonium bromides, obtained from the corresponding substituted methyl anthranilates, with following intramolecular cyclization of the reaction's intermediates [3]:



### 2.3 *In vitro* screening of biological activity of isocoumarins derivatives

*In vitro* screening studies of antibacterial and antimicrobial properties of the synthesized compounds by diffusion in agar in clinical strains of *Staphylococcus* and *Candida* fungus are conducted in Ivano-Frankivsk National Medical University. The levels of activity are determined by the values of diameters of the stunted growth zones of test strains. Preliminary results indicate commensurate antimicrobial activity compared to standards (Rivanolum, Aethonium) against certain strains of *Staphylococci*. Also, some compounds show similar antimicrobial activity of Chlorhexidine against some clinical strains of *Candida albicans*.

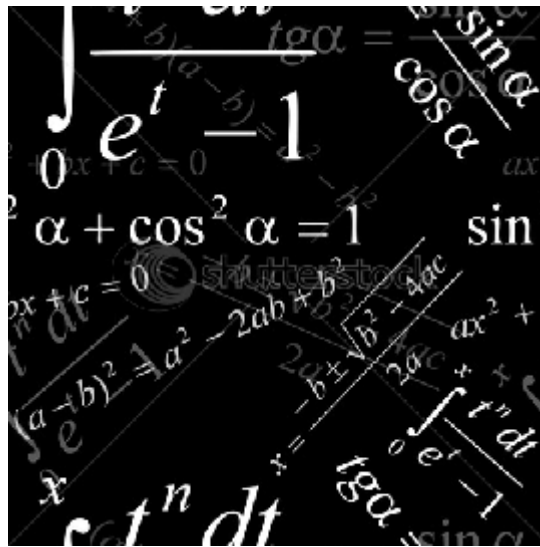
## 3 Conclusions

The *in silico* screening of biological activity of the 3,4-dihydroisocoumarin-3-carboxamides were carried out using web-service PASS. Selected compounds were synthesized by arylation reaction of unsaturated compounds with *ortho*-methoxycarbonylarenediazonium bromides, obtained from the corresponding substituted methyl anthranilates, with following intramolecular cyclization of the reaction's intermediates. Obtained compounds are on *in vitro* screening studies now. Preliminary results are being analyzed.

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# Mathematics



**Radboud University Nijmegen**  
The Netherlands 2012

# Generalized conjugate-permutable subgroups and their applications

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## Introduction

All groups under consideration will be finite.

The central object of group theory is the notion of normal subgroup. It is well known that if  $H$  is a normal subgroup of a group  $G$  then  $H$  permutes with every subgroups of  $G$ . In 1937 O. Ore [1] introduced the notion of quasinormal subgroup. A subgroup  $H$  of a group  $G$  is called quasinormal in  $G$  if  $H$  permutes with all subgroups of  $G$ . It was shown that not every quasinormal subgroup is a normal subgroup, but it was shown that every quasinormal subgroup is subnormal. In 1997 T. Fogel [2] introduced the conception of conjugate-permutable subgroup. A subgroup  $H$  is called conjugate-permutable if  $H$  permutes with all its conjugates.

In this paper we introduce a generalization of conception of conjugate-permutable subgroup.

**Definition.** Let  $R$  be a subset of a group  $G$ . We shall call a subgroup  $H$  of  $G$   $R$ -conjugate-permutable if  $HH^x = H^xH$  for all  $x$  in  $R$ .

Note if  $R = G$  then  $R$ -conjugate-permutable subgroup is conjugate-permutable and if  $R = \{1\}$  then every subgroup is  $R$ -conjugate-permutable.

## 1 The purpose of the investigation

One of the central problems of group theory is the characterization of the groups on the properties of given systems of their subgroups. As such systems are usually considered all maximal, minimal, Sylow, cyclic primary subgroups, products of subgroups and etc.

The aim of our investigation is to describe the finite groups in which the above-mentioned subgroups' system is composed of  $R$ -conjugate-permutable subgroups.

## 2 Method of the investigation

A distinguishing feature of this project is the use of new methods based on the choice for  $R$  Fitting subgroup  $F(G)$  and their generalizations  $\tilde{F}(G)$  and  $F^*(G)$  and use of their properties.

Fitting subgroup  $F(G)$  of a group  $G$  is a maximal normal nilpotent subgroup.

A generalization of Fitting subgroup  $\tilde{F}(G)$  was introduced by P. Schmid [4] and defined by  $\Phi(G) \subseteq \tilde{F}(G)$ ,  $\tilde{F}(G)/\Phi(G) = \text{Soc}(G/\Phi(G))$ .

A subgroup  $F^*(G)$  is another generalization of Fitting subgroup. It was introduced by H. Bender [5] and defined by  $F^*(G)/F(G) = \text{Soc}(C_G(F(G))F(G)/F(G))$ .

**Example** Let  $G$  be the symmetric group of degree 4. Let  $H$  be 2-Sylow subgroup of  $G$ . Then  $H$  is a maximal subgroup of  $G$ , which is not a conjugate-permutable subgroup. Note

$F(G) = F^*(G) = \tilde{F}(G) \subseteq H$ . Thus,  $H$  is a  $F(G)$ -conjugate-permutable subgroup in  $G$ .

## 3 Main results

**Theorem A.** A group  $G$  is nilpotent iff all maximal subgroups of  $G$  are  $\tilde{F}(G)$ -conjugate-permutable.

We show that we can not use  $F^*(G)$  in place of  $\tilde{F}(G)$  in theorem A.

**Theorem B.** A group  $G$  is nilpotent iff all Sylow subgroups (all abnormal subgroups, normalizers of all sylow subgroups) of  $G$  are  $F^*(G)$ -conjugate-permutable.

**Theorem C.** A group  $G$  is nilpotent if all cyclic primary subgroups of  $G$  are  $F^*(G)$ -conjugate-permutable.

We show that inverse of Theorem C is false.

**Theorem D.** A group  $G$  is nilpotent iff  $G = AB$  where  $A$  and  $B$  are nilpotent  $F(G)$ -conjugate-permutable subgroups of  $G$ .

**Theorem E.** A group  $G$  is supersoluble iff  $G = AB$  where  $A$  and  $B$  are supersoluble  $F(G)$ -conjugate-permutable subgroups of  $G$ . and  $G'$  is nilpotent.

## 5 Conclusion

From theorems A and B as corollaries we have well known criteria of nilpotency of group  $G$  in terms of normality of its Sylow and maximal subgroups. From theorems A, B, C as corollaries we have some results from [2] and theorems 2.3 and 2.4 [3]. Also we generalized Baers' theorem [6].

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# The history of substitutions ciphers

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## 1 The purpose of the investigation

The goal of this paper is to show the history of cryptology and classic hand substitution ciphers from antiquity to the beginning of the 20th century. It is associated with names like Gaius Julius Caesar, Abú Júsuf Jaqúb ibn Isháq ibn as-Sabbáh ibn Omrán ibn Ismail al-Kindí, Johannes Trithemius, Friedrich Wilhelm Kasiski, Guglielmo Marconi and a lot of other famous people. History of cryptology can be seen as a fight between creators of ciphering systems and scholars who use knowledge parts from language studies, math and logic to decipher encrypted text without the knowledge of the used system or password. The goal of the research part of paper is verifying this hypothesis: Latest ciphering systems are more complex for deciphering, this means, and that they have better defence against, cryptanalysis than older ciphering systems. During time the cipher text is more like random generated sequention of letters.

## 2 Method of the investigation (in comparison with known methods)

Introduction to the history of encryption based on the study of literature, followed by selection and a detailed description of the five substitution cipher systems created in various stages of human history. It is atbash cipher, Vigenère's cipher, Plaifair's cipher, Delastelle's cipher BIFID and a cipher known as Fractionated Morse.

English plain text and its translation into Czech language is encrypted with the selected encryption systems. A passage from bilingual version of a book called Tracy's Tiger was used. Both plain texts and all cipher texts are explored by frequency analysis and calculated the index of coincidence.

## 3 Results of the experiment

The results of frequency analysis essentially confirm the given hypothesis, which we accept as a rule. Apparent exception is Vigenère's cipher with the low index of coincidence, but in reality it is easy to solve this ciphering system.

## 4 Conclusion

Vigenère's cipher is the exception. However, the fact does not invalidate. The reason is that the frequency of the letters is very similar and so is the index of coincidence. So we could say Vigenère's cipher is as a beautiful house built from bad bricks.

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## SECOND AMAZING PROPERTY OF BISECTORS

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Several Years ago in 2008 we had a research project about amazing properties of bisector [1]. We solved the problem of Sharygin, which was the following:

**If two line segments formed from connecting the bases of triangle's bisectors are equal, is the original triangle isosceles or not?** We found all the possible triangles.

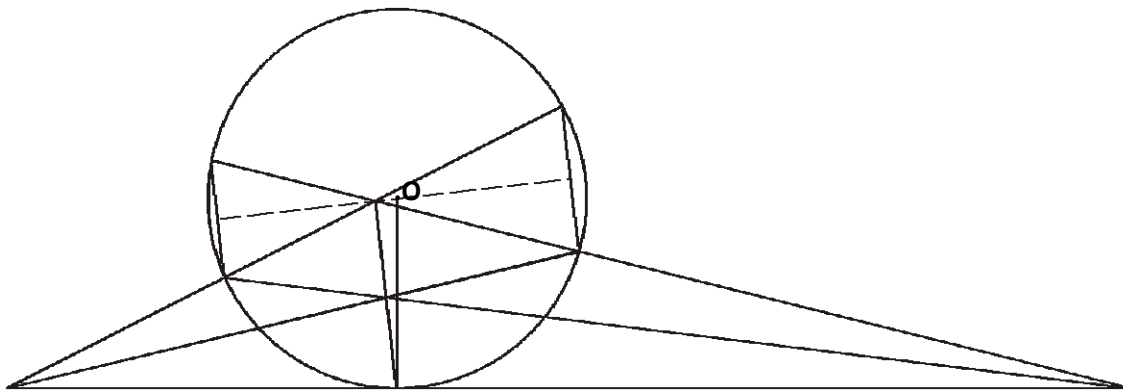
Coming back from the presentation in Chernivtsi our supervisor Mamuka Meskhishvili posed a new problem which was the following:

**If the circle passes through the bases of bisectors and tangents one of the sides, will the triangle be always isosceles?**

This time we succeeded to find all the possible triangles. This happens when an angle  $\angle C$  is obtuse and is within:

$$138^{\circ}35'25'' < C < 139^{\circ}17'13''$$

This is one of our triangles:



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## Generalization of DePalerma problem

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Two best mathematicians of Frederic II, brothers DePalermas made up a problem for greatest mathematician Leonardo Fibonacci (Fibonacci). He had to find a number which would be a perfect square and if we add or subtract 5 from it, we should get also a square number [1-2].

Fibonacci solved this problem. This number is

$$\left(\frac{41}{12}\right)^2$$

$$\left(\frac{41}{12}\right)^2 + 5 = \left(\frac{49}{12}\right)^2 \quad \left(\frac{41}{12}\right)^2 - 5 = \left(\frac{31}{12}\right)^2$$

We could generalize this problem and found new solutions for Fibonacci's problem.

Second solution for Fibonacci case is:

$$\left(\frac{3344161}{1494696}\right)^2$$

And the third one is:

$$\left(\frac{2498505940 \ 4727155836 \ 44801641}{1116723858 \ 0859145436 \ 5352960}\right)^2$$

We can find new solutions with the help of our recurrence relation:

$$X_{n+1} = \frac{(X_n^2 + r^2)^2}{4X_n(X_n^2 - r^2)}$$

Given formula has a nice geometrical sense. It is addition operation for elliptic curve-  $\oplus$  [3-5].

If given two  $P$  and  $Q$  rational points on the curve, draw a line through these points. The third point on the curve, where this line intersects the curve is  $P \oplus Q$  and it will be also rational. If  $P = Q$  just draw the line tangents to  $P$ . Obtained point where this tangent intersects the curve will be rational too. In scientific literature this case is denoted by

$$P \oplus P = [2]P .$$

New solution from our recurrence formula is:

$$(x_{n+1}; y_{n+1}) = [2](x_n; y_n)$$

i.e. if we draw tangent to  $(x_n; y_n)$ , intersection point of tangent and curve is  $(x_{n+1}; y_{n+1})$ .

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## Nearly-Perfect Cuboid

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A perfect cuboid (PC) is a rectangular parallelepiped with integer sides  $(a, b, c)$  whose face diagonals  $(d_{ab}; d_{ac}; d_{bc})$  and space (body) diagonal  $(d_s)$  are integers. The existence or otherwise of (PC) is a problem known since at least the time of Euler. In [1] is noted that nearly-perfect cuboids are known to exist. These are cuboids with only one of  $a, b, c, d_{ab}, d_{ac}, d_{bc}, d_s$  rational. In our project are found nearly-perfect cuboids with one irrational face diagonal.

Finding instances of PC is equivalent to finding solutions of the following system of Diophantine equations:

$$\begin{aligned} a^2 + b^2 &= d_{ab}^2 \\ b^2 + c^2 &= d_{bc}^2 \\ a^2 + c^2 &= d_{ac}^2 \\ a^2 + b^2 + c^2 &= d_s^2 \end{aligned}$$

A solution with integer space diagonal and two out of three face diagonals is

$$\begin{aligned} a &= 627 \\ b &= 53 \\ c &= 104 \end{aligned}$$

$$\begin{aligned} d_{ab} &= 3\sqrt{52777} \\ d_{ac} &= 680 \\ d_{bc} &= 185 \\ d_s &= 697 \end{aligned}$$

which was known to Euler [2].

In our work we found new method of finding of nearly-perfect cuboids. Our numerical cases:

$$\begin{aligned} a &= 5035485, \\ b &= 7050868, \\ c &= 8968176 \end{aligned}$$

$$\begin{aligned} d_{ab} &= \sqrt{75070848738649} \\ d_{ac} &= 10285149 \\ d_{bc} &= 11408020 \\ d_s &= 12469925; \end{aligned}$$

$$\begin{aligned} a &= 5079408 \\ b &= 1762717 \\ c &= 2242044 \end{aligned}$$

$$\begin{aligned} d_{ab} &= \sqrt{28907556852553} \\ d_{ac} &= 5552220 \\ d_{bc} &= 2852005 \\ d_s &= 5825317 \end{aligned}$$

These solutions are impossible to obtain by known methods [3,5].

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# Ideas to the Collatz-problem

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## 1 The Collatz-problem

The Collatz-problem is one of the unsolved mathematical problems. It was posed by Lothar Collatz 1937 and it's also called the Hasse's algorithm, Kakutani's problem, Ulam's problem and – because of its task – the  $3x + 1$  mapping or  $3n + 1$  problem. The task is the following:

Let  $n$  be a natural number. If  $n$  is even, divide it by 2 to receive  $n/2$ . If  $n$  is odd, multiply  $n$  by 3 and add 1 to get  $3n + 1$ . Now, repeat this indefinitely. Lothar said that – and that is the conjecture – you will always reach 1 at some time.

## 2 The ideas to the conjecture

In my presentation I want to show a way how to proof the Collatz-conjecture. In this proof I exclusively used simple methods of mathematics. The ideas are the following:

In case of  $n = 1$  the conjecture is true. So I have to proof it's true as well for every  $n > 1$ .

Let's assume, the conjecture is true for every natural number from 1 up to  $n - 1$ . When I proof that  $n$  gets after a certain number of repetitions to a number, which is more low than  $n$ , then I have proofed that the Collatz-conjecture is true for  $n$  because all numbers lower than  $n$  will get at some time to 1.

Lemma 1:

If every number  $n > 1$  get to any number more low than  $n$ , then it's proofed that every number is a Collatz-number (that's a number, which is complied with the Collatz-conjecture).

It's simple to accept this:

The conjecture is true for  $n = 1$ . If  $n = 2$  gets after a certain number of repetitions to a number more low than 2 (here: 1), then  $n = 2$  comply the Collatz-conjecture. Since  $n$  gets to 1 and the conjecture is true for  $n = 1$ , the conjecture is true for  $n = 2$ , too. If  $n = 3$  gets at some time to a number more low than 3 (here: 1 or 2), then it's a Collatz-number, too. Since  $n$  gets to 1 or 2 and the conjecture is true for  $n = 1$  and  $n = 2$ , the conjecture is true for  $n = 3$ .

And so on.

Therefore, the problem is simplified to an easier one because you not have to show that every number gets to 1 but that every number gets to a more low number.

## 3 The proof of the collatz-problem

To verify the collatz-problem you have to verify that every natural number gets to a more low number. Therefore, I differ some cases:

I.  $n$  is even. Then you can also write for  $n$  (let  $t$  be a natural number):

$$n \equiv 0 \pmod{2} \rightarrow n = 2t$$

Now, you have to divide  $2t$  by 2 because it's even. So you get  $t$ . Since  $2t > t$  is true, every even number gets to a more low number.

II.  $n$  is odd. I split this case in more cases because it's easier then – and I chose  $n \equiv 1 \pmod{8}$ ,  $n \equiv 3 \pmod{16}$ ,  $n \equiv 5 \pmod{8}$ ,  $n \equiv 11 \pmod{16}$  and  $n \equiv 7 \pmod{8}$ .

You can proof these cases like that:

$$n \equiv 1 \pmod{8} \rightarrow n = 8t + 1$$

First you have to multiply  $n$  with 3 and add 1:

$$3n + 1 = 3(8t + 1) + 1 = 24t + 4$$

$24t + 4 = 2(12t + 2)$  is an even number. So you have to divide it by 2 to get the next number – it's  $12t + 2$ .

$12t + 2 = 2(6t + 1)$  is an even number, too. So you have to divide it by 2 as well. You get  $6t + 1$ .

Since  $8t + 1 > 6t + 1$  is true, every number  $n \equiv 1 \pmod{8}$  gets to a more low number.

The other cases you can proof on similar ways.

If this is done, every case was reviewed, so the Collatz-conjecture is true and proofed.

## References

I did not use any references for the proof.

# Rediscovering The Euler's Theorem

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## 1 Purpose of research

In each calculation of mathematics, we always face the fractional number. Nowadays, with the development in mathematics, the fractional number become complicated. Determining or finding the fractional number is often we did in elementary school. But, how can we find the number of proper fraction are there on a wide sequence of fractional number, of course, we will face a big problem. See that problem, we try to solve it by new method that is easy.

## 2 Method of research

We do a combination from several derivation of mathematics formula. In the reality, how much the proper fraction in a sequence of fractional number with the same denominator is depended on the how much the prime factor on it. Through the factorization, it is easy to find the prime factor of the denominator. Using that prime factor, we can determine how much the proper fraction in very wide sequence of fractional number with same denominator. With using the combination to that prime factor, we get the general equation, but it is very long equation if the denominator has many prime factors. In order to make it simple, we try to find a method to simplify that equation, which is using the polynomial concept. We see that the pattern of polynomial is same with our equation.

## 3 Result of research

So, the final general solution that we get is :

$$y = \frac{n}{f_1 f_2 \dots f_n} (f_1 - 1)(f_2 - 1) \dots (f_n - 1) \quad (1)$$

Note :  $y$  is the number of proper fractions.

This is like Euler's Theorem, but the derivation that we use is easier (using sequence of fractions) than Euler's derivation, so it can be understood easily by us. In other word, an elementary school student also can understand about Euler's Theorem without have to learn about math subject in university.



# Kodu in Co-Geo: A game based learning in mathematics

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## 1 Introduction

This project is about developing game based learning using simple programming from Kodu World. It focuses on Coordinate Geometry as a pioneer project due to their complementary element both in the Kodu World and the concepts rely on the topics itself. This project started in February 2012 and has been developing since then by the Kodu Team in Alam Shah Science School, Malaysia.



Fig. 1 The screenshot showing the starting of kodu game

## 2 Problem Statement

Conventionally, it is believed that lecture by mathematics teachers in their classroom is a good way to transmit knowledge. Problem-centered teaching starts by giving students a real world problem. Students are expected to solve the problems by themselves, albeit under the guidance of the teacher. But the key strategy of mathematics teaching should focus on keeping the students' interests on mathematics. If the students are interested in learning mathematics, then the teacher's task becomes easier. Unfortunately, the traditional teaching methods pay more attention on teachers. Thus, Mathematics lesson should offer alternative methods as a better effort to meet the needs of the new generation today.

## 3 Objectives

The main purpose of this project is to create an effective way to engage today's youths as they learn mathematics. Through playing and developing games which also serve as educational tools, we have invented some video games embedding the concepts of plotting the points, gradient, distance, and mid-point in Coordinate Geometry as an elementary stage. This project involved Kodu programming which is designed to be accessible for the students and enjoyable for anyone. Hogle, J.G.(1986) found that use of a game for learning mathematics intrinsically motivating, appropriately challenging, as well as offering elements of curiosity, fantasy and control. Therefore, this invention

consists a set of games that involved challenge, usually against one or more opponents, governed by a set of rules and have a distinct finishing points.



Fig. 2 The screenshot showing an example of instruction on the game

## 4 Content

This set of game used Kodu language because it is specifically designed for game development and provides specialized primitives derived from gaming scenarios. The language is simple and entirely icon-based. The game developer can composed the programs in pages, which are broken into condition and action. Programs are expressed in physical terms, using concepts like vision, hearing, and time to control character behavior. This game was developed with a built-in learning process that makes the game enjoyable. The progress a player makes in this game is through learning the selected concepts in Coordinate Geometry. The process of understanding a new concept through gaming makes an individual feel a sense of reward whether the game is considered entertaining or vice-versa. Well-designed games can motivate the player to face the challenge in an interactive experience that actively engage learners in the learning process. Rules and goals inspire motivation and provide immediate outcomes and feedback. All sets of games have problems solving situation that sparks creativity.

## 5 Conclusion

With this pioneer project, we hope that it can be further explored by all students around the world. Kodu in Co-Geo involves fantasy elements that engage students in a learning activity through narrative or storyline. It can motivate students and allow them to develop awareness to consequentially. Students that participate in playing Kodu in Co-Geo can offer deeper, more meaningful insights in all academic areas.

# Heterogeneity of the spatial distribution in cases of chromosomal pathology and identification of potential risk factors for disease

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## Introduction

Trisomy of chromosome 21 (T21; Down syndrome, DS) is the most common aneuploidy in live births [1] with a frequency of 1 in 600 newborns.

The only established risk of having DS pregnancy is highly associated with advanced mother's age [2]. Nevertheless, the majority of children with DS (60%) born to young mothers. A number of other factors have been suggested to increase the risk of DS, however consistency between studies has been poor and they did not provide substantial evidence of the increased risk in birth of DS children from young parents [4].

## Objective

The aim of our study was to examine space distribution of DS cases and its possible conjugation with geologically active zones (GAZ) within geographically defined region of St Petersburg City. The following problems were performed: (i) DS cases mapping; (ii) identification of DS clusters in separate houses; (iii) evaluation of the distribution of DS mothers by age inside and outside the clusters; (iv) identification of DS agglomerations over the large areas; (v) collation of DS agglomerations with zones of active breaks (geological structures that produce a complex of physical and chemical entities including radon and heavy metals).

## Materials and methods

The study comprises 2431 cases of Down syndrome including 2102 live births and 329 prenatally diagnosed fetuses delivered during 1970-2009. The data were abstracted from The St Petersburg Register for Down syndrome. All cases were karyotyped pre- or postnatally. The cases of siblings or inherited and presumably inherited T21 (e.g. two or more cases of abnormal pregnancy) were excluded.

The information about the number of houses in St Petersburg and also the number of flats and floors in specific buildings were abstracted from St Petersburg Committee for State Property Management. The information on the geological structures in the city was provided by St Petersburg State Mining University.

The study area comprised a geographically defined region of St Petersburg City with low levels of migration into or out the region. The mapping was conducted using geographic information system "2GIS Software". For this purpose we developed an application for visualization addresses within geographic map and expressing additional information.

Collected data were analyzed using binomial test and Fisher exact test for confidence level  $p < 0,05$  [3].

## Result

We found spatial inhomogeneity in distribution of DS cases. Identified 253 cases of births / conceptions of several unrelated individuals with T21 in the same house, including: 23 - of the three cases, 5 - of 4 and 2 - of 5. Analysis of the agglomeration of DS cases showed that they mostly coincide with the nodes of tectonic fractures.

## Conclusion

Our data suggest the influence of zones of discomfort in the biodiversity on mutation process in the human germ cells. Studies of GAZ conjugacy with single-nucleotide polymorphisms of DNA variability and spontaneous level of chromosomal aberrations in somatic cells will explore the nature and mechanisms of GAZ impact in terms of health and dynamics of the mutational variability in the population.

## Acknowledgement

I am greatly indebted to PhD Natalia Kovaleva (St Petersburg State Pediatric Medical Academy, Russian Federation) and D.Sc. Eugeniy Melnikov (St Petersburg State Mining University, Russian Federation) whose statement of the problem and account to the study made this work possible.

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# Quivers of self-injective algebras

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## 1 Introduction

Let  $k$  be an algebraically closed field. It is a well-known fact, that each finite-dimensional  $k$ -algebra can be uniquely associated with a quiver that is a directed graph. The representation theory of any finite-dimensional algebra  $A$  is reduced to the representation theory of some path algebra with relations  $kQ/I$ . In this case, the quiver  $Q$  is uniquely determined and called quiver of an algebra  $A$ . So in the representation theory of finite-dimensional algebras all questions are reduced to questions about path algebras with relations. So path algebras with relations are of our interest.

## 2 Objective

The class of self-injective algebras is very interesting for study, because it includes many useful types of algebras such as a very important class of group algebras or Frobenius algebras. The purpose of our work is to establish what sort of quivers is generated by self-injective algebras.

## 3 Materials and hypothesis

Usually the representation theory of finite-dimensional algebras (especially when specific algebras are considered) arises in studying two big classes of algebras: algebras of finite homological dimension and self-injective algebras. In the class of algebras of finite homological dimension there is a subclass of algebras which is called hereditary algebras. There is a theorem which states that a path algebra with relations  $kQ/I$  is a hereditary algebra if and only if the quiver  $Q$  does not have oriented cycles and  $I$  equals zero. Thus a quiver of a hereditary algebra does not have oriented cycles.

The class of algebras of finite homological dimension and the class of self-injective algebras are somewhat opposite to each other, so our hypothesis is that a quiver of a self-injective algebra has to be covered by cycles, i.e. each arrow of the quiver can be completed to a directed cycle.

## 4 Methods and results.

The answer to this question is very simple: a quiver of a self-injective algebra has to be covered by cycles, i.e. each arrow of the quiver can be completed to a oriented cycle. More precisely, some quiver is a quiver of some self-injective algebra if and only if it is covered by cycles. This result was expected, because the class of algebras of finite homological dimension and the class of self-injective

algebras are somewhat opposite to each other. But the proof is rather complicated.

The proof that a quiver of some self-injective algebra is covered by cycles is quite simple, and in some particular cases it can be found in literature (e.g. for symmetric algebras), but the proof that any quiver covered by cycles is a quiver of some self-injective algebra presents more difficulty. To prove this, we wanted to “join” algebras to each other, but we could not define this operation in the language of algebras. So we had to introduce a new language, in which path algebras are replaced with path categories with zero morphisms, finite-dimensional algebras are replaced with nilpotent categories and Frobenius algebras are replaced with Frobenius categories. First we answer the question in this language and then we return to the language of algebras by considering “morphism algebras” of these categories and answer the initial question.

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# Test Felner's criterion for some sequences of subsets of Thompson's group F

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## 1 Introduction

Thompson's group F is an interesting mathematical object. This group allows for some interesting interpretations and has a rare set of properties. One of the open problem associated with this group - is its amenability or the existence of a no degenerate finite-additive measure on the set of subsets that is invariant under translations.

## 2 The purpose of the investigation

Using Felner's criterion, one can try to positively solve the problem of amenability by searching the correct sequence. What I did in this paper.

## 3 Results

In this paper we consider some sequences of subsets of Thompson's group F, for whom as a result of the counting limit was found out that they are not Felner's sequences, and was proved a theorem stating that Thompson's group F is impossible to construct a countable additive left-invariant probability measure.

## 4 Conclusion

In this paper has been significantly narrowed the class of sequences that can satisfy by the Felner's criterion, and proved a very important theorem stating that Thompson's group F is impossible to construct a left-invariant countably additive probability measure.

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# Confidence intervals in hypothesis that means are equal

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## 1 Introduction

Problem of constructing a *confidence interval* for difference between means of two normally distributed populations frequently appears in mathematical statistics. Such confidence intervals emerge in applications of statistics in physics and engineering. The most general case of the problem is called Behrens-Fisher problem, which has no exact solution yet known. It is of particular theoretical interest.

## 2 Objective

A goal of our work was to improve methods of constructing confidence intervals developed in previous works by Fisher and Welch.

## 3 Methods and results

What we do is construct a confidence interval for each of the two populations using Fisher lemma. Thus we get two inequalities, each describes a confidence interval for the population mean and

holds with certain probability  $1-\alpha$ . After that we simply subtract one inequality from another, thus obtaining an inequality, probability of holding of which lies within  $1-\alpha$  and 1. We call an interval described by such an inequality *almost confident*.

We prove some properties of the obtained almost confident interval, the most important being that under some condition, too complicated to be placed in this abstract, our interval covers difference between means more precisely than t-test confidence interval.

It is proved that difference between radii of those intervals converge to zero as sample lengths approach infinity.

Thus we achieve our objective.

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# An estimate for growth rate of epsilon entropy for infinite dimensional compact sets in a Hilbert space

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## 1 Introduction

Theory of approximation is one of the classical areas of mathematical analysis. First step in approximation problems is a proof of the possibility of approximation with any precision. Probability of uniform approximation of the continuous functions with polynomials is deduce from classical Weierstrass theorem. On the next step the task about estimate approximation growth rate and a number of polynomials that is needed to approximation set of functions (for example, a manifold of differentiable functions with bounded derivative) with any precision arise. Generalization of these questions led A.N. Kolmogorov to the introduction of the notion of the epsilon entropy of compact subset in a metric space.

## 2 The purpose of the investigation

In this work I have studied and proved estimate growth rate of the epsilon entropy for a different infinite dimensional compact sets in a Hilbert space.

## 3 Method of the investigation (in comparison with known methods)

Let  $X$  is metric domain and  $N(K, \epsilon)$  is minimum cardinal number of  $\epsilon$ -circuit of manifold  $K$ . Apparently, if  $K$  is a compact, then  $N(K, \epsilon)$  approach to infinity for all  $\epsilon > 0$ .

Function  $H(K, \epsilon) = \log_2 N(K, \epsilon)$  is called an  $\epsilon$ -entropy of manifold  $K$ . It is necessary to notice that if  $K$  is a compact set in complete space  $X$ , then its  $\epsilon$ -entropy will be ascertain for all  $\epsilon$ .

Then I consider space  $l^k$  and enter some sequence of real positive monotonically decreasing sequence. It is quite clear that we can generalize ellipsoid definition for  $l^k$ , where this sequence will be his axes.

In this paper I have proved that if sequence approach to 0, then ellipsoid is a compact set.

## 4 Results of the experiment

Main result in the paper is a theorem, which improves and generalizes the estimate ellipsoid  $\epsilon$ -entropy for  $l^k$  received by Alex Yezhikov ([3]):

$$n \log_2 \frac{1}{\epsilon} + \sum_{i=1}^n \log_2 a_i < H(\epsilon) < n \log_2 \sqrt{\frac{2^k - 4}{2^k - 1}} \frac{1}{\epsilon} + \sum_{i=1}^n \log_2 a_i \quad (1)$$

$$\text{where } a_{n+1} < \frac{\epsilon}{2} < a_n \quad (2)$$

Also, I have examined  $H(\epsilon)$  for different sequences and proved that  $\log_2(1/\epsilon)$  is exact bottom set of  $\epsilon$ -entropy for every possible ellipsoids in every  $l^k$ , where  $k$  is natural number. We can made  $H(\epsilon)$  arbitrary close to  $\log_2(1/\epsilon)$  changing sequence.

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# Parallels and Hyper-parallels in Hyperbolic Geometry

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## 1 Introduction

Researches on parallel and hyper-parallel lines in hyperbolic geometry represent a part of a very important theoretical and practical knowledge in geometry and, more widely, in mathematics.

A concept of parallel lines in hyperbolic geometry differs from the perception of parallels in Euclidean geometry.

Hyperbolic geometry is based on Axioms of absolute geometry, and the parallel postulate of Euclidean geometry is replaced with the Lobachevsky postulate.

Lobachevsky postulate: In two dimensional space, for any given line  $a$  and a point  $B$  not on  $a$ , there are at least two distinct lines through  $B$  that do not intersect  $a$ .

There are two types of parallel lines in hyperbolic geometry – parallels and hyper-parallels.

## 2 Definitions

Let the line  $a$  and a point  $B$  (not on  $a$ ) both in the hyperbolic plane.

Boundary lines,  $a_1$  and  $a_2$ , are said to be asymptotic to the line  $a$  in a point  $B$ , if they divide two sets of lines - a set of lines which contain  $B$ , and intersect with  $a$ , and a set of lines which contain  $B$  and does not intersect with  $a$ . One of these lines is said to be parallel with  $a$  in one direction, and the other one is said to be parallel with  $a$  in the opposite direction.

All other lines which contain point  $B$ , nonintersecting with  $a$ , are said to be hyper-parallel (ultra-parallel) with  $a$ .

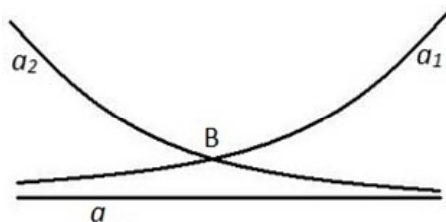


Fig. 1. Lines  $a_1$  and  $a_2$ , asymptotic to line  $a$

## 3 Main Results

Next hypotheses for asymptotic and hyper-parallel lines are considered in this research.

**Theorem 1:** The angle of parallelism is acute.

**Theorem 2:** Let a point  $B$  be an end point of a ray parallel to a line  $a$ , and  $K$  any point on that ray, and  $B'$  and  $K'$  orthogonal projections of  $B$  and  $K$  on  $a$ . Then  $\angle B'BK' < \angle BB'$ .

**Theorem 3:** Let  $a$  and  $b$  be two parallel lines, and  $l$  any segment. There is exactly one point  $L$  on  $b$ , with orthogonal projection  $L'$  on  $a$ , such that  $\angle LL' \cong l$ .

**Theorem 4:** There is exactly one line in hyperbolic plane, perpendicular to one arm of an acute angle, and parallel to the other arm of that angle.

**Theorem 5:** There is exactly one line which is perpendicular to two hyper-parallel lines.

**Theorem 6:** Let a line  $b$  be perpendicular to two different lines  $a$  and  $c$  in points  $A$  and  $B$ , respectively. And let a segment  $l$  be any segment longer than  $AB$ . Then, there are exactly two points,  $K$  and  $L$ , both on  $a$ , with orthogonal projections,  $K'$  and  $L'$ , both on  $b$ , such that  $\angle KK' \cong \angle LL' \cong l$ .

## 4 Conclusion

Researches in hyperbolic geometry are significant for development of physics and astronomy. Hyperbolic geometry is widely applicable in the addition of the speed of light. Einstein's general theory of relativity describes space as a plane (Euclidean), but also elliptically curved (hyperbolic) in areas where the substance exists. As the universe expands, even the space without substance of mass can be described using hyperbolic mode, based on a study of spatial infinity.

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# Numerical constructions. The sum of cubes and squares

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## 1 Introduction

The origin of the notion of a number is one of ingenious demonstrations of a human mind. There is a great number of informational transformations, processes of control and coding information which use and realize theoretical-numerical algorithms. Reliability and stability of cryptographic means of data protection depends on their peculiarities. It is especially of current importance in the age of rapid development of informational technologies. Numerical, combinatorial models and systems are widely used in such spheres as cybernetics, informational-measuring and computer engineering, radio engineering, communication, electrical engineering and machine building.

## 2 Theoretical part

The opportunity of presenting a natural number  $N$  or its degree in the form of sum of equal degrees of natural numbers is worth the attention among all those peculiarities, for example:  $N = x_1^k + \dots + x_s^k$ , and defining the least  $S = S(k)$ , for which every natural number allows such a presentation. The study of the peculiarities, structure and classification of the existing models and constructions, the search of the new ones, defining the conditions for existing, revealing mutual relations and interpretations can be considered quite relevant. Mostly the classical methods of the theory of numbers, combinatorial and mathematical analysis using tabular, theoretical-numerical and matrix interpretations are applied to synthesize such systems.

The issue of the possibility of dividing natural numbers or their degrees into the sums of cubes and squares is studied within the current work. Topicality of the problem is justified by the existence of well-known geometrical problems, connected with the sum of two squares, generating "Pythagoras' and Heron's threes", looking for integral triangles.

The objective of the work is to study the numerical constructions, connected with dividing a natural number into the sums of cubes and squares of natural numbers and calculating the algorithm of possible presentations.

The object of the research can be described as numerical constructions.

The subject of the research is the possibility of calculating the constructions mentioned above.

The chosen objective assisted fulfilling the following tasks:

- Familiarizing with the literature on the topic and discovering current problems and ways of their solving;
- Studying the problem about the sum of two squares and setting up, proving the hypotheses connected with this problem;

- Studying the question about the existence of the numbers which can be divided into the form of the sum of cubes, the certain number of squares of natural numbers or representing their natural degrees in the certain above;
- Calculating the algorithms for creating the studied constructions;
- Clarifying the question about the number of possible dividing;
- Working out new sums (problems) connected with the studied question which can be used within mathematical Olympiads and contests.

The work consists of two chapters. The first chapter includes analysis of the problems connected with dividing into cubes and squares (for instance, famous sums (problems) by Fermat or Euler); the researcher's own directions of studying the sum (problem) about the sum of two cubes. The second chapter contains researcher's own studies of the main question encouraged by solving the problem "Numerical constructions and sums of cubes and squares" within the XIV Ukrainian tournament of young mathematicians; attempts of generalizing on the random natural level and researcher's own sums (problems) on the theme.

## 3 Results

Researcher's own way of solving the problem mentioned above and the algorithm for creating certain constructions (the method of jointing) created during the process of the solving can be found within the work.

We consider the opportunities for the further studies unlimited, particularly in the field of grounding other interesting peculiarities dividing a natural number into three, four squares and studying the laws of distributing natural numbers for which that dividing is possible.

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# Research Varignon's theorem, generalization Wittenbauer's and Varignon's theorems, development of them

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## 1 Introduction

Mathematics is very progress science. If we solve one task, in fact this mean that we solve lots of tasks. Mathematics at first is gymnastics for our brains. Also mathematic is very effective apparatus. In this investigation two geometrical theorems were researched – the Varignon's theorem [1] and the Wittenbauer's theorem [2].

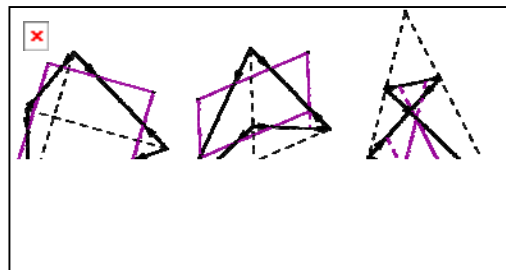


Fig. 2. Authorial theorem(2)

Let these parallelograms are called diagonal parallelograms. Also the following facts were marked. Thus authorial theorem(3) were created:

In arbitrary quadrangle points of the intersections of the diagonals and homothetic vertexes of the diagonal parallelograms, are collinear and they create five lines, which intersect in point of the intersection of the diagonals of the first quadrangle. And if O is point of intersection of the diagonals of the first quadrangle, O<sub>1</sub> and O<sub>2</sub> are points of intersection of the diagonals of the "diagonal" parallelograms, then we have quotient  $\frac{OO_1}{OO_2} = \frac{p_1}{p_2}$  when

p<sub>1</sub> and p<sub>2</sub> are perimeters of the parallelograms respectively. For homothetic vertexes this quotient is also true. Location of the points O<sub>i</sub> with respect to the point O depends on the index of n. Let these lines are called diagonal lines (Fig. 3)

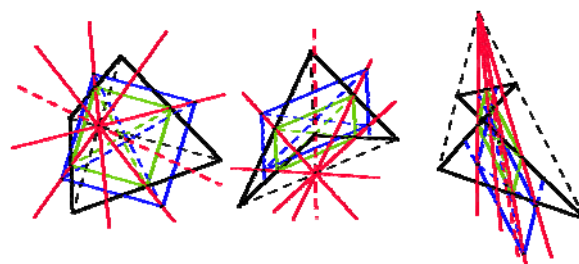


Fig. 3. Authorial theorems(3,4)

And authorial theorem(4)(Fig.3):

Lines, which join the midpoints of the neighboring sides (a and b, which intersection angle is α) of the quadrangle and the intersection point of the diagonals, create angle (β) and line segments (c and d) make an equality:

$$ab \cdot \sin \alpha = cd \sin \beta$$

If we take in the side of quadrangle arbitrary point P, join it with intersection point of the diagonals, prolong before intersection with the opposite side, we will have point P'. Let this transformation is called – diagonal homology. (homology or perspective – transformation [3]) and obtained point – diagonal transformation of the first point. Also let quadrangle, which is obtained by joining respectively diagonal transformations of the ends of

## 2 Developing and new facts

In Varignon's theorem we divide the sides of the arbitrary quadrangles on two equal segments, in Wittenbauer's theorem we divide the sides on three equal segments. What will we have, if we divide the sides on four, five or any arbitrary natural n? Thus authorial theorem (1) was created:

Quadrangle, which is made by the lines of the points of the partition, is parallelogram. For convex and reentrant quadrangles the area of this parallelogram is  $2 \frac{(n-1)^2}{n^2}$  of the area of the first quadrangle. (Fig. 1)

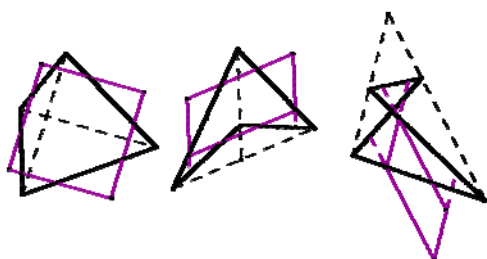


Fig. 1. Authorial theorem(1)

Also we can take not only natural n. Thus authorial theorem (2) was created:

If on the line of the side of the arbitrary quadrangle put aside vector, which begin is a vertex of the quadrangle, and if this vector multiply on arbitrary n (but not zero), we will have the vector, which begin is a vertex of the quadrangle, and it's length will be equal a length of the side, and we repeat this procedure for all sides and vertexes, then if combine the ends of the respective vectors, we will have the parallelogram. For convex and reentrant quadrangles the area of this parallelogram is  $2 \frac{(n-1)^2}{n^2}$  of the area of the first quadrangle. Index of n depends on directions of the vectors. (Fig. 2)

described above vectors called diagonal quadrangle. So the following fact is authorial theorem(5):

Lines, which have the sides of the diagonal quadrangle, intersect with the diagonals of the first quadrangle. (Fig. 4)

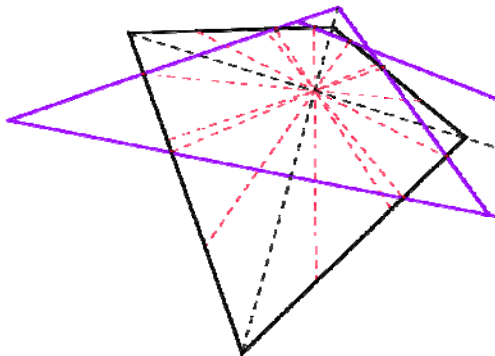


Fig.4 Authorial theorem(5)

The following fact was used in proving of the next fact. Let it's called authorial theorem(6):

If we take on the sides of an arbitrary quadrangle two points on each, join points near vertexes prolonging before intersection, we will have first obtained quadrangle, and if we do the same with diagonal transformations of the first points respectively, we will have second quadrangle. These quadrangles are homological with center in intersection point of diagonals of the first quadrangle. (Fig.5)

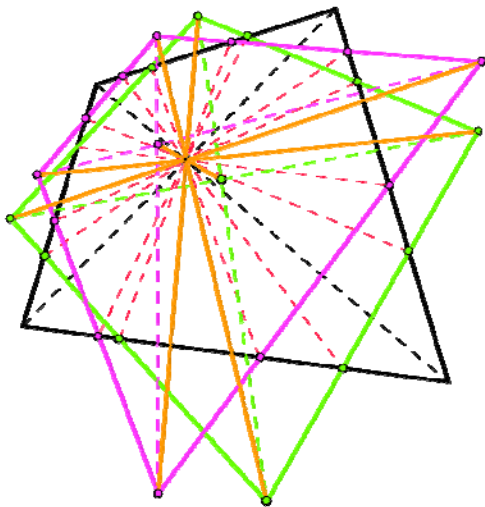


Fig.5 Authorial theorem(6)

So by the authorial theorem(6) we can marked the following theorems. Authorial theorem(7):

The diagonal quadrangle and the diagonal parallelogram with the same quotient  $n$  are homological with center in intersection point of diagonals of the first quadrangle. (Fig.6)

And authorial theorem(8):

The vertexes and intersection points of the diagonals of the diagonal quadrangles lie on five diagonal lines of the first quadrangle. (Fig.6)

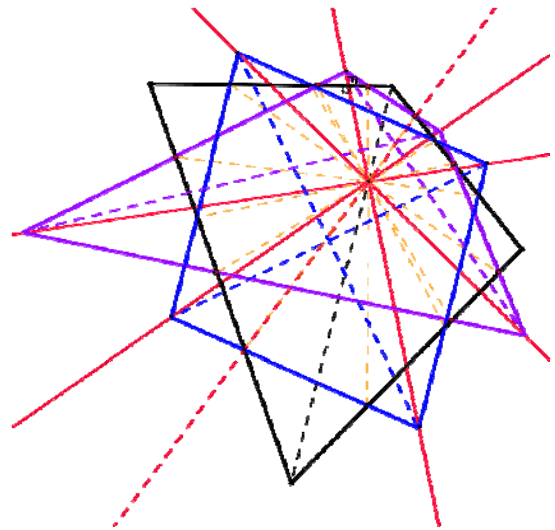


Fig. 6 Authorial theorems(7,8)

### 3 Methods of investigation

All the authorial facts were proved. Authorial theorems (1, 2, 3, 4) were proved with elementary geometrical facts, based on similarity of triangles, and parallel lines. Authorial theorem(5) was proved with Menelaus theorem [3] and one simple lemma, which we can proved with elementary facts. Authorial theorem(6) was proved with Desargues' theorem[3]. And, finally, authorial theorems(7,8) were proved with authorial theorems.(3,6)

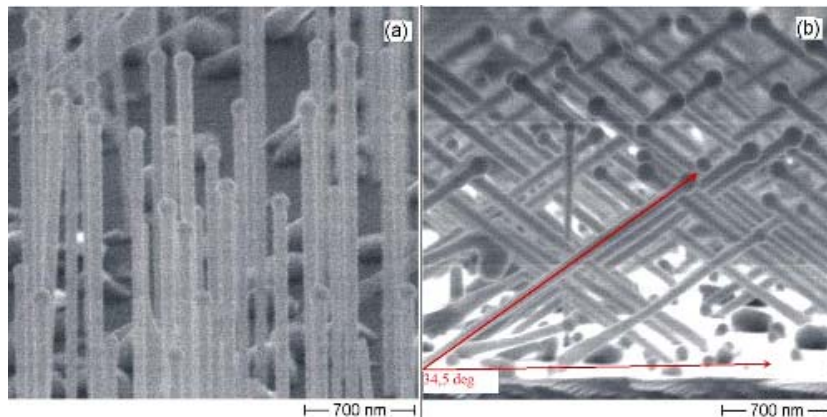
### 4 Conclusion

The full research includes method of solving olympiad tasks with use the Varignon's theorem, five authorial olympiad tasks and eight authorial theorems. This investigation we can introduce as an extra mathematical lesson. Also now practical benefit of these facts is researched. These researched were given to patent department and Copyright in scientific work was got.

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# Applied Physics



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# Smoke ring cannon

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## 1 Introduction

One of the most popular and the most interesting toy is vortex cannon. It is a usual staff (a cup, for example) that can produce powerful air vortex because of the deformation of the membrane. It is possible to fill cannon with smoke [1] that will cause the visualization of the vortex. The earlier investigations concern the general description of the phenomenon [2,3] and the description of the experimental setups. This investigation concerns the physics of the ring formation and its following motion, the quantitative data of the experiments and simple mathematical model.

## 2 The purpose of the investigation

Firstly, the smoke ring generator should have been made to produce different rings (different types, diameters, width, velocities) keeping certain parameters under control. One of the main purposes was to investigate and explain the process of formation of the rings, to find out the necessary conditions to observe the phenomenon. Also it was important to investigate the motion of the ring in the medium after its formation and to describe its deceleration qualitatively and numerically.

## 3 Method of the investigation

The key method of the investigation was the obtaining of the experimental data and its following processing. All the data have been obtained with the high-speed camera and special soft using the experimental setup. The theoretical assumptions and certain conclusions have been made according to the results of the data processing. One of the methods of the processing was the obtaining the experimental dependencies and following fitting them. It allowed to prove mathematical model and achieve the best convergence.

## 4 Result of the experiment

The video data have been obtained and processed with the special soft after inversing. Consequently, the law of motion of the ring has been obtained. Because of keeping such parameters as the degree of membrane's deformation, the diameter of the aperture under control, the respective

dependencies have been obtained. The processing of the law of motion of the ring has allowed describe the deceleration of the ring mathematically and compare the theory with the experimental data.



Fig 1. Smoke ring

## 5 Conclusion

The main reason of the formation of vortex rings is the viscous friction in the stream and the medium. The short impulse allows the vortex to form a stable ring that can continue its forward motion. The medium maintains the stability of the ring during its motion until it has a velocity. Approximation of the solid disk [4] can be used for the mathematical description when it comes to the motion of the ring with deceleration in the medium.

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# Mirages in water

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## Introduction

Mirages appear in the air when there is a significant difference in air temperatures in layers. At the same time the speed of light is different in warm and cold air. This is the reason for refraction [4]. It is known that we may also observe the layers of warm and cold currents in liquids. The speed of light should also vary in this case. Therefore, we may observe mirages in water similar to those observed in the air.

## 1 The purpose of the investigation

In our thesis we studied the conditions of receiving mirages in water on the basis of comparative analysis with a similar phenomenon in the atmosphere. **The object** of our research is the optical properties of water. As **the subject** of the research we chose the conditions in which we may observe water mirages.

**The aim of the research** is to study the conditions of receiving mirages in water.

## 2 Method of the investigation

To fulfill the aim we defined the following tasks:

- Studying the literature on this problem [1,2,5].
- Conducting laboratory experiments with the aim to get layered inhomogeneous liquids with a changing index of refraction.
- Acquisition of different kinds of mirages [3].
- Making a mathematical model of mirages on the data of the experiment.
- Explaining natural phenomena on the basis of received results.

## 3 Main results

In the course of the experiment we received liquid medium with a changing index of refraction. To change the index of refraction we used the change of liquid temperature and density. In both cases we achieved the bending of the light ray in the optically inhomogeneous liquid. To change the temperature we heated the water unevenly and cooled it with the help of ice. To change the density we prepared different salt liquids. We have received experimentally mirages of some kinds described in literature: superior, inferior, double and triple mirages.

We have considered an optical-mechanical model to find the location of mirages and describe the ray path (an optical-mechanical analogy is the similarity between the particle path in a potential force field and the path of rays in an optically inhomogeneous medium) [6].

## 5 Conclusion

Mirages in water appear on condition that the index of refraction does not change gradually but unevenly with the height in sheets of water. In such conditions light rays going to the observer from different objects experience a total internal reflection at the border of sheets of water with a different index of refraction.

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# An environmental underwater camera with movement controller

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## 1 Introduction

Many people who went on diving trips before are amazed by the view underwater. Naturally they would want to take some photos of what they saw, but ordinary cameras are not designed for underwater photographing. On the other hand, the professional devices for underwater photographing are too expensive and hard to operate. This leads to my product, the movement-controlled underwater camera, which could make ordinary cameras capable of underwater photographing.

## 2 Overall Plan and Design Step

In mobile racing games, such as Need For Speed, players could control the car by rotating the phone with different forces. This is because the movement changes the acceleration value on different axes. Inspired by the racing game, I designed a similar movement controller with a double-axis accelerometer to manipulate the camera.

We elegantly design the proper entropy value to switch the power, focusing and shutter respectively by controlling the accelerometer on the two different axes and designing a 1s time delay element. The following is the structure of control circuit.

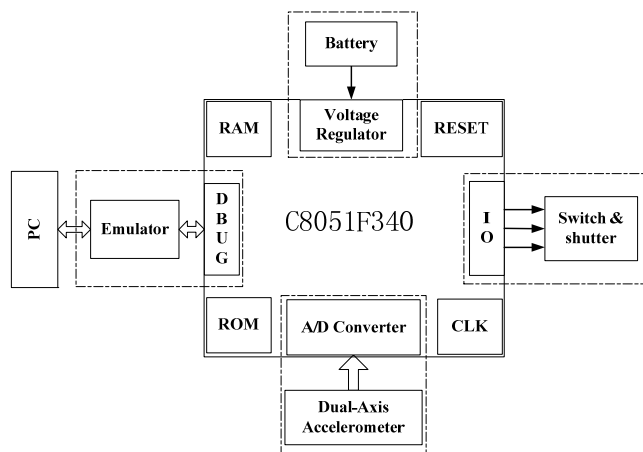


Fig. 1 The structure diagram of control circuit

Figure 2 shows the turning on/off program flow chart.

As it was said above, the double-axis accelerometer made it possible to control the camera's power switching, shutter and focusing. Then comes the problem of making the device waterproof. I got the idea when I was having lunch in the cafeteria, my lunch box fell into some water but the food was unharmed. This reminded me that our ordinary lunch box might be able to be used as a shell to protect my digital camera as well. So when you want to take a picture

underwater, you could simply move the lunch box upwards and forwards, controlling the camera with movement control.

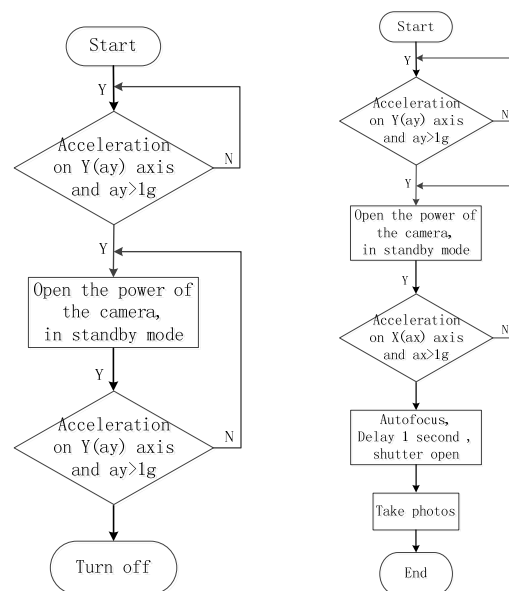


Fig. 2 Taking photos program flow chart of diving camera

With specific ideas in mind, I'll have to connect these devices together and make them work as an ensemble.

- 1) First, I pulled the signal lines connected to the function switches out of the camera.
- 2) Then, with my teachers help, I designed the main control circuit based on the double-axis accelerometer.
- 3) After that, I placed the transformed camera in the lunch box and fixed them with foamed plastic.
- 4) Finally, we made a series of test to prove the reliability of the product.

## 3 Advantages and Future Prospects

This product is specifically designed for families and non-professionals who want to do underwater photographing. So, the price and convenience are the two main advantages of this product in the future. Compared to the professional devices, this is a much cheaper choice, but what makes it unique is that it is movement-controlled, which gave it many possibilities in the future, only by designing more entropy intervals and adding an axle. For example, we could add a video-taping function in the future. We might even add WiFi to the system or use the GPS to protect the user's safety. In a word, this product still has a long way to go and a wide space for expansion. In fact, it is an **environmental** product. A patent for an invention has been applied.



# Voltage influence on the incandescent light bulb efficiency

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## Introduction

A light bulb converts electrical energy into light and heat. Light energy is the useful part, unlike heat, which is energy loss. This paper, on the basis of the measurements, describes how the voltage change affects the efficiency of an incandescent light bulb and the spectrum of its radiation.

## Method of the research

The base of the measuring device is a three-layer glass calorimeter filled with a known mass of water. The calorimeter was made of glass to minimise the absorption of light energy. Light bulb efficiency can be determined by measuring the current and voltage drop across the lamp and the time required to increase water temperature by 1 Kelvin. The temperature change was measured with a Pt100 resistance thermometer in a four-wire Kelvin connection. This method of measurement avoids errors caused by wire resistance. All measurements were performed on a small 1.5 W, 24 V lamp. Light bulbs smaller than 25 W require no fill gas, just a partial vacuum free of oxygen and water vapour [1].

The light bulb spectrum was studied using simple spectrometer which uses a compact disc as a diffraction grating. The spectrum was photographed with a digital SLR camera with a fixed aperture, shutter speed and sensitivity to light so that images of the spectrum at different voltages were comparable to each other. Photographs of the spectrum were analyzed using ImageJ [2]. The spectrometer was calibrated using a high-pressure sodium lamp which contains additional elements such as mercury. Since sodium and mercury have peaks in their emission spectrum for which wavelengths are well known calibration was performed between two peaks: 589 nm for sodium and 435 nm for mercury.

## 1 Results of the experiment

The efficiency of the light bulb increases with increasing voltage up to the declared voltage for certain type of the light bulb (Fig. 1). Even at that point the efficacy of the light bulb remains still low (under 16 %). This fact can be explained by the theory according to which a higher voltage increases the temperature of the filament and the peak of radiation curve moves to higher frequencies, thus increasing the amount of radiated light energy in the visible part of the spectrum. The analysis of the lamp spectrum at different voltages confirmed the described theoretical assumption. All measurements were carried out ten times. The errors in measurements were calculated using standard deviation. The trend in light bulb efficiency can be well approximated with the second order polynomial.

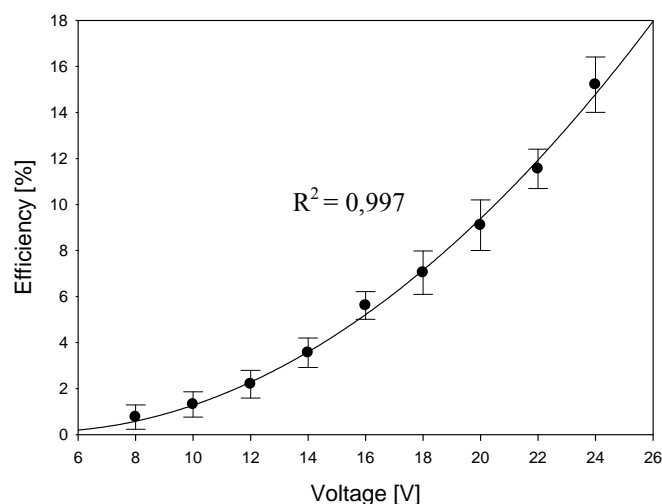


Fig. 1 Light bulb efficiency as a function of voltage

## 4 Conclusion

The aim of this research was to investigate how the voltage change affects the efficiency of the incandescent light bulb and the spectrum of its radiation. Precise measurements in temperature change were performed with an independently constructed three-layer glass calorimeter and the circuitry with a Pt100 resistance thermometer. A simple spectrometer with a compact disc was constructed and calibrated. Measurements indicate that incandescent light bulb efficiency increases with increasing voltage.

Based on the evidence of low efficacy of the incandescent light bulb some countries have passed measures to phase out such light bulbs introducing an energy saving compact fluorescent lamp or light-emitting diode for general lighting.

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# Thermal insulation in buildings

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## 1 The purpose of the investigation

The project aims to investigate the escape of heat through thermal insulation.

## 2 Method of the investigation

The study tested various materials and thicknesses. The most commonly used is polystyrene. Other tested materials were cotton, wood and bricks. The research is based on experiments carried out with the help of simple objects available at home, such as a box. The box was then used as a form for all other materials. The temperature in the measured area was registered after the end of the given period, which was the same for all the experiments. The heat loss was measured and quantified during the work.

## 3 Results of the experiment

The research shows the amount of heat escaping through various materials and also the cause of the heat loss. When heating a given place, the most important is the type of material and its thickness. Other factors include the seal and the period for which the space remains closed with no access of the air.

## 4 Conclusion

During the work we counted and compared the measured heat loss. The results of the research make wood preferable to all other tested materials used as thermal insulation.

Material	The coefficient of heat leakage $\mu$
Polystyrene	$38,3 \frac{\text{kJ}}{\text{m}}$
Glass wool	$25 \frac{\text{kJ}}{\text{m}}$
Wood	$22,6 \frac{\text{kJ}}{\text{m}}$
Bricks	$71,6 \frac{\text{kJ}}{\text{m}}$

Table 1. The coefficient of heat leakage

# The effect of spectral composition of light on plants

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## 1 The purpose

The purpose of this project was to ascertain the effect of monochromatic light on plants, the defensive factors the plant used against it, the extent of adaptability of the plant and the effect of duration and amount of the radiation on various types of plants.

## 2 Experimental methods

The monochromatic light source used in the project was a laser Laserex LDP – 450AV situated in an utterly darkened room. The plants used in the experiment, garden cress (*Leppidum sativum*) and pea (*Pisum sativum*), were one by one ceaselessly exposed to the monochromatic light of various intensity and duration. Simultaneously, 5 other plants of the same kind placed under normal light were observed.

## 3 Results

The result of the microscopic examination of the garden cress leaf after 14 days of radiation of 30 mW/0,625 cm<sup>2</sup> (48 mW/cm<sup>2</sup> + 10% loss by using the concave to extend the area of the radiation to 5x12,5 mm) was an observation of the venation ascending on the surface of the leaf and dead cells. During the observation of the pea plant, which was exposed to the radiation 30 mW/0,1 cm<sup>2</sup> (300 mW/cm<sup>2</sup>) without using the concave for 34 days, the utter pierce through the leaf on the spot of the incidence of photons was visible already the 16th day of the experiment and a considerable extent of degradation all over the leaf beginning with the dead cells closest to the spot of the incidence of photons was observed.



Fig. 1. Comparison of pea leaf under monochromatic light (right) and normal daylight (left).

The wavelength of the laser affecting both plants used in experiment was 650 nm, therefore the energy of the

radiation was in both cases  $1,84039 \cdot 10^5 \text{ J mol}^{-1}$ , although the plants were able to absorb only  $1,39869 \cdot 10^5 \text{ J mol}^{-1}$  of the provided energy.

Wavelength [nm]	650 nm	
Plant	Garden cress	Pea
Intensity [W/m <sup>2</sup> ]	432 W/m <sup>2</sup>	3000 W/m <sup>2</sup>
Duration [h]	336 h	816 h
Energy [J mol <sup>-1</sup> ]	$1,84039 \cdot 10^5 \text{ J mol}^{-1}$	
Energy absorbed [J mol <sup>-1</sup> ]	$1,39869 \cdot 10^5 \text{ J mol}^{-1}$	

Table 1. Values

## 4 Conclusion

Since the plants lacked blue wavelengths, which affect the state of pores and therefore water regulation, the leaves were drying out even though the plants were regularly watered. On the other hand, the plants also developed an adaptability to the radiance of monochromatic light for the observed plants enduring the monochromatic light lasted even longer than the plants under the light of normal spectral composition in general, though the thermal, water and pressure conditions and the humidity of air were identical for both plants exposed to monochromatic light and plants exposed to normal daylight.

Different spectral compositions of light affect various periods of plant development and processes with different level of effectiveness. Having found appropriate combination of light sources with relevant combination of wavelengths and intensity corresponding to a specific kind of plant, its use and various periods of development, it is possible to increase the quality of plants and enhance conditions for the plant growth.

# Optimization of the Electro-Magnetic Cannon

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## 1. Introduction

Electro-Magnetic (EM) guns (cannons) convert the electrical energy stored in a stationary power supply into kinetic energy of a moving projectile. The main superiority of such cannons on the conventional ones is that higher velocities can be achieved. So the development of electromagnetic gun construction is very actual.

The purpose of our investigation was to find out some directions in which the optimization of EM cannon construction can be achieved.

## 2. Method of the investigation

At first we investigated theoretically the parameters and construction principles that can play sufficient role in the simplest EM gun model efficiency. Then we constructed our model of EM cannon and observed the influence of mentioned parameters and construction principles on the obtained velocity of the projectile experimentally.

## 3. Investigation of EM cannon

### 3.1. Theoretical considerations

The simplest model of EM gun consists of a tube, solenoid, ferromagnetic projectile and an energy source - capacitors. Its acting principle is the following: when during the capacitor discharge an electric current passes through a solenoid, it creates a magnetic field, which magnetizes the projectile and attracts it towards the coil centre.

The force acting on the projectile can be expressed as [1]:

$$F \sim N \cdot I \cdot (d\Phi/dx), \quad (1)$$

where  $N$  is the number of loops in the solenoid,  $I$  – capacitor discharge current and  $d\Phi/dx$  – magnetic flux gradient at the projectile. Thus optimal construction of EM cannon assumes achieving maximal value of this product.

The other very important moment is the so called “solenoid middle-point problem”: after the projectile passes the centre of the coil, the acting force changes its sign, attracts the projectile back into the solenoid and slows it down thereby decreasing the final velocity. Thus the construction of EM cannon must avoid this problem.

### 3.2. Our construction of EM cannon

Analyzing construction of EM cannon it is known that among other parameters the Iron Shell around solenoid plays an important role. However, in difference to other investigations [1, 2] we show that Iron shell must consist only of the front and the back washers (Fig. 1). This helps

to get higher gradient  $d\Phi/dx$  at the place of projectile input without significant increasing of coil inductance  $L$  and thus without suppression of discharge current.

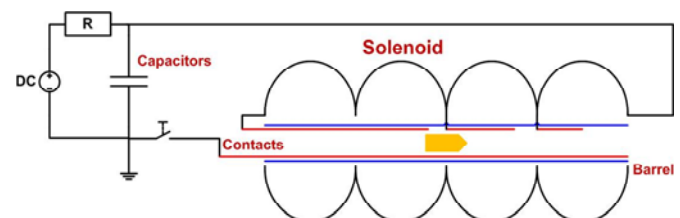


Fig.1. Our construction of EM cannon.

Also we offer our solution of the “solenoid middle point problem”. It is necessary to switch off the current flow when the projectile passes the solenoid center. It can be achieved if relevant part of EM cannon barrel contains conductor and the projectile itself is a part of the circuit.

We propose more advanced solution with “consequent switching-off” the solenoid parts behind the projectile (Fig. 2). In such case almost always exists the force acting on the projectile in the forward direction.

Fig.2. Circuit scheme.



### 3.3. Obtained results and conclusion

We observed that our construction of the shell gives much better results (~20% better than full-surround shell).

Our “consequent switching off” scheme also gave ~15% advantage over “switching off in the center” scheme.

With  $C=900\mu F$ ,  $U=300V$ ,  $85mm*\varnothing 42mm$  solenoid and  $8mm*15mm$  projectile we got ~42m/sec velocity.

For further investigations we think to develop the “consequent switching off” scheme.

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# Bullroarer - The native Australian telephone

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## 1. Short introduction

The bullroarer is a simple device consisting of a wooden slat and a string. It produces an pulsating humming sound when swung overhead (see Fig. 1). During the swinging of the slat one can also observe that slat moves slightly down and up. The Australian Aborigines and many other traditional cultures have used this instrument as a conduit for the voices of their gods or in rainmaking rituals. What is the reason for this Sound and what are the relevant parameters ?



Fig. 1. A bullroarer swung overhead

## 2. Experimental methods

In contrast to previous experiments we found in literature, we used an industrial engine (shown in Fig. 2) to swing the bullroarer in a circular path.

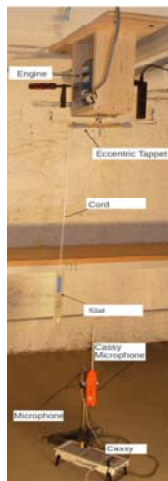


Fig. 2. Experimental engine setup

This allowed us to change the velocity of the used slats systematically. We recorded the produced sound with two microphones. Highspeed camera recordings allowed us to study the motion of the slats in detail. In addition we investigated the motion of different slats in windtunnel experiments.

## 3. Results / Conclusion

We found that the produced sound is due to the spinning of the slat around the string. The string winds fully first in one direction and then the other, alternating. As a result, the vibrational frequency changes constantly. A spectral analysis of the sound showed a clear harmonic structure with a dominating fundamental frequency. This is the reason for the low humming sound of the bullroarer. Important parameters for changing the sound of a bullroarer are the velocity of the slat, the size of the slat and the characteristics of the used strings. We verified that the up and down movement of the slat during the operation of a bullroarer, is due to the Magnus force. The experiments in the wind tunnel showed that the slats rotated with similar frequencies as in the engine experiments.

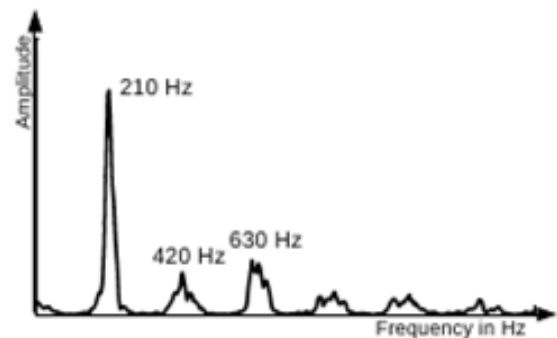


Fig. 3. A frequency spectrum of the Bullroarer

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# New material for information technology, or the study of the Bismuth Ferrite

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## 1 Short introduction

Nowadays the control of information is a key issue for everyone that is why the way of the information storage is a basic question. The capacity of modern storage devices seems to be huge, but the quantity of the accumulated data is increasing rapidly, so we are going to reach the upper limit of present storage capacity soon. Therefore the development of the memory units is a current and important topic both for basic and for applied research.

## 2 Theoretical model

Modern data storage technologies use the magnetization of very small ferromagnetic particles on the hard drive's discs. One of their main disadvantages is that their magnetization can be easily erased by small external fields, and the storage process is relatively slow. According to recent research, if ferromagnetism and ferroelectricity appear together in a material, and these properties have an effect on each other, one can possibly create a device [1], in which the storage of information needs less energy, while data density and processing speed increases drastically, compared to present technologies. However, this so called magnetoelectric effect is very rare and poorly understood. Our prime purpose was to study the magnetoelectric effect in the most promising family of multiferroic materials,  $\text{BiFeO}_3$ , for which we needed to prepare well defined samples [2].

The samples were prepared via the sol-gel chemical method from nitrate reactants. Post processing for purification included leaching with nitric acid and post annealing at high temperatures. The resultant materials were characterized by and  $^{57}\text{Fe}$  Mössbauer spectroscopy. The latter is a very sensitive method to investigate the local electric and magnetic fields around iron atoms with a  $^{57}\text{Co}$  radioactive source [3].

## 3 Result and conclusion

During my research work I studied Mössbauer spectroscopy, basics of multiferroics and the preparation and purification of some multiferroic materials, especially  $\text{BiFeO}_3$ . As a result, I have found that leaching out the impurities in  $\text{BiFeO}_3$  with nitric acid is not suitable, which is in contrast with literature data. Interestingly, after the post annealing of the primary

products the same stoichiometry of  $\text{Bi}_2\text{Fe}_4\text{O}_9$  was found, as after the dilute nitric acid washing.

So to produce well-quality samples we had to change the parameters of the preparation. After many preparations we succeeded in producing sample with good quality that means we have a lot of sample with above 90% and two samples with 100% of bismuth ferrite.

After that I studied the ferroelectricity in the material. I doped the sample with cerium and I got that the ferroelectricity decreases during the increase of the cerium. That means the Bismuth ion is responsible for the ferroelectricity. To measure the ferroelectricity in the material I used the Sawyer-Tower circuit. After that I studied the magnetic state of these materials. I am giving an account of the results during my presentation.

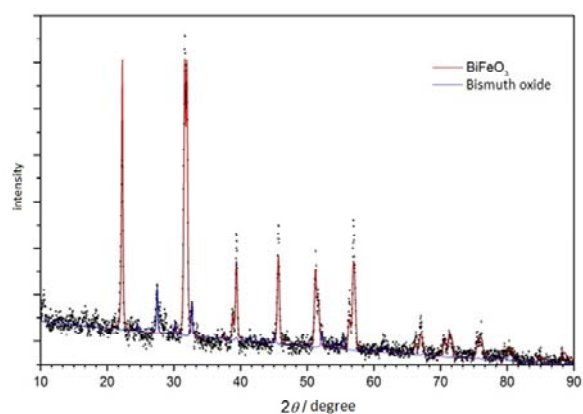


Fig. 1. Spectra of the  $\text{BiFeO}_3$  using XRD

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# Plastic bamboo composite at peace with waste

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## 1 Purpose

Noise and plastic waste are the most common problems that we face nowadays. Although our ear could only hear 20Hz to 20 KHz frequency, the high frequency sound above required may cause bodily discomfort and disturbance. In Indonesia, people produce 26500 tons of plastic wastes each day. These massive amounts of plastic wastes are neither recycled nor handled well. Through some observation, the wastes of bamboos can also be combined with plastic as a composite. So in this experiment, we are using this composite to reduce noise in the surrounding.

## 2 Methodology

The first step is to make the plastic bamboo composite. The plastic bamboo composite is made by mixing melted polypropylene plastic waste with *Gigantochloa apus* bamboo waste. These materials are mixed by using the hotpress machine in 30 minutes of heating. After that, using the coldpress machine, the plastic bamboo composite (PBC) is shaped into a 30x30cm panel. One of the PBCs are cut into 10x10cm panel and tested on sound absorbing as a sound baffle. Testing procedure for the sound baffle is applied by measuring the amplitude difference between the input audiosonic frequency and output audiosonic frequency. The variation of layer number is applied in order to find out the ability of PBC to reduce the input frequency. The frequency tested on the sound test is from 20Hz up to 20KHz (audiosonic).

## 3 Result of the experiment

From the sound test by applying variety in amount of layers, it could be seen that mostly the result shows that the more the layer is added, the lower the amplitude of sound wave is passed. In the first test with only one layer, the PBC is able to reduce quite drastic the amplitude of frequency of 8 KHz until 10 KHz. In the second test which is added by one more layer, the result shows that these two layers are effectively reducing the amplitude of frequency of 500Hz to 1 KHz, 2 KHz to 3 KHz and 8 KHz to 10 KHz. In the third test, the two layers of PBC is added by another one and the result shows more difference in ranges of amplitude in the frequency of 500Hz to 1 KHz, 2 KHz to 3 KHz, and 7 KHz to 10 KHz. But at the frequency of 1500Hz to 1600Hz, there is an increasing of amplitude eventually. The third test is by adding another layer from both layers before. The result is that the PBC reduces amplitude from 400Hz to 3 KHz and 8 KHz to 10KHz. For the last test, all four layers of PBCs are tested together and the result shows decreasing of amplitude about 30dB to 40dB at frequency of 2 KHz to 10 KHz.

No	Specimen	Frequency Range (Absorbed)	Min – Max Intensity Level (dB)
1	A	8 KHz -10 KHz	40dB
2	A + B	2 KHz - 3 KHz	40dB
3	A+B+C	2 KHz - 4 KHz	49.5dB
4	A+B+C+D	2 KHz - 10KHz	60dB

Table 1. Sound test result

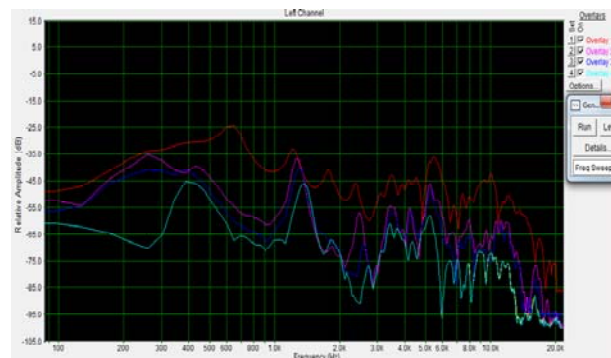


Figure 1. Example of the spectrum wave result

## 4 Conclusion

The PBC is applicable as a sound barrier which applies the properties of a sound absorber. The average effectiveness of the PBC to reduce sound is from 8000Hz to 10000Hz which is proper to use in meeting rooms and amphitheatres. This PBC is also good in office buildings and homes to avoid the sound of thunder and traffic noises. In conclusion, the PBC can be used as the alternative material for interior buildings rather than exterior or high chances of frequency such as industry or airport.

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# Pattern of connectedness in social networks, a boon or a curse?

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## 1. Introduction

Traditional communities were usually small-sized due to spatial and temporal restrictions in making connections. They were supported by cooperation among the community members, for cooperation maximizes the overall fitness of the group. Within a community, was very well connected to one another and it was easy to organize cooperation.

Recent technological advancement such as mobile phones and social networking services has created yet another social network with large numbers of participants. Since the stability of the communities heavily depends on the structure of the network, large-scale social networks may or may not accommodate cooperation.

The goal of this study is to find out whether cooperation would emerge more often in social networks compared to non-social networks. Non-social networks serve as the control in determining whether cooperators flourish in social networks. This approach combines past studies on analysis of social networks and evolutionary dynamics of non-structured populations.

## 2. Materials and Methods

### 2.1. Preparation of model networks

Social networks have unique features that are not shared by non-social networks [1]. First, they tend to be clustered, meaning the neighbours of a given node are more likely to be connected each other than a randomly chosen pair of nodes. Such tendency is expressed by high clustering coefficient,  $C \in [0, 1]$ . Second, social networks show assortative mixing, meaning that hubs are connected with other hubs. This tendency is expressed by high assortativity,  $r \in [-1, 1]$ .

To see the effects of  $r$  and  $C$  in a quantitative manner, model networks with varying  $r$  and  $C$  values were created. In this study, assortativity was allowed to vary from -0.30 to 0.30 by the unit step of 0.02 and  $C$  from 0.05 to 0.30 by steps 0.05.

### 2.2. Time evolution of fitness

In this study, the fitness was determined from the payoff matrix of Prisoner's Dilemma. The change of individual strategy over time, which is either cooperation or defection, the so-called death-birth update mechanism was used in the limit of weak selection [2].

Fixation probability [3] was chosen to quantify how likely the cooperation is to emerge on a given network. Initially, 70% of the individuals are cooperators and the rest are defectors, placed randomly. If the entire population becomes cooperators within ten million updates, that trial was considered as a fixation of cooperation.

## 3. Results and Discussion

As shown in Fig. 1, the network with lower assortativity and clustering coefficient had a higher fixation probability of cooperators.

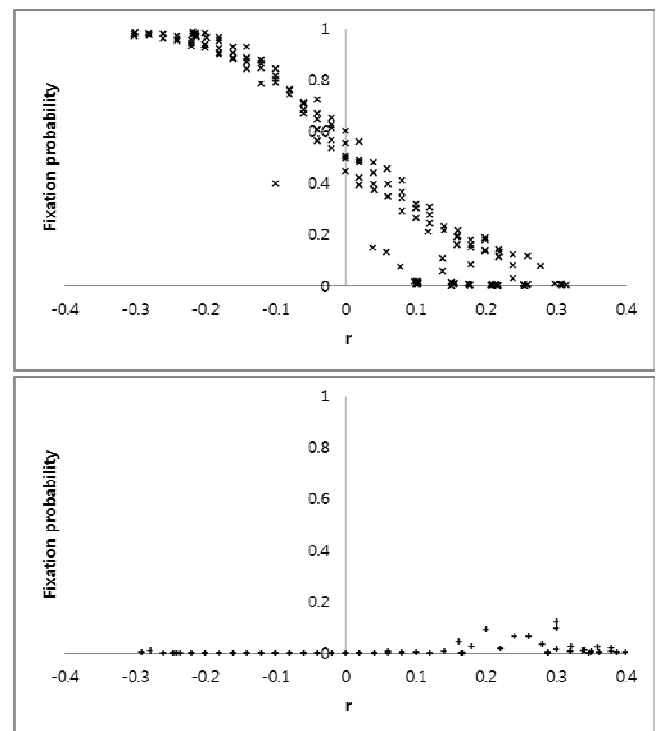


Fig. 1 Fixation probability of cooperators (above:  $C = 0.1$ , below:  $C = 0.3$ )

This perspective seems a bit counter-intuitive, but may give us a clue to why the modern communities suffer from the lack of benevolence.

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# Leisure Ride (Le Ride)

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## 1 Introduction

We aim to tackle three main problems that generally affect our country's growth. The first problem is the health rate of people in Malaysia which is decreasing. Next, there is no current exercise equipment suitable for all ages. The last problem is office workers who do not have an alternative to stay awake in the office unless they have caffeine.

We got the idea to build Le Ride from the current existing electric chair and a kid's toy. We created the Le Ride to make it function as exercise equipment suitable for all ages, increasing health and promoting alertness among office workers. Le Ride is a four wheel equipment which stands on the ground. Le Ride does not use any electrical energy or even a small motor to generate movement. One can easily hold the steering wheel with both hands and alternate the hand movement back to forth to move the Le Ride.

We concluded a series of experiments to test the function of Le Ride. Le Ride definitely can make a good exercise equipment. One can either build up his arm muscles or even just have a general workout. For the elderly, they can use the Le Ride just to get a good sweat, thus making them healthier. Obviously, kids would prefer playing Le Ride with their friends.

## 2 Problem Statement

Nowadays, there are only a few exercise equipment suitable for all ages. Office workers often feel sleepy when working the long hours and lot of people do not get enough exercise generally. This may lead to a reduced state of health in the country.

## 3 Objectives

We want to invent an exercise equipment that can be used indoors for all ages and also promoting general well-being among Malaysians.

## 4 Methodology

The components used to build a prototype of Le Ride are 2 trolley wheels, and a special part that generates the movements. This part uses the four physic concepts which are inertia, centrifugal force, gravity, and friction in order to drive the car forward and backward. The combination

between all these concepts can generate the movement with the steering that is attached to this special part is propelled by the hand of the users. This special part is two wheels that are attached to the steering wheel by a lever, in such a way that they are located behind the axis of rotation of the steering column. The torque applied to the steering wheel causes a lateral friction force by the wheels on the ground, a force parallel to the axle and perpendicular to the direction the wheels are rolling. If a component of this force points to the back of the Le Ride, the reaction force of the ground on this car (by Newton's law) points partly forward and accelerates the car. This is the force that drives the Le Ride forward and it ultimately comes from the force exerted on the handlebars. Based on the Fig. 1, the distance travel for this car is the total distance of X and Y. For the first turning, the most friction is focussing on the left wheels and for the second turn, the friction is focussing on the right wheels. This exercise equipment is also equipped by a sit for the convenience. For safety, this Le Ride is also equipped with a brake. Le Ride is also portable equipment so that the users can use it anytime, anywhere.

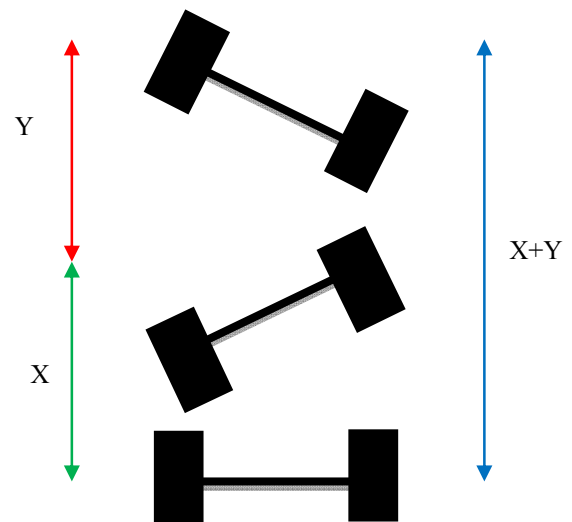


Fig. 1 Front part (wheel) which generates its movement

## 5 Conclusion

We from Alam Shah Science School hope that this equipment could bring a transformation to the recreation world. We believe that this invention would have a very high commercial value because of its advantages: portability and safe to be used for all ages.

# Smart Tsunami Alert System

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## 1 Introduction

Tsunami is a natural disaster with devastating consequences as recent events had shown. When tsunami happens, it brings a bad impact as the results can be horrendous. An early warning system that is cheap and reliable to warn the countries that may be potentially hit is vital to save lives and properties.

## 2 Problem Statement

Although the existing tsunami detecting device is operationally used till now by many countries, there are still some disadvantages of the current system. For instance, this current device known as the Dart II system requires qualified technicians to service and repair the device. Each DART station consists of a surface buoy and a seafloor bottom pressure recording (BPR) package that detects pressure changes caused by tsunamis. The results are then transmitted to a satellite and back again to the Earth, to the Tsunami Warning centre. However, this modern machine-made extravaganza still has its disadvantages indicating there are still some certain facts that do not fulfill the objectives of creating a detection device that is low cost and environment friendly. At the same time, current detection devices utilizes high technology parts and it consumes power that requires high capacity of storage batteries, not to mention it requires regular servicing and replacement of parts. In the other hand, many devices are not functioning because of lack of maintenance due to cost, lack of expertise and shortage of spare parts. In some ways, developing countries simply cannot afford the very high expenses to service the device. The Tsunami tragedy that hit Japan recently struck our mind, and we thought of inventing an efficient tsunami warning system.

## 3 Objectives

Our objectives are to create a new tsunami alert system that is affordable to any countries especially third world countries that has a high possibility of getting hit by a tsunami. Therefore, we have invented this detection device that utilizes non-polluting and renewable free energy resource. Furthermore, it is low cost and do not need high technology to build as it utilizes existing technology that does not require high expertise to service the device. Basically, this device that we have invented consumes mostly solar power and requires also storage batteries. The device is non-polluting, not to mention it is also

environmental friendly. It detects Tsunami by sending the signal to the satellite, depending on the level of sea tide.

## 4 Content

We use the simple concept of electrical circuit to make it work. If the circuit is connected, the device transmits signals to the satellite which indicates normal sea levels. The satellite in turn will direct the signal to the Tsunami alert centre on Earth. In certain post tsunami occurrences, like drastic fall and rising of sea levels will make the circuit disconnect and thus indicating a trouble may be on the way. The system uses double buoys, one floating and another submerged. In normal conditions, only the top buoy sends a signal to the satellite. When the sea level rises, the cable of the buoy will become taut and will automatically break the circuit, thus both buoys will send no signal and vice versa for when the sea level falls. The diagram below shows roughly how the circuit inside the buoys works. The device will also use solar panels to collect energy and use solar energy to supply power and will also use storage batteries to store the energy. This way, it will not consume energy from sources that may pollute the environment. In other words, it is eco-friendly.

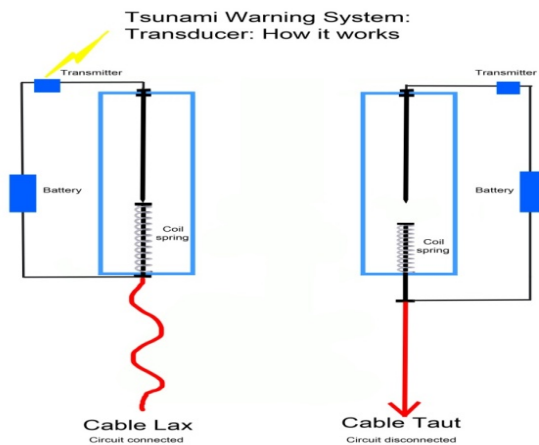


Fig.1 how electrical circuit inside buoys work

## 5 Conclusion

With this new Smart Tsunami Alert System, many third world countries and also developing countries can keep an eye on their coastal shores. The device will keep the people of the country safely evacuated before the big tide comes in. The Smart Tsunami Alert System offers the same function as DART II for less.

# Organic photovoltaic cells based on buckminster fullerenes

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The purpose of our research was to find out if we could improve the efficiency of organic photovoltaic cells (OPCs). OPCs are a relatively new type of solar cells, based on conducting organic molecules. The advantages of OPCs are their flexibility and the great possibilities for cheap production methods. Because of the good light absorption of the organic molecules, only a thin active layer is needed compared to for example silicon solar cells. This results in lower material costs.

Disadvantages are that organic molecules oxidize fast, therefore the efficiency will decrease rapidly. This problem can partially be solved by using a layer that prevents air reaching the active layer. Another problem of OPCs is their low efficiency (approximately 5% [3]). This is why research is very important.

The active layer of an OPC consists of a donor material and an acceptor material. The energy of incoming light causes the excitation of electrons to a higher energy state but they are still electrically bound to the 'holes' they leave. The excited electron with the 'hole' it left, is called an exciton. The excitons will diffuse to the interface between the donor and the acceptor. There the electrons will go to the acceptor due to the lower LUMO (lowest unoccupied molecular orbital) of the acceptor. Due to the higher work function of the cathode the electrons will reach the electrode. The 'holes' left by the electrons will go towards the donor polymer and eventually reach the anode. If the electrodes are connected a current is generated.

The diffusion length of an exciton is 1-10nm[1]. Therefore a bi-layer structure as in silicon cells will result in a very low device efficiency. For OPCs a so called bulk heterojunction structure is needed. This means that the donor and acceptor material are mixed. A lot of research in this area is focused on creating an optimal morphology in OPCs. Changing the materials used for the device will also affect the morphology.

In our lab research we tried to enhance the device efficiency by applying other acceptor materials. We did our research at the Zernike Institute for Advanced Materials, University of Groningen. We were guided by Gert-Jan Wetzelaer MSc. We used poly(3-hexylthiophene) (P3HT) as donor polymer and we switched between three different types of acceptor materials. We used [6,6]-phenyl C61 butyric acid methyl ester (PCBM). This is a very common used acceptor fullerene in organic photovoltaic research. We also used bis-PCBM: a doubly functionalized C60 molecule, using the same derivatization as PCBM. We read that by adding a second adduct a higher device efficiency could be reached [1,2]. Finally we used indene-C60 bisadduct (ICBA) indene: benzocyclopentadiene. We read that devices built with this material also reached very high efficiencies[3].

We used 6 substrates. On each substrate were four surfaces. Each of a different size: 0.09cm<sup>2</sup>, 0.16cm<sup>2</sup>, 0.36cm<sup>2</sup> and 1.01cm<sup>2</sup>. Every substrate consisted of glass with a layer of 140nm indium tin(IV)oxide (ITO) on the surfaces; this would become the anode of the device. After cleaning the

substrate, a 60nm layer of PEDOT (poly(3,4-ethylenedioxythiophene) - PSS (polystyrenesulfonic acid) was added. This layer smoothens out the ITO surface and enhances the performance of the devices. On this layer came the active layer, consisting of P3HT with the acceptor material. On two substrates we used PCBM, on two other substrates we used bis-PCBM and on the last two substrates we used ICBA. After annealing the substrates for 15 minutes (T=135°C), we added 1.0 nm LiF and 100 nm aluminium (the cathode).

We used a fast drying process to be able to produce our OPCs in one day, therefore our efficiencies are lower than in most other research. Because we used this technique for all our cells we could see what the effect of a second adduct would be.

Our best PCBM cell reached an efficiency of 2.56%. Our best bis-PCBM cell reached an efficiency of 3.41%. This was a satisfying result, because it confirmed our expectations. Our best ICBA cell reached an efficiency of 2.63%. This may be better than the PCBM cell, but we hoped it would even be better than the bis-PCBM cell. Since it was the first time ICBA was used in this laboratory, we probably did not use an optimal production process. This may have resulted in a lower device efficiency due to a less optimal morphology.

Bis-PCBM and ICBA have a higher LUMO than PCBM. This results in a higher open circuit voltage (Voc) of the devices with this bisadducts in the active layer. Therefore less energy is lost during the electron transfer. This was one of the main reasons for a higher efficiency of these devices. A disadvantage of using bisadducts is that the electron mobility decreases. Therefore the short circuit current (Isc) decreased a bit, but this was in no comparison to the increase of the Voc. Therefore we concluded that using one of our bisadducts will increase the efficiency of the OPCs.

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# Getting out beads

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## 1 The purpose of investigation

Many of us played with string of Christmas beads in childhood. When we took long enough part of the beads out of the container, we could observe the beads rushing down, making a lot of noise. However did we see that the beads sometimes detached from the container's edge? It certainly proves to be a very interesting phenomenon. I have tried to explain it and investigate as widely as I can.

## 2 Theoretical work

In the beginning I have investigated the phenomenon from a theoretical side.

So the first relatively easy question to answer is:  
What forces act on the beads in its move?

There are gravity, friction and centrifugal forces.

The cause of beads movement is difference of weights of the beads hanging from each side of the beaker. Their net force must be bigger than the resistance force.

In my research I tried to find the time dependent speed and position functions.

The reason of beads detachment is centrifugal force. This force can be decomposed into components, which bear different meaning in the beads movement.

I calculated the speed which is needed to observe detachments.

$$V \geq \sqrt{\frac{\pi R g}{2}}$$

I also recognize that the bead's shape and the length of gaps between them are very important, because beads hooks to the beaker and when it does so after detachment it results with another detachment. Following detachments are even higher.

## 3 Experimental work

I used different sized beads. I also used containers of different heights.

My next step was recording a lot of movies. Using computer program I watched them all in slow motion. It was big breakthrough in my research and helped me draw many interesting conclusions.

## 4 My first research

I used 3-meters beads. Measured parameters were: time of the fall, average speed, average acceleration, influence of vertical component of Centrifugal force on movement.

Beaker height was  $h=0,05\text{m}$  and beads fell from height of  $H=0,75\text{m}$ .



## 5 Conclusions

If the height of beaker is too big, chain does not detach or it does it for very small heights.

The highest speed is achieved by the heaviest beads.

The highest number of detachments in a unit of time occurs when we use the smallest beads.

The chain detaches at the biggest height, when we use the biggest beads.

Vertical component of centrifugal force can significantly influence beads' motion.

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# Peltier Mini Refrigerator

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## 1 Aims

The main aim of experiment is creating experimental system which cannot exchange energy with surrounding. The only way to do so is using optimization criteria, e.g. the size of chamber or the thickness of polystyrene. After making the system we can add few parts (e.g. Peltier Cooler) to make it be a small refrigerator.

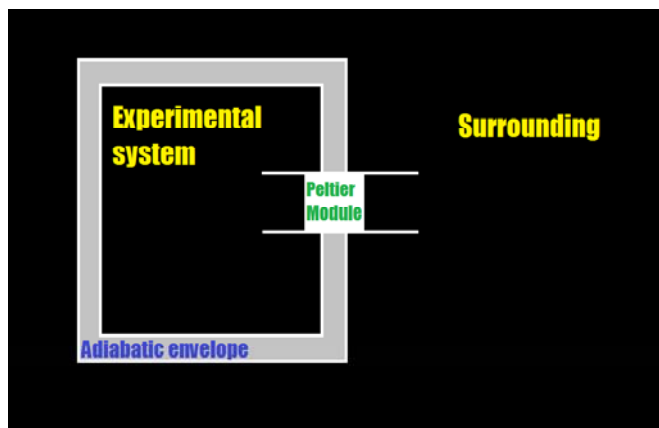


Fig. 1. Main aim of experiment

The refrigerator was used to describe all the physical phenomena occurring during its work. However, I also decided to use it as a brand new way of investigating phenomena which need temperature changes to be observed.

## 2 Peltier Module

Peltier module is a small cooler (40x40mm) consisted of two parallel ceramic tiles. Between them there are alternately arranged doped semiconductors: n-type and p-type. They are connected by metal pads- Peltier Connections. After turning on the voltage source, one side of module gets hot and the second one cold.

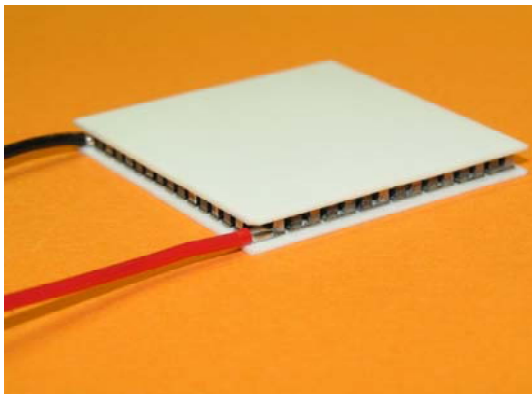


Fig. 2. General building of Peltier Module

## 3 Heat effects in Peltier Module

The heat emitted by the warm side of module is the sum of three thermal effects: Joule's Heating, Peltier Effect and Thomson Effect. Joule's Heat is simply the heat produced by the current during its work. Peltier heat is emitted by the warm side of module and consumed from the cold side because of electrons' energy changes while flowing from one kind of doped semiconductor to another. Thomson heat is generated in conductors or semiconductors, which do not have the same temperature in all their length.

## 4 Experimental system

To create experimental system I placed three pyramid arranged Peltier Modules in the top of polystyrene cooling chamber. To measure the temperature I used three DS18B20 microcontrollers.

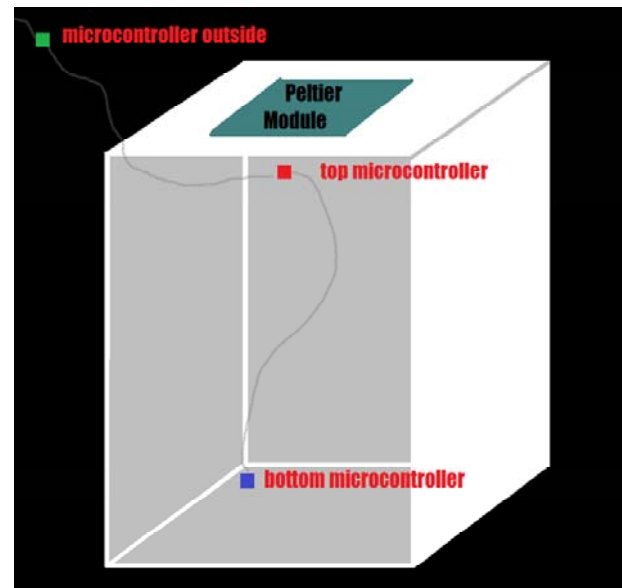


Fig. 3. Experimental system

## 5 Performance of Peltier Modules

Peltier Module as a cooler has a small efficiency. The biggest difference between temperatures inside the fridge and outside it I have observed was almost 20 degrees. As the refrigerator it is not a good result, but as the experimental system to some physical phenomena it was enough. Using my fridge and temperature microcontrollers inside it I was able to investigate them.

# Balloon - a reservoir of energy

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## 1 Introduction

Humanity is continuously searching for alternative sources of energy. However using wind or sunlight do not currently supply us with a sufficient amount of energy. Moreover, usage of energy in cities is also increasing. Energy use is different during days and nights, as well as dropping during weekends. That is why storing energy is inevitable. Today there are different ways of storing energy, however, they are ineffective or very expensive. The aim of my research is to find an effective and cheap way of storing energy.

$$F_{jet} = 2S(p - p_0)$$

## 2 Balloon – a reservoir of energy

In my research I wanted to determine whether it is possible to store energy in a balloon. I compared two methods of collecting energy – energy of compressed air in the balloon, and the elastic energy of a twisted balloon.

### 2.1 Energy of compressed air

When we put some air into the balloon, the volume of it increases. Air pressure inside the balloon is changing. First it is increasing very fast, then it is slowly decreasing to increase again in the end. We can approximately divide this process into three shorter processes: isochoric, adiabatic and again isochoric. After that simplification we can calculate the change of enthalpy of the air, which equals the gathered energy inside the balloon, as shown in Eq. (1).

I concluded that a balloon has some advantages, thus it might be a future alternative method of energy storage.

### 2.2 Elastic energy of a twisted balloon

In order to see whether the previous method is effective, I decided to compare it with another method, outlined in this section. I found out that twisting a balloon obeys Hook's law, as dependence between the force and number of twists is almost linear. In this case I also determined energy gathered [1] in a balloon – Eq. (2).

$$E = \pi r F n \quad [2]$$

## 3 Using gathered energy

In order to determine whether energy gathered in a balloon could be easily used, I built two vehicles.

Energy gathered in balloons made these vehicles move, so I could determine their effectiveness.

### 3.1 First vehicle

The first vehicle is using energy of compressed air in a balloon. Through a nozzle, some air escapes. Due to the principle of conservation of momentum, the vehicle starts moving. Jet force depends on the cross section of the nozzle and the difference of air pressure inside and outside the balloon (Eq. (3)) – it is changing all the time.

Surprisingly, a new balloon appeared to be [3] less effective than one that was already used a few times. After optimizing the relevant parameters, I measured the distance travelled by the vehicle and calculated its efficiency. The outcome was about 5.8%.

### 3.2 Second vehicle

The second vehicle looks extraordinary, but the way it works is simple. After twisting the balloon, it starts to untwist, causing the arm to rotate. However, ground makes a full rotation of the arm impossible, so the big tube starts to roll, moving the vehicle. In this case, after optimizing parameters, I estimated that the efficiency of this method for storing energy is approximately 25.9%.

## 4 Conclusion

A balloon is a toy everyone knows and has played with. The phenomena occurring as balloons store and release energy are

$$\Delta H = |\Delta W| + \Delta U$$

very sophisticated and interesting. It is possible to collect energy in a balloon through different ways, which are quite effective and cheap. The next step is to do the same in a macro state, so that balloons (special one's) could collect energy for a whole city.

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# Let's measure with the camera!

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## 1 The purpose of the investigation

Surely everyone has experienced what it is like when a ball hits them in the back. We were curious what the velocity of a well-kicked, or a strongly thrown ball is, and what acceleration it can have. In our investigation the purpose was to examine the dynamic and kinematic phenomena, to study the velocity of those objects, which have a speedy acceleration. We wanted to examine the phenomena, as well as to prove, that these things are important.

## 2 Method of investigation

For this purpose, we could use professional acceleration sensors, since our school owns these tools. The sensor seems to be a good choice, because it can store a lot of information, but many problems may occur during their use. Even if we have enough sensors to examine all the subjects we want, the following question arises: how can we place the sensor into the balls? Besides, the sensors may be damaged by the high acceleration, that is why we chose another method. Our Physics teacher recommended the use of a digital camera and a computer program which helps in the examination of the data. A digital camera (or the camera of the mobile phone) can be found in every house, so for this purpose we do not need extra money. You just need to download a software and you can use the method. In the program we set the subject's position in each frame which automatically moved on to the next frame, making it even easier to work with. The software uses simple algorithms to calculate the velocity and the acceleration of the subjects.

The method is the following:

First, we make a short film about the subjects we want to examine; we use a fixed camera. The film is an array of consecutive pictures, played so quickly that they seem to be a motion picture. These pictures are called frames. A camera can take 25-30 frames per second. We used the 30 frame/sec mode, in order to analyse the phenomena in smaller time units.

The software produces diagrams and tables with which we could draw the conclusions.

## 3 Results

We found out from the measurements that a strongly thrown ball can reach even a 36 km/h velocity and when it collides, its acceleration grows up to 17G. A well-kicked ball's velocity can be more than 75 km/h. Both in running and jumping the acceleration of the limbs is the highest, while the acceleration of the head is quite low. An exact measurement may also be carried out by using a camera and the computer program. The speed with which the information spreads within the nervous system also plays an important role in the outcome of the examined phenomena.

Our body parts reach a high velocity without us noticing and such light objects as balls easily reach high acceleration and velocity.

## 4 Conclusions

By analyzing the films, the effectiveness of each sporting activity can be increased.

We can observe the force produced by each body part and we can increase or decrease it by practice in order to reach better results. If we notice that somebody is not able to produce enough power with his arms or legs, specific muscle power increasing exercises are carried out to develop the targeted muscles. Thus, one can improve their sporting results quickly.

If the sportsman becomes aware of the excessive use of the wrong muscle group, he can easily improve his results by paying attention to the specific muscle groups.

## Reference

<http://www.cabrillo.edu/~dbrown/tracker>

# Thermal aerial vehicle

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## 1. Introduction

I've studied two kinds of aerial vehicle in my project:

- 1) The vehicle that takes off because of the buoyancy force. It looks like a capsule with a burner inside.
- 2) The aerial vehicle that takes off because of the air convection streams. It looks like a tube with low weight, made of a material with high heat of combustion.

## 2. The purpose of the investigation

The purpose of the work is to develop the termal "aerial vehicles", to investigate the main principles of their work and main characteristics. The problem under investigation is multivariable, consequently, quite exciting.

## 3. Method of the investigation

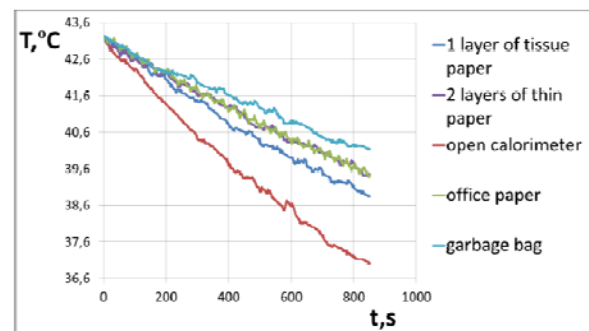
There are two ways of realization of the launch process. In the first way, the source of heat is attached to aerial vehicle. Then the heating is going on permanently, while the flame is burning. The second way is based on the fast heating of the air inside the device by the heat source being situated on the ground, so the common weight of the construction can be decreased, however then there will be no opportunity to heat the aerial vehicle while the flight.

First type construction leads to two incompatible problems to be solved. So far as the flight requires maintenance of the highest possible temperature of the air inside the aerial vehicle, the heat isolation of the walls of aerial vehicle is of great importance. However, using of very thick walls requires more power of the burner. Results from Archimedes law, that the necessary density of the warm air inside the device is proportional to the weight of the capsule and inversely proportional to the volume of the air inside it. So the weight of the capsule and the framework should be as low as possible, and the volume of the air inside the rocket should be as big as possible. The optimal solution is the capsule to be spherical.

Using the Archimedes law and the ideal gas law I got a dependence between the temperature of the warm air, necessary for vehicle to be launched, and the temperature of the environment, vehicle weight and weight of the air inside, therefore the necessary amount of heat for the device to be launch.

Second type construction. After the tube is set on fire from the top, the air situated under and inside the tube is being sucked towards the flame, and the air flows along the walls resulting to the vehicle involving in the stream.

## 4. Results



I counted loss for various materials. For example I explored the possibility of using a candle as a heater. The air heating time, necessary for vehicle to launch, was approximately two hours (without consideration of the heat loss). Also I found the capacity of a cotton tampon, saturated with alcohol. In theory the construction should launch in two minutes, what was corresponded with the experiment.

A tea bag, formed into a tube, is launched in 3-5 seconds to 1-3 meters high (it depends on the kind of tea bag).

As a result, I built a theoretical model, which made it possible for us to calculate the time necessary to heat the air enough for rocket to launch.

$$t = \frac{\gamma P_{atm} V_{air} \frac{m_{vehicle}}{m_{air} - m_{vehicle}}}{2(P_{burner} - P_{loss})}$$

Using it, it's possible to determine the necessary capacity of the burner to launch the rocket for given rocket's weight and volume.

Also the theory of the thermal aerial vehicle was developed.

# The chain trick

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## 1. Introduction

Magic tricks are very popular and some of them can be explained by physics. One of these experiments requires only a ring and a chain. The chain is placed over the hand and the ring is then lifted from the lower end such that it is outside of the chain. The ring may then be held by two fingers of the other hand or by using thumb and middle finger of the same hand. Sometimes, when you drop the ring, it will not fall on the floor but make a knot around the ring, as shown in Fig.1.



Fig 1. A knot around the ring

## 2. The purposes of the investigation are:

- 1) To explain the phenomenon and study its appearance from relevant parameters;
- 2) To investigate the motion of the chain during the ring falling.

## 3. Methods of the investigation

The process of the ring falling was filmed on a video using high speed camera with frame rate 500 fr/sec. Different combinations of rings and chains were used. The physical model of the phenomena was developed by use of the dynamics approach.

## 4. Results

The appearance of the phenomenon was explained. The main thing is that first finger should be moved away immediately, while the second finger is still supporting the ring. After moving away the first finger, the ring starts to rotate around the second finger. When the second finger is away too, the ring continues to rotate. Then the ring pushes the lower end of the chain aside, which, due to its weight, generates a restoring force. The rotation of the ring over  $90^\circ$  causes the stretching of the lower ends of the chain aside. If a restoring force component tangential to the ring overcomes the frictional forces, the two ends of the chain can move from the lower ends of the ring upwards on each side of the ring. If they reach the middle of the ring, the knot can form.

A lot of experiments were not successful, because the trick is sensitive to many parameters such as combination of mass and size of the ring, the stiffness of the chain, the friction between ring and chain, the length of the chain (the chain should be long enough, so the ring can end its rotation and the chain can form a knot).

# Frustrating golf ball

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## Motivation

In cheering for the Taiwan glory, Tseng Ya Ni, on LPGA, we also observe some frustrating phenomenon. When some players are putting, the ball doesn't always serve their minds. Sometimes, the ball may escape from the hole after it goes around the rim for a round or two. The frustrating golf ball brings so many questions to my mind, so I decide to investigate about it.

## Tools

The basic tools used for the experiment are shown in the picture.



Fig 1. Experiment equipment set

## Theory

### 1. Velocity and Angular Frequency

- (1) The motion when the ball rolls in to the hole.
  - If  $V_0 < 0.457$ , the ball will rolls for a while on the rim without touching the oppiste site of hole.
  - If  $V_0 > 0.457$ , further consideration should be taken into account.
- (2) When  $V_0 > 0.457$ , the ball touches the opposite side of the hole.
  - If  $V_0 < 1.313$ , the ball will be captured.
  - If  $V_0 > 1.313$ , further consideration should be taken into account.

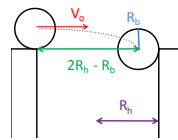


Fig 2. The ball rolls into the hole

- (3) When  $V_0 > 1.313$ , two scenarios happen:
  - A. If  $v_{ft}^2/R_b > g\cos\theta$ , the ball escapes by flying.
  - B. If  $v_{ft}^2/R_b < g\cos\theta$ , two situations may occur:
    - a. If  $\frac{1}{2}mV_{ft}^2 + \frac{1}{2}I\omega_t^2 > mgR_b(1-\cos\theta)$ , the escapes by rolling away.
    - b. If  $\frac{1}{2}mV_{ft}^2 + \frac{1}{2}I\omega_t^2 < mgR_b(1-\cos\theta)$ , the ball rolls back into the hole.

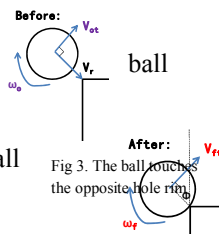


Fig 3. The ball touches the opposite hole rim.

### 2. Putting Accuracy and Critical Velocity

- (1) There is a tolerable deviation from the rolling path for the ball to fall in. Three phenomena happen with different  $\delta$  (fig 4): flying escape, forward rolling escape, and backward rolling escape.



Fig 4.  $\delta$  is the deviation from the radius.

- (2) The ball being able to escape requires a critical velocity. The more inaccurate the putting is, the more possible that the ball will escape with smaller critical velocity.

## Experiment

1. To test if the actual escape initial velocity is 1.313m/s.
  - set different initial velocity for the rolling ball
2. To understand the relationship between critical velocity &  $\delta$ 
  - set the parameter of  $\delta$
  - Observe ways the ball escapes

## Result

1. According to the data, the realistic velocity is 1.5m/s.
2. By using software(tracker) to analyze the high-speed video of the motions of the golf ball, the result shows that the critical velocity will decrease along with  $\delta/R_h$ .

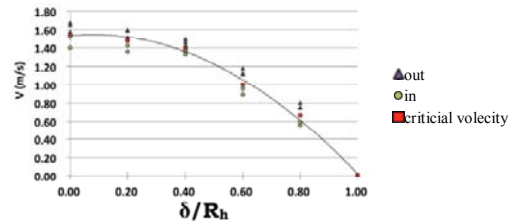


Fig 5. Relationship between accuracy and critical velocity

## Conclusion

According to investigation on the preceding phenomena, if the accuracy is neglected, velocity is a key factor to the result whether the ball escapes from the hole. Critical velocity drops sharply when  $\delta$  gets larger. To sum up, velocity and accuracy are the imperative parameters that lead to the escape of the ball.

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# Using the ion implantation technique biocompatible products of develops

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## 1 Purpose

In recent years, the surface properties of materials (wear resistance, hardness, friction, etc..) Improvement or optimization is an important place in the field of materials engineering. The desired mechanical, chemical and environmental characteristics that have most of the volume is often very difficult and expensive to produce them or not possible. Surface modification techniques, allows obtaining materials with desired properties of the entire surface. In some applications, ion implantation, thin coatings has become more economical and advantageous.

In this study;

- Definition of the ion implantation of the difference in the other coating methods
- MEVVA ion implantation system, the introduction of differences in ion implantation
- Proof of biocompatibility' method of ion implantation in metals
- Dental implants used in the titanium plates were implanted in zirconium, biological, chemical, mechanical properties of biocompatible developed to make
- Ion implantation through an example of a dental implant in the body, used in the detection of biomedical products aimed provability' with ion implantation.

In this direction;

- MEVVA ion implantation system features superior detection
- The appropriate time and dose calculations for the application of ion implantation
- Titanium plates, zirconium and oxygen implantation performed
- Plates' have been implanted;
  - AFM, SEM and EDX analysis done
  - Measurement of the ion oscillations
  - Retention tests were aimed at the realization of that cell.

## 2 Method

To improve the human body, any organ or tissue designed to perform certain functions in the production of prostheses and implants from biocompatible materials, despite the often very long healing process. In this project, through an example of a dental implant; MEVVA (Metal Vapor Vacuum Arc) ion implantation system titanium samples implanted with zirconium ions accelerated in the electric field equilibration, economic, biocompatible aimed to develop a medical product.

In this study, 0.1-0.07Ra roughness was created two experimental groups. Zirconium and oxygen hydride (Zr+O) ion implantation was performed. Implantation parameters were 50kV and  $2 \times 10^{17}$  ion/cm<sup>2</sup> dose. SEM of

the implanted samples, EDX, AFM surface morphology were examined by tests; biocompatible of SAOS cells are incubated for 12-24h to investigate the holding cell adhesion test was performed. In addition, intensive 4day intervals during the 16days the samples were kept in the salivary fluid, for the Zr ion oscillation tests were performed every 4days.

## 3 Result

Sticking to the ion-implanted surfaces of the test according to the cell adhesion test, the number of cells, the control surfaces were seen more often. In addition, the secretion of salivary fluid Zr ions was found to be negligible at. Cell adhesion and biocompatibility of the product proved to be a result of ion oscillation tests. According to methods of coating surfaces of metal ion implantation method, and more economical, as well as corrosion, wear more durable also increases the product biocompatible. Thus, method of tissue regeneration in biomedical science, prosthetics, surgical instrument can be used in many products, such as production.

## 4 Conclusion

Titanium Zirconium surface as a result of vaccination with the percentage of cell adhesion was found to be better than the other substances. Implantation ion-ion emission of the surfaces was not. These features are applied to the implantation of biocompatible materials that feature evidence. Vaccination with Zr, Ti implants, and biocompatibility is higher than other dental implant alloys. In addition to the lives of implantation increased.

This study was conducted on a sample of dental implantation with the ion implantation method has proven to be used in biomedical science. Prostheses, surgical instruments, used in many potential uses, such as waiting to be discovered there.

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# Development of the ecological electric battery

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## 1. Abstract

Modern life is impossible without electric battery. It's used everywhere: in the TV remote control, in car's immobilizer etc.

Besides a number of advantages (a small size, low cost, capacity, high current), also the modern galvanic cells have some disadvantages: large mass, the components are contained the heavy metals.

The aim of this work is research of alternative power supply.

This research is actual because the project is devoted to simulation of ecological manufacture galvanic element. Its utilization doesn't require a sophisticated technology and has a low cost.

## 2. Theoretical part

Basically, a galvanic element consists of two electrodes and the electrolyte. The work of the galvanic element is based on the interaction of two metals – the electrodes dipped into the electrolyte. The electrode with negative electrochemical potential (Cr) gives its electrons for the electrode with positive electrochemical potential (Cu).

## 3. Experimental part

In this project the galvanic cell with the electrodes made of deposited metals coatings on the cellulose padding is proposed. Coating of Cu and Cr are used to produce electrodes for this galvanic element. The deposition is produced with the magnetron ion-plasma sputtering system. The thickness of the metal coating on the electrode surfaces is measured with the quartz resonator [1]. The thickness of metal of this galvanic element is 1 – 2  $\mu\text{m}$ . The construction of galvanic element is similar with voltaic pile. The galvanic elements are joined one by one. As an electrolyte the natural acids and salts are used. On the border electrodes the voltage is taken. Fig. 1.

According to the row of electrochemical voltage, between copper and chrome the voltage is 1,08 V [2]. The experiments show that one pair of electrodes (copper-chrome) produces the voltage 0,6 – 0,8 V depending on the type of electrolyte.

## 4. Conclusion

Depending on the geometrical size of battery the current changes. Advantages of this galvanic element are:

- utilization is simple and not harmful for the environmental;
- production of the galvanic element is cheap;
- shape of the battery can be random;
- small mass;
- universal using.

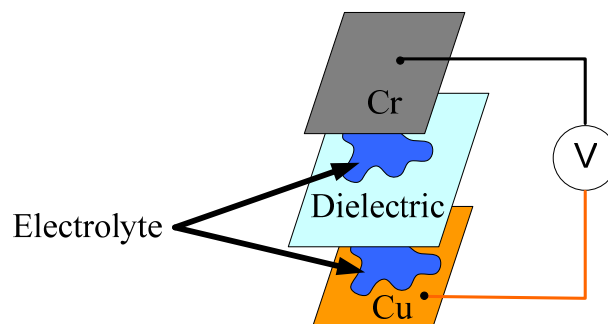


Fig. 1. The picture shows the model of the experiment.

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# Hurricane Fighting Devices

Levkovskyi Borys

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## 1 Introduction

It can be used in fighting with hurricanes, and various phenomena like this. The task is to develop some devices, effective in fighting with hurricanes. The originality of the research is that the energy of vertical and horizontal currents of the hurricane are reduced due to the creation of vertical and horizontal air current, directed against the respective currents of the hurricane. That means, that the hurricane destroys itself.

## 2 Theoretical part

To write this research the author analyzed some natural processes in atmosphere and the ways to tame them. The author arrived to the conclusion that the major part of them are very expensive and have great capacity. Another ways are harmful for the environment. Thus an idea of a respectively cheap and environmentally friendly device has appeared.

## 3 Experimental part

The author has proposed a number of unique ways and devices for hurricane fighting. The drawings of them are given in the addendum. On the figure 1 we see the cross-section of that device. Propellers (1) are fixed on the vertical axes (2) in a cylinder frame (3) with a nozzle (4) in its lower part. S-shaped plates (5) are deadily fixed on the axis (2), system of fixing (6), horizontal current of air (7). On this drawing right we see the device with horizontal frame (3) and a system of propellers(1) inside. Vertical axis (8) with immortable vertical S-shaped plates (5) is connected to the axis (2) trough the train gear (9). The hurricane fighting is done in the following way: the horizontal hurricane current (7), influencing the vertical S-shaped plates are forcing to move the axis with the propellers on it. Rotating in cylinder frame they create a strong air current, which is directed down through the nozzle. As a result the vertical hurricane current decreases dramatically, which leads to the hurricane ruination. The same is done when the frames are horizontal. Then the rotation is transmitted from the axis (8) to the axis (2) through the train gear. To provide the rotation of vertical axis in the necessary direction vertical plates are S-shaped. Nevertheless the device has some drawbacks. Frames and S-shaped plates are located on the different height above the ground. The hurricane speed there is also different. It was eliminated in the next device. The system of description is the same, but the plates are on the same level as the frames and the rotation from the axis on which the plates are fixed is transmitted to the axis through the train of gears. The limitation is that the cylinder frames with nozzles have a difficult geometrical form. It leads to difficulties in production and thus increases the cost. This problem is supposed to be sold out in the third device. The principle of work and designation is similar to the previous

devices. The only difference is that a drop fairing is placed in the cylinder frame without nozzle.

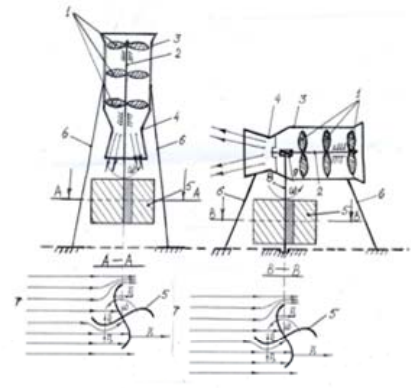


Fig.1. Device fir hurricane fighting

## 4 Results

The presented devices in fighting and eliminating the hurricanes are original and produce high level of economical effect as they do not need any special sources of energy. They are simple in their designs, effectively deal with vertical and horizontal currents of the hurricane. Implementation of the system of these devices will allow to decrease hurricane energy to safe level and to escape human casualties and save huge financial costs. All of them are environmentally friendly.

## 5 Discussion

All of the above-mentioned ways and devices in hurricane fighting are protected with 6 patents of Ukraine as a useful model.

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# Cadmium Manganese Telluride Crystals as a Material for Optical Isolators

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The semimagnetic semiconductor Cadmium Manganese Telluride ( $\text{Cd}_{1-x}\text{Mn}_x\text{Te}$ ) is actively studied as a perspective representative of the family of the solid solutions. Manganese atoms usually occupy crystal lattice sites without spreading into intersites and form nearly ideal solid solution. Changing the ratio of components we can controllably affect material's properties; for example, affect the magnetism value changing the concentration of the magnetic component Mn, etc. The interest in this semiconductor has recently grown because of the possibility of the practical in the spintronics devices. There also is a perspective of using  $\text{Cd}_{1-x}\text{Mn}_x\text{Te}$  crystals with  $x = 0.45$  as a material for optical isolators when the wave length is about 620 nm [1]. Therefore, the important question is obtaining optically perfect  $\text{Cd}_{1-x}\text{Mn}_x\text{Te}$  single crystals that could be practically used.

For the purpose of solving this problem in this project the optimization of the processes of single crystals growing and the research of the specific resistance and transmission spectrum of the optical radiation of  $\text{Cd}_{1-x}\text{Mn}_x\text{Te}$  crystals depending on the Mn content was held. The research was realized on the Department of Physics of Semiconductors and Nanostructures of Chernivtsi National University.

Single crystals were grown in the high-temperature furnaces according to modified Bridgeman method. Temperature modes of the furnaces were optimized considering physical and chemical properties of the solid solution and the results of the research. The process was held in the quartz containers covered by pyrolytic graphite. There were applied ultra-pure components for the synthesis. It has given a possibility to prevent optical absorption by the impurities in the area of the photon energy that is smaller than the band gap. The content of Manganese was changed in different crystals from  $x = 0.04$  to  $x = 0.5$ .

During the  $\text{Cd}_{1-x}\text{Mn}_x\text{Te}$  charge heating from room to high temperatures (230-300 K) for the time of 10-15 h. component sintering happened. Because Mn's melting point is higher than the melting point of the container where the melting process is held Manganese was dissolved in CdTe melt within  $T = 830$  K. The time of dissolving is depending on the Mn content (from 65 to 85 hrs.).

Every observed crystal has cubic lattice. The measured values of lattice parameters for different values of  $x$  were within:  $x = 0$ ,  $a = 6.479 \pm 0.002$  Å;  $x = 0.1$ ,  $a = 6.466 \pm 0.003$  Å;  $x = 0.3$ ,  $a = 6.436 \pm 0.003$  Å;  $x = 0.4$ ,  $a = 6.422 \pm 0.002$  Å;  $x = 0.5$ ,  $a = 6.402 \pm 0.003$  Å. When  $x = 0.4$  and bigger the samples were changing their color from black to red-orange.

In  $\text{Cd}_{1-x}\text{Mn}_x\text{Te}$  crystals the specific resistance value measured in the room temperature was growing with increasing Manganese content from 1 kΩ·cm to 1 000 kΩ·cm.

The optical radiation transmission research was held on the spectrometer complex KSVU-23. Spectral dependences of the optical radiation of the polished samples of 7 mm

diameter and 1 mm thickness with different Mn content were studied (Fig. 1). It was found that increasing the magnetic component content led to the shift of absorption edge into shorter waves' area (from 850 nm to 615 nm). This shift was caused by increasing of the semiconductor's ( $\text{Cd}_{1-x}\text{Mn}_x\text{Te}$ ) band gap with increasing  $x$  [2]. Sharp rise in the spectral curves from minimal to average values of the transmission coefficient was observed, which shows high optical structural perfection of the grown crystals. Maximum value of the transmission coefficient was 60-63% - that is quite good result.

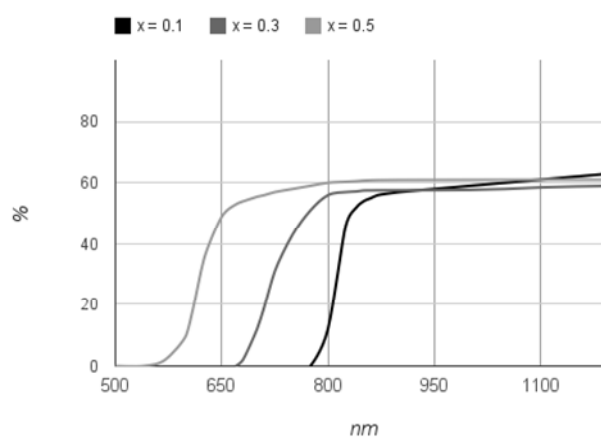


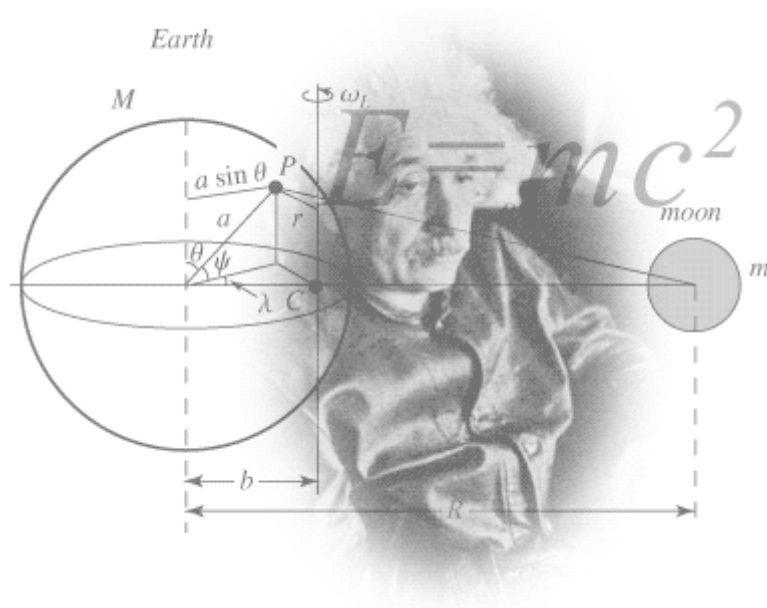
Fig. 1. Spectral dependences of the optical radiation transmission on the  $\text{Cd}_{1-x}\text{Mn}_x\text{Te}$  solid solution composition

In such a way according to optimized method the solid solution's crystals of  $\text{Cd}_{1-x}\text{Mn}_x\text{Te}$  with high optical quality were obtained. We can change their content, affect controllably the radiation transmission from 610 nm to 850 nm.

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# Physics



Radboud University Nijmegen  
The Netherlands 2012

# Hertz's new cloth

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## 1 Introduction

Generation and propagation of electromagnetic waves is an important topic, which is a part of every high school physics-curriculum worldwide. However, among the students, this topic is very often considered as rather difficult and counter-intuitive. In-front-of-class experiments can be very useful in explaining basic phenomenology but the appropriate experimental equipment is rather expensive and not available in many high schools. This paper reports successful development of two simple and cheap 'replicas' of famous Hertz's experiments, which have been found as very convenient for use in high school physics class.

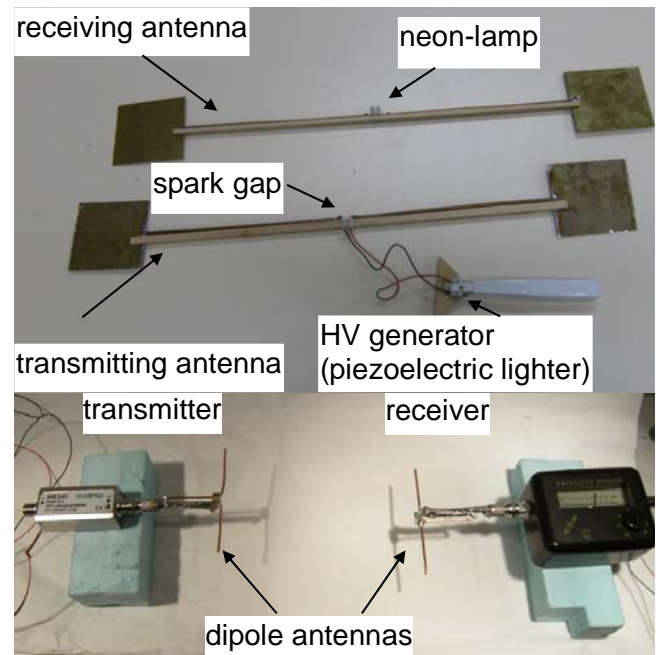
## 2 First Setup – 'Classical Hertz'

This main idea was to develop simple transmitter and receiver together with associated antennas capable to mimic famous Hertz experiments [1,2] and, therefore, enable demonstration of basic EM phenomena such as propagation, polarization, reflection etc. The first setup uses a cheap piezoelectric gas lighter as a high-voltage pulse generator (a transmitter). Time domain measurements with a digital oscilloscope revealed that this device is capable of producing the pulses with magnitude of 5 kV with rise time of 50 ns and duration of 50  $\mu$ s. Analysis of this waveform showed that associated spectrum contains frequency component in radiofrequency band (1 MHz). The lighter was connected to a simple dipole antenna with loading capacitive plates, made out of brass (Upper part of Fig. 1). A similar antenna, loaded with a small neon-lamp taken from voltage tester, was used as a receiver. Several additional parts (reflector, polarizer, loop antenna) were prototyped, as well. Four basic experiments, that demonstrate radiation, polarization and orthogonality between E and H field vectors, were designed and tested. It was found that these experiments clearly show associated background physics and the measurement results were in very good agreement with theoretical predictions. The approximate cost of 'Classical Hertz' setup is only 20 EUR.

## 3 Second Setup – 'Modern Hertz'

The second setup is more complex (Lower part of Fig. 1), but it operates in 2GHz microwave band and, therefore, enables demonstration of additional EM phenomena (guiding, focusing and standing wave formation). A cheap satellite TV amplifier was modified into an oscillator by adding a simple positive feedback. Measurements revealed that this 'transmitter' generates stable microwave signal with a frequency of 1.8 GHz. In the next step, a commercial satellite signal finder was modified in order to be used as a receiver. Several different antennas (dipoles, dipoles with corner reflectors, helical antennas) and an additional

transmission line with a capacitive probe were designed and built. As in the previous case, several experiments that demonstrate propagation, polarization, reflection, interference, focusing and guiding of EM waves were designed and tested. All the measurement results were consistent with the associated theory. The approximate manufacturing cost of 'Modern Hertz' setup is 50 EUR.



**Fig.1** Developed Experimental Prototypes:  
**Upper:** 'Classical Hertz', (operating in 1 MHz band)  
**Lower:** 'Modern Hertz', (operating in 2 GHz band)

## 4 Conclusion

In this paper, two 'replicas' of original Hertz's experiments, designed for use in the high school physics classroom, are proposed, built and tested. Developed systems are cheap and they consist of easily accessible modified commercial components. They operate in 1MHz and 2GHz bands and enable simple, accurate and intuitive demonstration of propagation, polarization, reflection, interference, focusing, and guiding of electromagnetic waves.

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# PLANE CONDENSATOR'S LIST VIBRATION

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The given paper is addressed to researching complex vibration system. We will view the vibration system which consists of plane condenser lists. One of the list is fixed and another one is put on a narrow axis which is able to slide without friction. Parallel to the moving list, we placed hard water spiral (k) without weight. The area of the condenser list is S and the weight of the moving list is m. The condenser's lists are connected to the source of electricity power by wires. (See the figure).

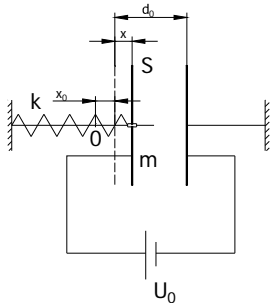


Fig. Plane condenser with moving list

We can view and discuss three possible occasions of the voltage on the condenser's lists: 1. Constant voltage, 2. Sinusoidal voltage, 3. Saw voltage. We can see zero and first order approximation of electric force between lists [1].

$$F_{el} = \frac{\epsilon_0 S U_0^2}{2(d_0 - x)^2} = \frac{\epsilon_0 S U_0^2}{2} \left( \frac{1}{d_0^2} + \frac{2x}{d_0^3} + \dots \right)$$

We calculate the parameter for vibration for each occasion (dependency on list coordinate times and vibration period), in the second case we discuss the resonance case. In the third occasion we define the initial condition for which we establish pseudo periodic variation picture.

In this research we studied the double system of vibration in different occasions. (spiral vibration and the electric charge changes on the lists). And this will help us discuss the complex vibration systems.

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# The ionic roundabout

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## 1. Short introduction

A conductive fluid in a magnetic field starts moving when a current is applied. This is called the “magneto-hydrodynamic effect” and can be used for a variety of technical applications like a generator or a propulsion unit. In our project we investigated the influence of the applied magnetic field and current on the velocity of the fluid.

## 2. Experimental methods

Figure 1 shows a simple demonstration of the MHD-effect which can be realized in one minute with inexpensive, easily available materials. The rotation of the liquid can be visualized by using a little bit of ink.

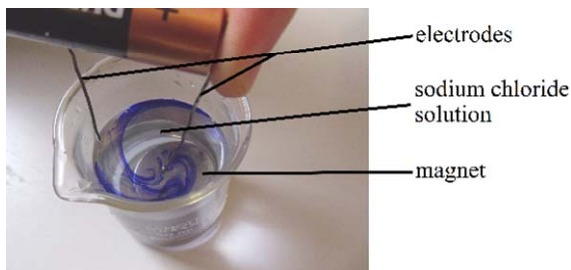


Fig. 1. Easy demonstration of the MHD-Effect

For a deeper investigation of this phenomenon we used the experimental setup shown in Figure 2.

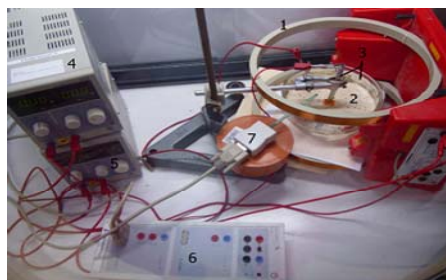


Fig. 2. Experimental Setup

As a fluid we used a sodium chloride solution (2). In order to change the magnetic field we used Helmholtz-coils (1) connected to a variable power supply (5). Another variable power supply (4) allowed us to change the current in the solution. We used aluminium electrodes (3) and measured the magnetic field with a hall probe (7). The movement of the fluid was recorded with a camera.

## 3. Application

As an application of the MHD-effect we constructed a small boat (Figure 3) which is using the Lorentz force as a power source.

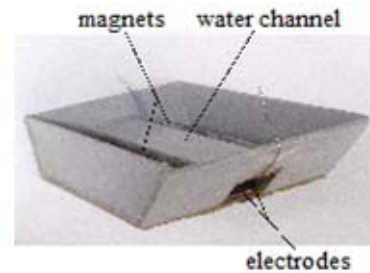


Fig. 3. MHD-Boat

## 4. Theoretical model

Due to the magnetic field the moving ions in the fluid are accelerated by the Lorentz force:

$$\vec{F}_L = n \cdot q \cdot \vec{v} \times \vec{B} \quad (1)$$

Taking into account the viscous force

$$\vec{F}_\eta = \eta \cdot A \cdot \frac{\partial \vec{v}_x}{\partial y} \quad (2)$$

and using cylindrical coordinates we were able to set up the differential equation for the motion of the liquid:

$$\frac{\Delta v}{\Delta t} = \frac{1}{\rho} \cdot \frac{I \cdot B}{2\pi r \cdot h} - \frac{\eta}{\rho} \cdot \left( \frac{1}{r} \cdot \frac{\partial v}{\partial r} + \frac{\partial^2 v}{\partial r^2} + \frac{\partial^2 v}{\partial z^2} \right) \quad (3)$$

## 5 Results

We numerically solved the partial differential equation with the software package COMSOL Multiphysics. Figure 4 shows the radial distribution of the velocity for different heights simulated by COMSOL. Both, experiment and theory, confirmed that the velocity of the fluid is proportional to the magnetic field and the current. The magneto-hydrodynamic propulsion boat worked well, though it still has to be optimized in the future



Fig. 4. Radial distribution of the velocity

# Inferring the physical parameters of extrasolar planets

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## 1 The purpose of the investigation

Throughout the whole history of mankind, people were always thinking about distant worlds which are inhabited by exotic, human-like creatures, or even humans. By 23 February 2012, there have been 760 planets discovered in 609 solar systems and 100 of them were multiple ones (The Extrasolar Planets Encyclopaedia<sup>[1]</sup>) In my project, I observed and analyzed three of these systems to determine the exact mass and radius, two of the most important properties of these planets. I also estimated the largest hypothetical moon in the case of XO-2.

## 2 Method of the investigation

I performed an analysis of selected objects, based on CCD observations taken at two observatories: at the Polaris Public Observatory of the Hungarian Astronomical Association in Budapest and the Piszkestető Station of the Konkoly Observatory, Mátra mountains, Hungary. The selected systems were: HAT-P-20b (Polaris Observatory, Celestron-11 telescope), HAT-P-14b, and XO-2b (Piszkestető Station, 1.01 meter RCC telescope, which is the biggest device in Hungary). Besides taking the data I have also reduced the taken images using the IRAF astronomical software package.

	$M_{\text{star}}$ ( $M_{\text{Sun}}$ )	$M_{\text{planet}}$ ( $M_{\text{Jupiter}}$ )	$R_{\text{star}}$ ( $R_{\text{Sun}}$ )	$R_{\text{planet}}$ ( $R_{\text{Jupiter}}$ )
HAT-P-14	1.39(5)	2.20(4)	1.47(5)	1.20(4)
HAT-P-20	0.76(3)	7.2(2)	0.7(2)	0.87(3)
XO-2	0.98(2)	0.57(6)	0.96(2)	0.97(3)

Table 1. The basic parameters of the examined objects<sup>[1]</sup>. Errors of the last digits are in parentheses.

The raw light curves of the targets were derived using an aperture photometry package of the IRAF software. Subsequently I fitted a model light curve to data points in every case thus the more precise determination of the parameters was possible. For XO-2b, a standard analysis of the light curve in terms of transit time and depth helped estimate the accurate size of the planet and to determine the

O-C diagram. Currently I am to complete these observations with radial velocity follow-ups of these systems to determine the exact masses.

## 3 Result of the experiment

The measured transit time at  $55628.3271 \pm 0.0002$  (BJD) is consistent with previous transits in the literature and zero transit timing variation within 0.0005 day rms scatter. Following two methods based on a dynamical concept to give an upper estimate for the mass<sup>[2]</sup> and radius<sup>[3]</sup> of a possible moon, we got  $3.41 M_{\oplus}$  limit in terms of mass and  $0.136 \pm 0.0042 R_J$  in terms of radius. XO-2b can not host any moon larger than these values. The derived transit depth of the transiting planets are: 13.3mmag for XO-2b, 8mmag for HAT-P-14b and 25mmag for HAT-P-20b; this leads to a size of the planets of  $1.10 \pm 0.0235 R_J$  (XO-2b),  $1.28 \pm 0.0470 R_J$  (HAT-P-14b), and  $1.06 \pm 0.0308 R_J$  (HAT-P-20b).

I have a running project which contains the homogeneous analysis of several exoplanet systems including the usage of the transit method and the radial velocity technique. The observation sites are in Baja, Szombathely, Budapest and at Piszkestető station. I would use the JKTEBOP<sup>[4]</sup> code for the fitting of the light curves. Hence more precise data would be available and the determination of a much more improved O-C diagram would be possible.

## References

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[4] <http://www.astro.keele.ac.uk/jkt/codes/jktebop.html> .



# How could the invisible be seen?

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## 1 How could the invisible be seen?

It sounds like a strange question. As we explore the world that we live in, we get to know more and more phenomena which is not visible by the naked eye, for example radioactivity is one of them. With the **cloud chamber (or fog chamber)** we can observe the traces of several radioactive particles, which can ionize the neighboring gas molecules. The precipitating vapour on free ions exposes the presence of alpha and beta particles in the form of fog traces, which can be observed by naked eye. We have two possibilities to make supersaturated vapour, with expansion (short pressure drop, constant temperature) or diffusion (large temperature drop, constant pressure). I choose the second possibility because I would like to make a long working cloud chamber [1].

## 2 Methods of the investigation

In diffusion cloud chambers the supersaturated vapour is produced through cooling. If the bottom of the chamber can be cooled under the critical temperature the methanol will be saturated. I took a sample of an old cloud chamber that was prepared in our school. This chamber is a glass barrel and the bottom is solid metal for the better heat conduction and therefore better cooling [2].

Different chambers were constructed. The bottom of my chambers is an aluminum plate with an aluminum „cold finger” that is direct contact with the cooling agent and cools the bottom of the chamber by conduction. The chamber is a simple plastic box that can be found in every kitchen. In order to see what happens in the chamber a piece of the box was cut out and this window was covered by thin and transparent polymer foil. The source of radiation was a piece of an old yellow wall tile.

## 3 Result of the experiment

When the above described device was assembled and set it started to operate immediately without any further adjustments. Many little fog trails could be seen which are started from the radiation source. The observed phenomenon was quite impressive. The chamber was working for many ours with a small amount of dry-ice. The operating temperature of the chamber's bottom was under  $-55^{\circ}\text{C}$ . Besides this sometimes a few fog trails appeared seemingly not from the direction of the radiation source. These trails presumably belong to the background radiation.



Figure 1: Fog trail in my chamber

After the above mentioned observations many interesting experiments were conducted with my chamber. During these two different species of fog trails were observed in the chamber. The first one was short and thick; the second one was long and thin. The first one presumably was a trail of an alpha particle; the second one may indicate beta particles. The first experiment was based on the alpha particles. I placed a piece of paper in front of the radiation source. All the trails were stopped at the paper. So the alpha particles have very bad penetration ability. This indicates the relatively big size of the alpha particles. For the next experiment I placed a simple magnet into the chamber. The straight fog trails were bent. I saw that the trails of beta particles (long, thin) were more bent than the alpha particles (short, thick).

## 4 Conclusion

In summary it was not easy to make a cloud chamber but it was absolutely worth of efforts because I could make interesting experiments with my chamber. It caused many pleasure for me to see the trails of radioactivity and I experienced the different properties of alpha and beta particles.

## References

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# On the Gravitodynamics of moving bodies.

By Daan van de Weem and Martijn van Kuppeveld

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## 1. Introduction

Since Maxwell wrote down his famous equations for electromagnetism, physicists have tried to apply them to gravity. The reasoning behind this seems obvious, when one looks at Gauss's law of electric fields (Eq.(1)) and Gauss's law of gravity (Eq.(2)), which are essentially the same, bar a few constants. Written in Einstein summation convention (with a +,-,-,- metric), they are:

$$\partial_i E^i = -\frac{\rho_e}{\epsilon_0} \quad (1)$$

$$\partial_i g^i = 4\pi G \rho_G \quad (2)$$

This reasoning was made even more appealing with the introduction of special relativity, which easily transforms electricity into electromagnetism. This all depends on the spatial inverse quadratic form of Coulomb's law, something it clearly has in common with Newton's law of gravity. The analogous theory is called gravitoelectromagnetism. Here we interchange all electric charges with masses and electric constants with the corresponding gravitational constants.

A problem was gravity's instantaneous interaction between particles, something that was impossible to reconcile with the principles of special relativity. This problem as well as the problem of Mercury's anomalous orbit [1] was fixed with Einstein's General Theory of Relativity. A new problem emerged however: The General Theory of Relativity is mathematically complex. As a result, very few exact solutions are found, all of which require extraordinary symmetries. Interest in gravitoelectromagnetism grew back with the realization that it could approximate general relativity and e.g. the launch of Stanford University's Gravity Probe B. Its main use lies in the relatively simple mathematics this approach offers and the familiarity of 'magnetic' effects for anyone with a basic understanding of physics.

## 2. Our research

An approximation is useless if its boundaries or margins are unknown. Our two main goals therefore were to analyse its precision and to find good applications.

Precision tests were done by manually computing the predictions of both gravitomagnetism and general relativity, using geodesic equations, and comparing them. From this we concluded that the approximation is optimal at nonrelativistic speeds and stable gravitational fields, and the error falls with distance. Combining special relativity with gravitomagnetism gave us the ability to explain

Mercury's anomalous orbit and the measurements of Gravity Probe B. The approximation is not quite elegant, however. Even though the shape of the fields is correct, a lot of seemingly random factors of 2 had to be included. We think this has to do with problems like the fact that a black hole metric is not homeomorphic to a Minkowski metric, due to its central singularity, but we do not have any formal proof. Another explanation we found is that in general relativity gravity couples with 4 momentum, instead of the one-dimensional electric charge electromagnetism deals with.

For the applications we sought simple models, which were easily analysed using gravitomagnetism, though these were mostly qualitative descriptions.

The first thing we investigated was gravitational radiation: we tried to derive this analogously to Larmor's formula. This gave a negative power output, however, causing a positive feedback loop, giving every particle an infinite amount of energy. We therefore had to abandon this description. After this we looked at gravitational vacuum magnetization, based on a paper of Hajdukovic[2], which seems to be existent, but negligible. Finally we looked at jet formation in quasars with a model based on viscosity. Although our analysis is oversimplified, it seems to be easily applicable in astrophysical magnetohydrodynamic computer simulations of Kerr black holes.

Further research could be looking at how multiple gravitomagnetic fields interact. This was impossible to examine for us, as there is no exact description of this in general relativity, therefore we could not make any comparisons. A strong computer could probably solve this. Another investigation could be on how to make a decent gravitomagnetic theory for radiation.

Our last goal was to make the research comprehensible to fellow students, who only had a very basic understanding of calculus and physics. This was of course not entirely possible, due to the tensor mechanics. We therefore put most of our calculations in an appendix and wrote some explanations for concepts such as Taylor series, vectors and angular momentum.

## Reference

- [1] R. Kleiss (2010) "The Physics of Spacetime" page 72, 2.3.6 Perihelion Precession
- [2] D.S.Hajdukovic (2011) "Is dark matter an illusion created by the gravitational polarization of the quantum vacuum?"

# Sand jets

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## 1 Purpose of the investigation

When a heavy sphere is dropped onto a bed of loose, fine sand, a remarkable phenomenon occurs: a large, focused jet of sand shoots upwards. Although similar looking jets are observed on impact in fluid systems, they are held together by surface tension. Surprisingly, the granular jet exists in the absence of both surface tension and cohesion. My aim was to explain the behavior of the sand and describe the phenomena quantitatively.

## 2 Method of the investigation

For my research I used a cylindrical container (0.5m high, 0.4m weight), filled with sand. After dropping the steel ball, we can observe the following series of visible events: first, the ball vanishes in the sand and a crown-like splash is created. Then, after a while, a jet shoots out of the sand at the position of impact. Finally, a granular eruption is seen at the position of impact, resembling a volcano.

The first thing I was able to measure quantitatively, was the dependence between depth penetration and the kinetic energy of the ball. For the experiment, I have used 2 steel balls with different diameters.

Scientists have already measured the behavior of the sand and a ball under the surface. They used composite x-ray imaging to show changes in local packing fraction after a metal sphere impacts a granular bed surface.

## 3 Results of the experiment

As I written before, I have measured the dependence between depth penetration and the kinetic energy of the ball. The following diagram illustrates the results:

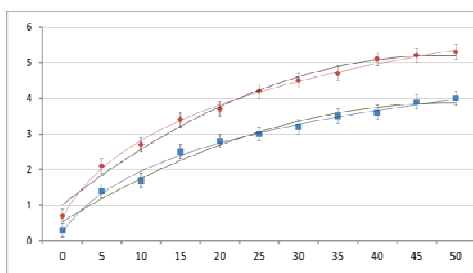


Fig. 1 Depth penetration versus the height drop of the ball. The red dots denotes the results obtained for the ball which diameter was 1.2 [cm]. In the second experiment (blue dots) I have used 0.8 [cm] wide ball. Sand bed was 20cm deep. The axis x shows the height of a drop and the

axis y denotes the depth of the penetration. All values are given in centimeters.

I was also able to vary the packing density of the sand in the container. Next diagram shows how depth penetration depend on the drop height of the ball and the packing density of the sand.

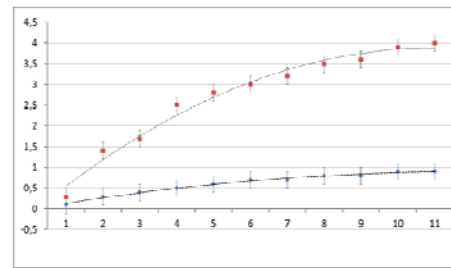


Fig. 2 Depth penetration versus the packing density of the sand. The volume of the denser sand (blue dots) equaled 0.7 of the volume of loose sand (red dots).

When the sand jet is falling down, we can observe the clusters and droplets formation. While the upper part of the jet is still going upwards, in the lower parts occur inelastic particle-particle collisions. This leads to density inhomogeneities in the jet.

## 4 Conclusions

This experiment shows that loose sand beds can sometimes behave like a fluid, although there is no surface tension. Jet height depends on many factors, eg. the initial height of the sphere, sphere diameter, compression of a sand bed and an ambient pressure.

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# An hourglass in the space

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## 1. Introduction

Due to obvious practical reasons, behaviour of granular matter is usually studied on the Earth. As a result its properties are relatively well known in the environment, where the gravitational acceleration is equal to  $9.81 \text{ m/s}^2$ . But granular materials of different sizes are common in the universe. For instance, they are present on the surfaces of planets and small bodies in the solar system [1]. Therefore, in order to explain, e.g., formation of various forms on the surfaces of other planets a knowledge of granular matter properties under reduced- or enhanced-gravity conditions would be required [2]. Moreover, such a knowledge will be necessary when people will try to exploit extraterrestrial resources. In particular, flow properties of granular materials would be important to design silos or hoppers or to store resources in heaps. The problem of **how granular flow depends on gravity** is interesting not only from purely practical, but also from theoretical point of view. In this paper this problem is studied both theoretically and experimentally. However, our analysis are restricted to the gravity dependence of the granular flow rate of sand in an hourglass.

## 2. Methods

Simple dimensional analysis suggests that the flow rate should be proportional to the square root of the gravitational acceleration. However, the problem is complicated and such an analysis may not include all the important factors. In the theoretical part of the work we demonstrate some of the complexities, e.g., that granular matter is different from liquid and does not obey the Torricelli's law. Because of the enormous number of the grains in a portion of sand one usually cannot study a movement of a single grain. It is not possible analytically, but this problem can be tackled with numerical techniques such as Discrete Element Method (DEM). And this is one of the two approaches we used to study the gravity dependence of the granular flow rate. The other one is the experimental measurements of the flow in an hourglass rotating in a centrifuge, where the centrifugal force mimics enhanced gravity conditions. The advantage of the DEM is that it allows us to study influence of both reduced and enhanced gravity, whereas it is very difficult to simulate experimentally reduced-gravity conditions. On the other hand the DEM uses simple models of the grains and the interactions between them what may prove to be insufficient to explain the real properties. This way these two methods can be treated as complementary to each other. Within the framework of the DEM, a triangle mesh describing a model hourglass has been created. Then it was filled with tens of thousands of particles interacting via

contact elastic repulsive forces, damping forces and friction forces. The simulations were carried out with the help of a high-performance *ESyS-Particle* program released by the University of Queensland under the Open Software License [3].

In order to carry out the experimental part of the study a centrifuge driven by an electric motor was built. The flow of the sand in the hourglass was filmed with a digital camera and then a video tracking software was used to determine the flow rate as a function of angular velocity.

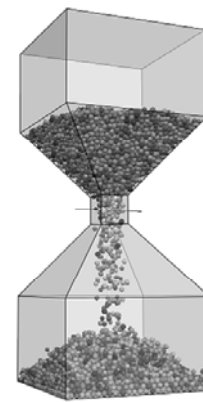


Fig.1. Hourglass used in DEM simulations.

## 3. Results

Results of both numerical and experimental studies indicate that the flow rate is proportional to the square root of the gravitational acceleration. This means that the simple dimensional analysis correctly describes at least some of the properties of granular matter under reduced- or enhanced-gravity conditions. This result may be of practical use, e.g., in determining the size a silo opening.

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# Solitons

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## Solitons

Solitons are localized waves that propagate along one space direction only, with undeformed shape and some particle-like properties. They are structural basis for viewing and understanding nonlinear phenomena such as: tsunami, solitons in fibre-optic networks, modelling of elementary particles and high temperature superconductors, or martensitic transformations in shape-memory alloys. Thus solitons are one of the most important research fields in modern day physics.



Fig. 1. Kink (black arrow) and antikink (red arrow) solitons rotate the pendulums from 0 to  $2\pi$  (kink) or from 0 to  $-2\pi$  (antikink).

## Kink solitons in transmission lines

The aim of my work was to investigate experimentally the behavior of kink and antikink solitons (Fig. 1) in mechanical transmission lines. Therefore, I have constructed and improved a linear transmission line (Fig. 2a) and a quite new circular transmission line (Fig. 2b).

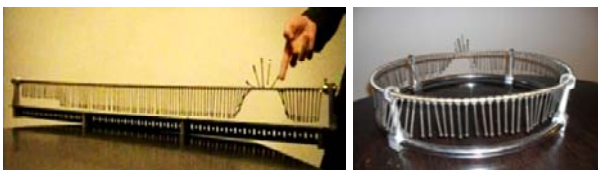


Fig. 2. Solitons on mechanical transmission lines linear (left) and circular (right).

The obtained results I have compared with the solution of nonlinear Sine-Gordon equation describing rotation angle of a pendulum in the transmission line (1)

where  $v$  is velocity of linear waves ( $a$  - distance between two pendulums,  $\tau$  - torque constant of a section of spring between two pendulums,  $I$  - moment of inertia of a single pendulum of mass  $m$  and length  $L$ ),  $\omega$  is circular frequency ( $g$  - the gravitation),  $v$  is velocity,  $t$  is time. The  $(\pm)$  signs correspond to localized soliton solutions which travel with opposite screw senses, i.e., kink and an antikink solitons. I have analyzed experimentally as well as numerically (using

program written by myself for modelling in „Mathematica 7”) the influence of different parameters ( $v$ ,  $a$ ,  $\tau$ ,  $m$  and  $L$ ) on kink and antikink solitons (Fig. 3). I observed the breather solitons as results of kink-antikink soliton collisions (annihilations).

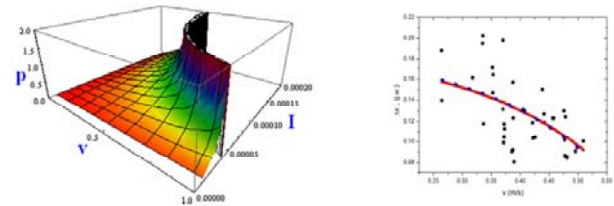


Fig. 3 (left). Theoretical soliton momentum vs.  $v$  an  $I$ .

Fig. 4 (right). Fitting the Lorentz contraction of soliton.

Contradictory to nontopological solitons, kink soliton may be entirely static. Soliton velocity is limited to the velocity of linear waves. Its amplitude is not related to its velocity. Sine-Gordona equation is Lorentz transformation invariant. Therefore, kink solitons satisfy features of relativistic particles. When soliton’s speed is getting closer to this extreme velocity, kink is getting narrower it is a result of Lorentz contraction (Fig. 4). its momentum and energy are described by following formulas. (2) and (3) where soliton mass is equal to  $m$ . Gravitation does not affect the mass of soliton.

## Performed experiments

I have filmed experiments performed using the linear and circular transmission lines, e.g., the experiments showing corpuscular properties of soliton (during collisions of many types), the behaviour of soliton lattice, acceleration of solitons moving between two types of pendulums, balance of dissipative torque by gradient of pendulum moments of inertia, and the behavior of solitons in potential wells formed by pendulums that have different moments of inertia. Obtained data were analysed using “Tracker”. I have fitted the experimental results with theoretical formulae.

## 1 Conclusions

Solitons are very interesting nonlinear phenomena. Using transmission line their properties may be studied very efficiently. Remarks of that investigation might be very useful considering understanding other nonlinear phenomena.

# Magnetocaloric Effect

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## 1. Introduction

On my research work I made investigation on magnetocaloric effect. This effect consists in the fact that paramagnetic bodies can heat up in exterior magnetic field.

This effect was first observed by a German physicist Emil Warburg (1880).

Currently many scientist are working on this effect, they want to find the optimal composition of the bodies to receive the highest increase of temperature and efficiency.

## 2. Theoretical Base

The theoretical base of this effect consists in the fact that paramagnetic bodies can heat up when the strength of the magnetic field is increasing adiabatically Fig.1.

Very interesting is fact that when the strength of magnetic field is constant we can cool the body to the initial temperature.

When body in in initial temperature and then the strength of field decreses adiabatically body will get cooler by the same value of temperature as on the first change.

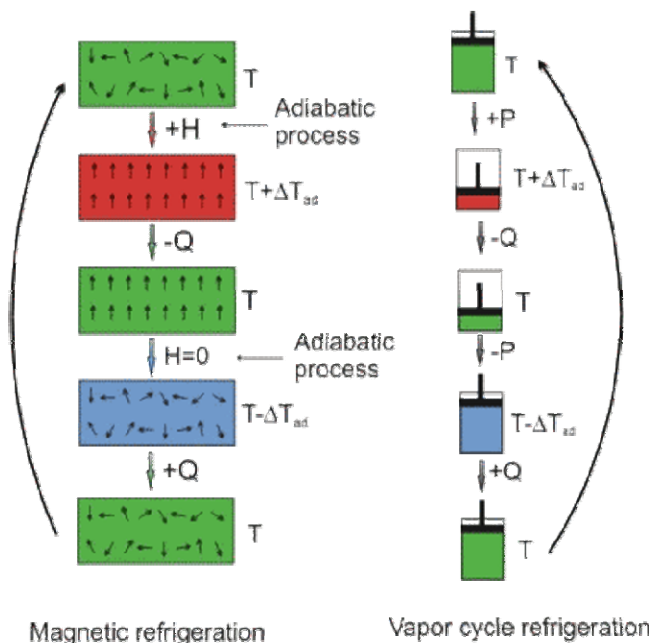


Fig. 1. Thermodynamic cycle.

## 3. Experimental Part

### 3.1. Sample of Gadolinium

To my measurements I used sample of Gadolinium Fig.2 it is very interesting element because it has one of the biggest magnetic susceptibility and Curie temperature about 20°C.



Fig. 2. My sample of Gadolinium

### 3.2. Results

#### 3.2.1. Influence on initial temperature

One of the most important parameter is initial temperature of the body. I measured the increase of temperature when strong magnet was moved toward sample. This graph shows the relation on change of temperature vs. initial temperature. Fig.3 we can see that the best initial temperature is about point of Curie.

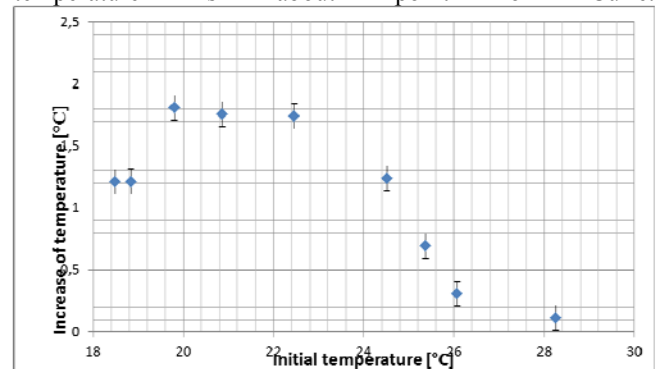


Fig.3 Change of temperature vs. initial temperature.

## 4. Summary

Magnetocaloric effect is a very interesting phenomenon and there is real chance to implement this technology to general use.



# EXAMINATION OF COMPOUND PENDULUM'S PERIOD

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## 1 Objectives

The main objective of mine experiment is measure, how changes the period of oscillation of the compound pendulum, when we stick an additional mass to various places on my pendulum and find the reduced length of my pendulum.

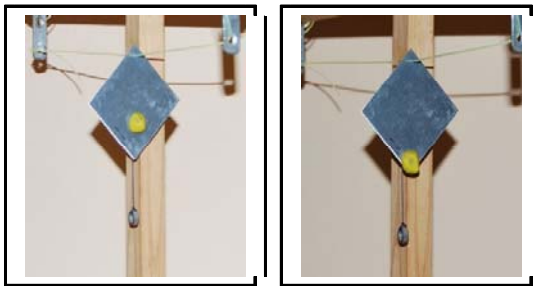


Fig. 1, 2. Examples of additional mass stick to various places

## 2 Compound pendulum

Compound pendulum any rigid body which is able to spin around the pivot **not** passing through the center of pivot point of this body. The period of oscillation and the reduced length is one of the pendulum's parameters.

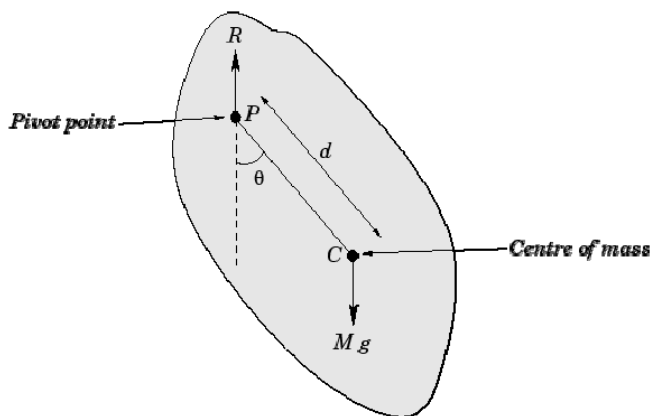


Fig. 2. Simple example of compound pendulum

## 3 Equations used in my experiment

To calculate main parameters like period of oscillation or reduced length I used a few equations, namely Steiner Theorem:

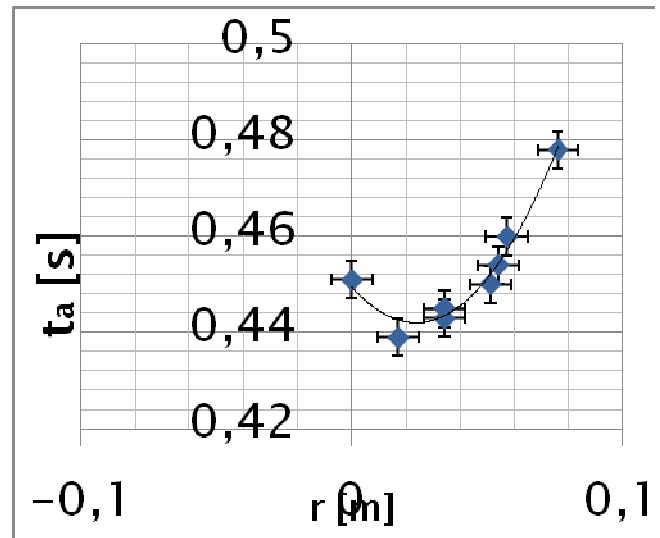
$$I_z = I_{cm} + mr^2 \quad (1)$$

*Eq.1 Steiner Thoerem*

and some another formulas (for period of oscillation, reduced length, etc).

## 4 Results of measurements

After series of my measurements I could create a graph showing my results, how changes the period of oscillation, when additional mass is stick in different distances from the axis of rotation.



Graph 1.

## 5 Conclusions

After all my measurements and calculations there are few conclusions about my compound pendulum and problem with find the reduced length.

First of all finally I proved that, if we stick the additional mass in the distance of the reduced length of the pendulum we can discover that the period of oscillation is approximately equal to the period of pendulum's oscillation without the additional mass.

Second conclusion is that when we add additional mass in the same distances from the axis of the rotation the placement of the mass does not affect the period of the oscillation.

And the last of all conclusion is that the period of oscillation of the pendulum is the longest when the additional mass is located in the furthest possible point from the axis of rotation.

# Impact crater formation mechanism

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## 1. Introduction

We all know there are meteorite craters on a surface of the Moon and some other celestial bodies. In some cases a hill appears in the center of a crater. Here I present the results of experiments that confirm earlier-made assumptions of hills formation and detect necessary conditions while a hill forms.

## 2. Research method

For experimental research the special equipment was set up. As a meteorite I used a steel ball that falls from a fixed height to a capacity with a granular material (baked soda) that models lunar surface (regolith). A launcher, that lets a ball to move, consists of electromagnetic coil, rigidly fixed on the supply, that stops holding a ball by pressing a button. The height of a ball falling, its diameter and mass, and density of “regolith” in a container were measured. The processes of balls falling and hills formation were shot at the high-speed camera.

The experiment showed that a hill is formed as the result of a vertical jet, which appears while a ball dives into a layer of soda. Experiment revealed that jet consists of two stages: an initial thin jet forms by the collapse of the cavity left by the impacting object stacked on top of a second, thicker jet which depends on the amount of the gas driven into the layer by a ball and trapped between grains (this stage is unavailable in Earth experiment conditions). Something new that I brought into the research of this phenomenon was finding of essential conditions of jets formation.

## 3. Results

I found that for each value of layer density there are special restrictions of a height of balls balling, according to the balls speed. Inside these range there is an optimal speed value that causes a jet of maximum height. If a speed is too much or too low the jet does not appear. I explained it by

this way: if a speed is not high enough a ball does not have an essential impulse to get into the layer, so the jet does not form. If a ball rise too high speed then a granular material starts behaving as non-Newtonian fluid, so its viscosity begins to depend on the velocity gradient of the ball. Therefore the layer does not let a ball move inside it, and a jet does not appear..

## 4. Conclusion

Thus experimental results let us confirm assumed mechanism of hills formation in crater during impact and offer a way to estimate the parameters of meteorites.



# Profilometer for investigation of the liquid curved surface

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## 1. Introduction

In the course of the study of capillary phenomena I had to deal with nontrivial forms of the surfaces of liquids. I needed to figure out the shape of this surface. So I decided to make the installation to determine shape of the surface.

## 2. Content

1. Establishment of the experimental setup.
2. Experiment.
3. The 3D reconstruction of the shape of surface..

## 3. Purpose of the investigation

The **purpose** of my work was to **measure experimentally** the curved surface of the liquid.

## 4. Method of the investigation

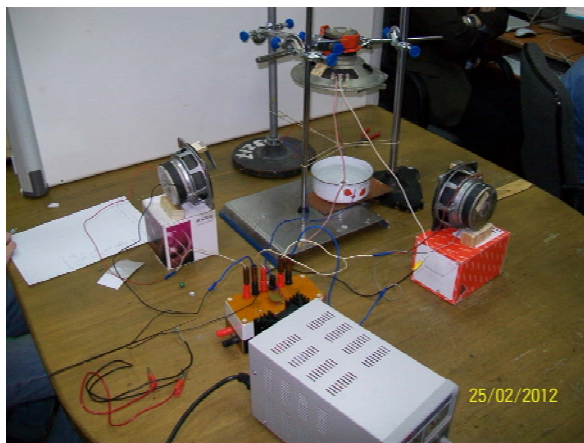


Fig. 1 Experimental setup

The experimental installation – profilometer – was developed. Main part of the installation is the metal needle that is positioned on a curved surface along the three orthogonal axes. Three speakers are used to control the motion of the needle along these axes. Each speaker moves the needle along one axis. The speaker provides a very system. Such scheme allows us to locate the position of the needle very precisely small shift due to a very small change

in voltage. Small movements are measured by use of the mirrors optical scheme.

The experimental points are loaded into a computer program that builds a 3D-model of the surface shape. This setup allows us to describe the shape of a curved surface, which should help in the investigation of surface effects. To determine touching needle with water was made by this electric circuit. (Fig.2)

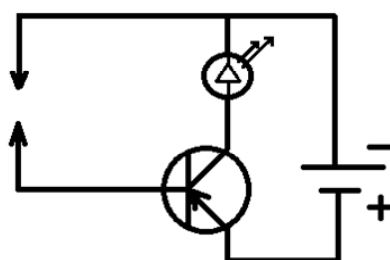


Fig. 2 Electroscheme for fixation of the needle-water contact

The LED lights up when the needle touches the water.

## 5. Results

The profilometer was developed and constructed. The surface profile can be measured with positioning accuracy -  $10^{-8}$  -  $10^{-7}$  meters.

# Rising bubble

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## 1. Introduction

When a single bubble rises from the bottom of the sea or a vertical tube, its rising velocity, shape, and motion change. While the motion of the bubble rises, its velocity, shape, and path change. The terminal velocity, the shape, and the rising path in liquids with different degrees of viscosity are investigated. In the experiments, viscosity is set as the main variable, because it is the main cause of different velocity and shapes of a rising bubble. There is also a relation between viscosity and depth.

## 2. Objectives

Three sets of experiments are conducted. First of all, an investigation was carried out to measure the terminal velocity of a single bubble rising in liquids with different viscosity. Secondly, the different shapes of a single rising bubble in different liquids are also observed. Thirdly, the zigzag motion is investigated.

## 3. Methods of investigation

### 3.1. The terminal velocity

Three kinds of liquid, water, glycerin and glue, are used in this experiment with the viscosity order from small to large. The reason that only the terminal velocity is investigated, because the velocity of the bubble changes extremely fast, and it reaches the terminal velocity in a short period of time.

The motion of the bubble, rising in a vertical tube, is filmed with a high-speed camera and analyzed with an application (Tracker).

### 3.2. Shapes

The same three liquids are again used. The photos of different shapes in different liquids are shot and then analyzed. In different conditions, there will be basic shapes and special shapes. The forces that form these shapes will be the main sector of this investigation.

### 3.3. Zigzag motion

Two kinds of liquids are used in this set of experiment, which are water and glycerin. Water represents low viscosity, and glycerin represents high viscosity. It is desirable to find out the relation between the viscosity and whether it zigzags.

## 4. Results of the experiment

According to our analysis, the terminal velocity in water is 48.07cm/s, glycerine 16.46cm/s, and glue 0.31cm/s. Apparently the terminal velocity of water is the largest and glue is the smallest. The velocity difference between these three liquids is mainly caused by the different viscosity.

The shape of the bubble in water is flat, that in glycerine shapes like a hemisphere, and that in glue shapes almost like a sphere. The rising bubble in the water forms a flat sphere because water is a low viscosity liquid and the vortex is stronger. The bubble in glycerin forms like a hemisphere, because the viscosity is higher and the vortex is weaker than water. The bubble in glue forms almost like a sphere because the surface tension is extremely large.

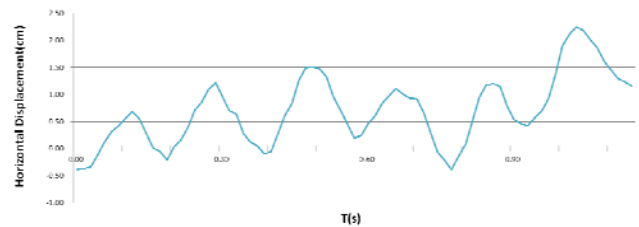


Fig. 1 Zigzag motion of water

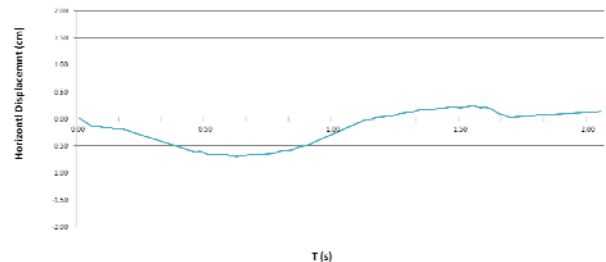


Fig. 2. Zigzag motion of glycerine

In Fig. 1, the bubble's horizontal displacement in water oscillates but that in glycerine (Fig.2) oscillates less. This shows that the bubble rising in low viscosity liquid tends to zigzag. According to the 2008 American Institute of Physics, the reason for the bubble to zigzag remains unclear.

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# Observation of single photons with the attenuated light source in the laboratory

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## 1. Introduction

Einstein's explanations of photoelectric effect is sometimes misunderstood that it proves the existence of single photons. In 1986, Grangier, Roger and Aspect performed an experiment to examine correlation between photoelectrons at the transmission and reflection outputs of a 50/50 beam-splitter (BS) [1]. They demonstrated that the field incident on the BS was well described by single-photon state. In 2004, Thorn et al [1] repeated and adapted the experiment of Grangier et al for undergraduate laboratory with the increasing count rate to violate the classical inequality. Additionally, they performed an experiment with a beam of ultraviolet laser light entering nonlinear crystal via spontaneous parametric down conversion, and made a measurement to the degree of second-order coherence.

## 2. Objectives

1.1 To prove the existence of single photons using the simple experiment that can be done in a high school laboratory.

1.2 To simplify the studying and understanding of quantum mechanics.

## 3. Related Theories

### 3.1. Classical fields

The degree of second-order coherence shows the correlations between the intensities of the transmitted  $I_T$  and reflected  $I_R$ . In the case of no time delay, the transmitted and reflected intensities are half of incident intensities  $I$ . It can be calculated using Eq.(1):

$$g_{TR}^{(2)}(0) = g_{LI}^{(2)}(0) = \frac{\langle [I(t)]^2 \rangle}{\langle I(t) \rangle^2} = g^{(2)}(0) \geq 1. \quad (1)$$

### 3.2. Semiclassical theory of photodetection

In this theory, the field is treated classically while the detector is treated quantum mechanically. It is found that continuous electromagnetic radiation is randomly converted into photoelectrons and the degree of second-order coherence can be determined from the probability of photocount.:

$$g_{TR}^{(2)}(0) = \frac{P_{TR}(0)}{P_T P_R}. \quad (2)$$

### 3.3. Quantum Mechanics Theory

In the experimental determination of  $g^{(2)}(0)$ , the individual and joint probability of detection in a time interval  $\Delta t$  and a counting time  $T$  are shown in Eq.(3):

$$P_T = \left(\frac{N_T}{T}\right) \Delta t \quad P_R = \left(\frac{N_R}{T}\right) \Delta t \quad P_{TR} = \left(\frac{N_{TR}}{T}\right) \Delta t. \quad (3)$$

Therefore, 
$$g_{TR}^{(2)}(0) = \frac{N_{TR}(0) \left(\frac{T}{\Delta t}\right)}{N_T N_R}. \quad (4)$$

## 4. Materials and Methods

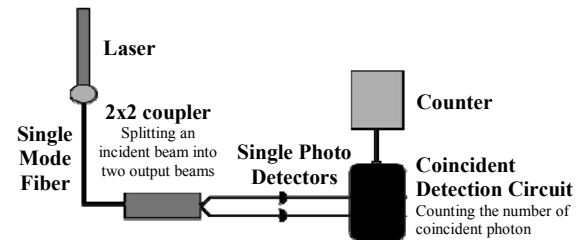


Figure 1. Schematic diagram of the experimental setup for coincidence measurement

## 5. Results and Conclusion

Counting time (sec)	$N_T$ (count)	$N_R$ (count)	$N_{TR}$ (count)	$g^{(2)}(0)$	S. D. of $g^{(2)}(0)$
0.01	58259	61761	39	0.00434	0.00057
	58180	62087	27	0.00299	
	58689	62218	36	0.00394	
Average	58376	62022	34	0.00376	
0.1	576680	618489	294	0.00330	0.00019
	577084	620726	291	0.00325	
	579512	618907	258	0.00288	
Average	57759	619374	281	0.00314	
1.0	5740811	6239012	2726	0.00304	0.00010
	5736183	6218051	2839	0.00318	
	5736183	6200013	2624	0.00295	
Average	5737726	6219025	2730	0.00306	

Table 1. The measurement report, where  $N_T$ ,  $N_R$  are the number of detected single photons,  $N_{TR}$  is coincidence detections

Results reveal that we can generate field containing single photons using a wideband fiber coupler as a 50/50 beam-splitter with  $g^{(2)}(0) = 0.00306 \pm 0.00010$  which violates the classical inequality by 9969 standard deviation. The validity of the results shows that it is possible to observe single photons with such experiment. Thus, it could be used for teaching fundamental concepts in quantum mechanics.

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# Experimental Researches of Dependence of Friction Coefficient on Temperature

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## 1 The purpose of the investigation

The research lies in an experimental establishment of dependence of friction coefficient on temperature.

## 2 Method of the investigation

To carry out the experiment a thermostat was made. The temperature was provided by bulbs in it. On the bottom of the installation there is a wooden stand for a working surface and a working body.



Fig. 1. Experimental apparatus

Friction coefficient was determined by measurement of acceleration of the researched body moving horizontally. Thread with a weight was fixed to the body on the other side and was thrown over the unit.

The time spent that the working body covered a definite distance was measured. Ten experiments were carried out each time at different temperatures. Then acceleration and friction coefficient were calculated.

## 3 Results of the experiment

Due to the results of the experiments it was established that friction coefficient has a tendency to linear decreasing with the increasing of temperature and becomes constant when reaching of certain temperature (Fig.2).

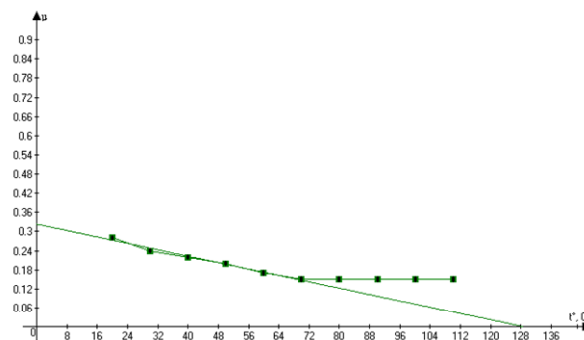


Fig. 2. A graph of typical dependence of friction coefficient on temperature

Possible reason of friction coefficient decreasing can be the evaporation of water molecules, which “stick” metals while sliding along one another. And its constancy after certain temperature can be explained that after some temperature molecules do not almost evaporate from a metal surface because almost all water molecules have been evaporated from the surface of the working body and the working surface, and with further increasing of temperature they will be evaporated so few that friction coefficient does not change.

Further it was established that at permanent relative humidity friction coefficient remains almost the same at different temperatures for different bodies and working surfaces.

## 4 Conclusion

Consequently, the hypothesis about the change of friction coefficient from the change of water molecules on the working body surfaces and surfaces has been confirmed, and the identified phenomenon can be taken into account in practice.

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