CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Parker G. Addison

Project Number

S1701

Project Title

The Effect of Gases on the Efficiency of a Solar Cell

Abstract

Objectives/Goals

This experiment is related to the growing quantities of greenhouse gases in our atmosphere. The experiment was designed to see if the greenhouse gases, or any other common gases, between a solar cell and its light source effect the output of the solar cell.

Methods/Materials

Assemble a cube vacuum chamber with six acrylic squares. Obtain tubing, valves, drills, etc. Connect pressure gauges to the chamber. Secure a solar cell and thermostat within the sealed vacuum chamber and output the solar cell to a multimeter outside the chamber. Obtain cartridges of Helium, Nitrous Oxide, and Carbon Dioxide. Have a steady light source a constant distance from the solar cell, and keep the temperature within the chamber 75*F. First, with the gas valve closed, turn on the vacuum pump and let all air be evacuated from the chamber. Then turn off the pump, close the pump valve, and open the gas valve until the pressure within the chamber is 14.7 PSI (atmospheric pressure). Record the output of the solar cell. Repeat process of evacuating and filling chamber with all gases and also without filling a gas.

Results

Averages --
Air: 8.05 Volts; Helium: 8.153 Volts; a Vacuum: 8.157 Volts; Carbon Dioxide: 8.18 Volts; Nitrous Oxide was unable to be tested.

StDv Air: 0.1003; StDv Helium: 0.0694; StDv Vacuum: 0.0478; StDv Carbon Dioxide: 0.01

F(stat): 2.6977; F(crit): 3.5874; P-Value: 0.0971

Conclusions/Discussion

The results of this experiment were unable to reliably contribute to the purpose. The expected results were based on the refractive index and absorption bands of gases, but the results may support a positive correlation between gas density and solar cell output. While it is possible that helium in our atmosphere can lead to more efficient solar panels due to its lower density, the carbon dioxide test was flawed due to temperature change, and the nitrous oxide test was defective. It is challenging to attempt to support or disprove the hypothesis due to the unreliability of the data. The project design needs to be amended in order to provide more accurate results. In conclusion, the null hypothesis may have been supported in that gases have very little to no effect on the output of solar panels.

Summary Statement

To determine if different gases between a solar cell and its light source have any impact on the output of the solar cell.

Help Received

Father helped assemble the vacuum chamber; Father helped open and close valves

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Manfred Virgil T. Ambat

Project Number

S1702

Project Title

The Nature of Variability of the Ultraviolet and Optical Spectral Energy Distribution of Active Galactic Nuclei

Abstract

Objectives/Goals

Active galactic nuclei (AGNs) are powered by accretion of matter onto supermassive black holes (SMBHs) in a structure called the accretion disk. The biggest problem with this accretion disk theory is that the light intensity of the accretion disk varies enormously (by a factor of 10) on short time-scales (on the order of weeks). To understand how SMBHs eat material we need to understand this variability. The external illumination theory hypothesizes that X-rays heat the accretion disk and cause it to vary. This model predicts the relationship between variability in the optical and UV frequencies. In this study, the external illumination theory is evaluated as a possible means for energy generation in AGNs.

Methods/Materials

Optical photometric data from the International AGN Watch database and UV data from the International Ultraviolet Explorer of six extensively studied AGNs (3C 390.3, Fairall 9, NGC 3783, NGC 4151, NGC 5548, and NGC 7469) were used. Optical and UV fluxes were graphed to test the external illumination theory's three predictions for each AGN: 1) The loci in the plots are really curves, and the curvature increases as one goes to higher frequencies, 2) the loci give an overestimate of the SED's constant component (host galaxy starlight contamination), and this overestimate is greater as one goes to higher frequencies, and 3) there is a greater scatter in an AGN's photometric data in optical-UV plots as compared to photometric data in optical-optical plots.

Results

The results concluded that the external illumination theory is a good model to address optical and UV variability because the optical-UV plots exhibit significant scatter in the data and an overestimation of the constant component in comparison to estimates from Bentz et al. (2013). The data's scatter makes it difficult to predict the curvature of the optical-UV relationship, but the results are generally in agreement with the predicted curvature of the external illumination theory.

Conclusions/Discussion

The significance of this research is that it brings attention to studying AGN optical and UV variability together to understand the energy generation of AGNs. Observation campaigns in the past have generally focused only on optical or UV variability, but this research shows that looking at both kinds of variability raises interesting questions about AGNs and accretion disks.

Summary Statement

This project's main focus is to assess the validity of the external illumination theory, which predicts that high-energy flares in accretion disks play a role in active galactic nuclei energy generation.

Help Received

Participant in the Science Internship Program at the University of California, Santa Cruz under Dr. Martin Gaskell

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Sophia A. Brodish

Project Number
S1703

Project Title
Testing Meteorite Impact Distances on Triton

Abstract

Objectives/Goals
Create an accurate model of Triton to test physical impacts from a meteorite. The use of the model helped to understand how different distances and angles change the force at which the meteorite would impact the moon, seeing whether the impacts are deep enough to bore through more than one layer of rock or ice.

Methods/Materials
To make the model of Triton as accurate as possible, the model had to have the same density as Triton. Calculations on density, velocity, and acceleration were used when making the model and testing the force of impacts. Each layer of the model was divided equally and frozen the same amount of time in order to account for the geysers on the moon that constantly recover the surface. Once the model was complete, it was tested multiple times or until the model showed severe damage. The force was then calculated based on the information collected before testing.

Results
Certain effects of the surface were more common than others. The distances and angles from the model did change what happened to the top surface and the layers underneath when shot by the bearing. Based on the data and observations, higher forces had a greatly different effect on the model than the lower forces. The highest force was about was about 0.4 Newtons, which occurred when being closest to the model, and the lowest force was about 0.0019.

Conclusions/Discussion
Some tests had large impacts while other tests merely made a chip in the surface. Every test did have some effect to the moon. With this, many more theories can be constructed to test further on the impact depth each meteorite creates.

Summary Statement
A model of Triton was created to test whether the angle or distance a meteorite is from the moon will affect the force at which it impacts the surface.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Sophia G. Clark

Project Number
S1704

Project Title
Just Can't Resist!

Abstract

Objectives/Goals
My objective was to try and make graphite a pressure sensitive resistance, and then to study the parameters influencing it's resistance (width of the graphite, elasticity...). Working with a circuit using potential dividers, I used aluminum foil and graphite powder to make a pressure sensitive resistance. The goal of this experiment is to use graphite powder as a variable resistance in a potential divider circuit.

Methods/Materials
Materials: aluminum foil, graphite powder, small plastic container, breadboard, transistor, resistor (6 ohms), ohmmeter.
Method: I started by glueing the two strips of aluminum foil onto the bottom of the plastic container and onto the piece of plastic that would go into the container. I then filled the container with graphite until the width came to 2.6 cm. I attached a wire onto each strip of aluminum foil, and linked these to the bread board where I had my potential divider circuit using a transistor. The board was also linked to the batteries as well as a light bulb. To perform the different tests I would attach the ohmmeter to the graphite resistance, and would do tests measuring the resistance each time.

Results
First of all that graphite powder is a very elastic substance, and would therefore be reliable when used for a pressure sensitive resistance. Secondly when doing the graph of the resistance of graphite vs. its width there was an parabolic function present. It was also shown that the larger the width of the graphite the greater the resistance it had, and an exponential function was made apparent there. To conclude, the greater the weight of the masses, the lower the resistance. After analyzing these results they are promising and logical ones.

Conclusions/Discussion
An idea for this project would be to convenience daily life while leaving less of a carbon footprint. With this project these sensors could be installed underneath less busy roads, or sidewalks, and at night when people would walk or drive over them, street lamps would illuminate. Thus saving energy by only keeping them on when people are present.

Summary Statement
My project is a pressure sensitive graphite powder resistance used as a variable resistance in a potential divider circuit.

Help Received
I was given access to scientific materials (such as ohmmeters) available at my school.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Catherine M. Colella

Project Number
S1705

Project Title
Spacecraft, Micrometeoroids, and Photons: A Model of Micrometeoroid Impingement to Simulate Thermal Shielding

Abstract

Objectives/Goals
Micrometeoroids pose a significant threat to space exploration. Resistance to micrometeoroid impact is a significant design challenge for spacecraft and spacecraft designers. Long-term exposure can threaten the functionality of spacecraft systems through loss of thermal control. This project investigates the effect of micrometeoroids, using a model, on thin gauge thermally protective metals. Thermal protective capabilities will be modeled and analyzed.

Methods/Materials
Cardboard box (black interior), 500 W halogen lamp, Styrofoam, thermocouple and probe, sand, various thin gauge metals. Heated metal in box using lamp until thermal equilibrium reached. Measured metal temperatures through repeated trials. Calculated photon emission based upon material and estimated emissivity using Stefan-Boltzman relationship. Repeated with sanding of metals to simulate impingement.

Results
Hypothesis of sanded (impinged) surface emanating more heat was shown. Thinner copper had unexpected results, presumably due to some possible invisible oxidation or perhaps more infrared penetration.

Conclusions/Discussion
Found thinner .oo3 in. material would be most successful for thermal shielding. Aluminum appeared to be best material. Results revealed large amounts of heat would emanate from an impinged surface.

Summary Statement
This project investigates the effect of micrometeoroids, using a model, on thin gauge thermally protective metals.

Help Received
Teacher provided suggestions. Parents showed how to use spreadsheets.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Clement J. Decker

Project Number

S1706

Project Title

Comparing Quantum and Classical Explanations for the Non-Interference of Orthogonally Polarized Beams

Abstract

Objectives/Goals

Determine whether the patterns produced by orthogonally polarized waves sent through a double-slit apparatus are examples of quantum or classical phenomena.

Methods/Materials

A Vernier diffraction apparatus is used for this experiment. The slit width was 0.08 mm and the distance between slits was 0.5 mm. The laser used had the wavelength 636 nm. To destroy interference, two polarizers with respectively orthogonal axes were placed after the slits. In a second experiment, a polarizer with an axis of 45 degrees to the horizontal was placed after the initial polarizers. A third experiment utilized two polarizers whose axes differed by 45 degrees placed after the slits. Using Logger Pro Software, data were recorded on a computer.

Results

In the first experiment, double-slit slit interference was destroyed while single-slit diffraction patterns were observed. In the second experiment, double-slit interference was restored. Furthermore, the origin of interference was calculated to be the slits. In the third experiment, the intensities of the patterns were too dim to provide conclusive data.

Conclusions/Discussion

The result of the first experiment suggests a quantum explanation. This is because the slits were calculated to be the origin of interference. However, it should be noted that the results may also be explained by classical mechanics. The second experiment suggests evidence of classical phenomena. This is because according to quantum mechanics, when which-path information is available the wave-function collapses and the light should not diffract. From the last experiment, no conclusive data are available. Thus, it is necessary to do more research to provide more conclusive results.

Summary Statement

My project investigated whether the patterns produced by orthogonally polarized beams sent through a double-slit apparatus were more accurately explained by quantum or classical mechanics

Help Received

Used lab equipment at LMU thanks to Dr. Michael Berg, Dr. Jeff Sanny, and Mr. Anatole Hoemk. Dad helped throughout and Dr. Randy Friedl and Dr. Jeff Sanny helped edit my abstract.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Shashank Dholakia; Shishir Dholakia

Project Number

S1707

Project Title

A Search for Exoplanets in Open Star Clusters Using a Novel Photometric Algorithm for the "Crippled" Kepler Mission

Abstract

Objectives/Goals

To date, over 5000 exoplanet candidates have been discovered orbiting around isolated stars. All of these stars once existed in open star clusters, yet the existence of exoplanets in open clusters has not been studied. In this project, we search for exoplanets in two open clusters, Messier 35 and Koposov 62. We hypothesized that we would not find exoplanets in clusters because gravitational interactions between stars would eject forming exoplanets.

Methods/Materials

The Kepler Space Telescope was instrumental in the search for exoplanets, but it failed in 2013. The salvage mission, dubbed K2, allowed limited observations to continue. We used images of the clusters, as well as a control group of isolated stars taken by the K2 mission every 30 minutes for 85 days. We wrote a novel, K2-optimized photometric pipeline in Python to search for exoplanets using the transit method.

Results

We discovered 4 exoplanets in a sample of 620 clustered stars. In an equal sample of isolated stars, no exoplanets were found. Three of the exoplanets found were hot-Jupiters, and one was a super-Earth. All four exoplanets orbit within 0.1 AU from their host star.

Conclusions/Discussion

We conclude that exoplanets do exist in open clusters. Furthermore, their prevalence may even be higher in open clusters than in other stars. A possible explanation for our results is the gravitational recapture of ejected exoplanets in open clusters. We are looking to analyze 4 more clusters as K2 images them. Because all stars form clustered, our findings may further the understanding of planetary formation in all stars.

Summary Statement

In our project, we wrote a novel photometric pipeline for the "crippled" Kepler Mission and used it to search for exoplanets in open star clusters.

Help Received

Parents and physics teacher helped and refined the project board and presentation

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Eleni C. Fafoutis

Project Number
S1708

Project Title
Predicting and Analyzing Coronal Mass Ejections

Abstract

Objectives/Goals
My objective was to predict and measure Coronal Mass Ejections (CMEs). I plan to develop and implement an algorithm generated from an Excel graph, that spans an entire solar cycle, which will enable us to better predict and analyze images of CMEs. I will also utilize the engineering program MATLAB in order to analyze images of CMEs taken by the SOHO satellite and determine the amount of ionized gas ejected by the CME, analyzing patterns in the cycle to make predictions.

Methods/Materials
Materials:
1. Microsoft Excel
2. MATLAB (Student Simulink Toolbox)
3. Laptop
4. SOHO/LASCO CME Catalog
5. Various CME images

Procedures: Part 1 - More than 10 tests, to input data, determine correct graph and algorithm. 1. First log all dates (from SOHO/LASCO CME catalog) , including missing ones, number them and label the amount of occurrences next to that numbered date. 2. Generate and add a trend line to the graph. Part 2 - Tested 5 different times to refine the program and the image. 1. Open up MATLAB Simulink Toolbox 2. Make the white-pixel program. 3. Run the image through the program. 4. Find the average amount of gas ejected per pixel.

Results
From the analysis of the data provided, I determined the presence of a pattern in CME occurrences. The trend shows the sun to be more active during the middle of the 11 year cycle. The sun became less active as it exited the solar cycle, with some days having no occurrences at all. Though the program I developed is far from complete, it handles the basic task of calculating white pixels in analyzing a photo of a coronal mass ejection. This makes the amount of ionized gas ejected into space much easier for astronomers and astrophysicists to analyze.

Conclusions/Discussion
In conclusion, my hypothesis proved to be correct.The data I was able to generate showed a pattern and a rough equation, estimating the amount of occurrences in one day. I was also able to successfully create a rudimentary program that will enable scientists to calculate things even faster than before.

Summary Statement
In this project, I attempt to predict the occurences of CMEs using an algorithm based on the data from an entire solar cycle, as well as analyze an image of a Coronal Mass Ejection with MATLAB.

Help Received
Thank you to my parents for helping me to edit and go over my report. Thank you to Dr. Cozean for aiding me in my project design.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Elizabeth Fletes; Alex Herrera; Armeen Mobasher

Project Number

S1709

Project Title

Observational Study of Properties of Active Galactic Nuclei

Abstract

Objectives/Goals

The objective of this project was to see how the morphology of galaxies who host Active Galactic Nuclei (AGN) are different from those that do not.

Methods/Materials

-If the Hardness Ratio of the sample is greater than -0.3 it is an AGN
-If the Hardness Ratio of the sample is less than -0.3 it is a non-AGN
-Gather additional data required to run the tests. Required data consists of:
-RA, Dec, Full_flux, HR_Classical, Flux_RADIUS, MAG_AUTO, A_IMAGE, B_IMAGE
Inputting Data into Galfit Using Aquamacs
Input data into corresponding location in the Image and Galfit Control Parameters. Change path A to the location of the data image. (This is what you will be experimenting with) Change path B to the location of the output image. (This is where the results will end up in) Change path C to the location of the data image. Keep path D the same. Change path H to the size of the image. Change path I to the size of the convolution box (x, y). Change J to the magnitude (MAG_AUTO).
Sersic
NOTE: Any unmentioned steps should remain unchanged
Change #1 to the position of the AGN/Non-AGN. Change #2 to a number between 20-25. This number is about trial and error- there is no way to know exactly which number to input. Change #3 to Flux_RADIUS. Keep #4 the same. Change #5 to a number between 0-4. Note: cannot equal 0. Subtract 90 from the position angle and input it into step #10.
Sky
In section sky, only #1 needs to be changed. To do so open the file in Topcat. When in the table, look for the header called "BACKGROUND" then type the corresponding number into #1.
Running the Program with Galfit
Open Terminal and type in "galfit" to open up galfit. Enter the name of the program to initiate the testing process.

Results

It was found that most of the galaxies were elliptical galaxies because their sersic_index was over 2.5. Based on the distribution of sersic parameters, it was found that there is a high likelihood for black holes to be hosted at the core of elliptical galaxies and not spirals.

Conclusions/Discussion

Summary Statement

We were curious to see if the presence of a Black Hole at the center of a galaxy affected the shape and size of the galaxy.

Help Received

Under supervision of Dr. Mobasher, we were able to do our project at University of California Riverside. Our mentors who guided us were Laura Green and Vivian U.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Raymond U. Gilmartin

Project Number

S1710

Project Title

Characterization of Magnetic Tunnel Junctions for Next-Generation Energy-Efficient Memory Technologies

Abstract

Objectives/Goals

Magnetoresistive random-access memory (MRAM) combines fast read/write time, high endurance, and nonvolatile storage. Magnetoelectric RAM (MeRAM), a new class of MRAM, uses voltage-controlled magnetic anisotropy (VCMA) and high resistance-area product (RA) to lower coercivity and limit the writing current when changing the polarity of the ferromagnetic layers in a magnetic tunnel junction (MTJ). High tunnel magnetoresistance (TMR) enables the resistance-state of an MTJ to be read accurately with greater tolerance and thus less sensitive, less expensive reading devices. The objective of this project is to characterize the relationship between TMR and RA to improve energy-efficiency and lower cost.

Methods/Materials

Using sputtering deposition and photolithography, MTJs were fabricated with an MgO insulator layer of graduated thickness between conductive Co(40)Fe(40)B(20) ferromagnetic layers. Ta buffer layers develop perpendicular magnetic anisotropy and a Pt cap prevents unwanted oxidation. To determine TMR and RA, the voltage across each MTJ was measured with a four-point DC probe station using a 0.01 mA current and a magnetic field sweeping between ±600 Oe.

Results

TMR has a maximum for MgO thickness, indicating optimal oxidation: peak TMR occurs when the MgO layer is oxidized and insulating and the CoFeB layers are un-oxidized and conducting. RA values increase exponentially with MgO thickness and are nearly identical across MTJ sizes, reflecting both the exponentially decreasing electron wave amplitude in the insulator and the resistance-resistivity relationship. RA, found to be above 1000 ohm micron sq, is sufficiently high at TMR peak to limit the current during VCMA switching.

Conclusions/Discussion

Sputtering deposition on buffer layers is sound and allows highly spin-dependent tunneling to occur. However, peak TMR is too low for application purposes, due to the possibility of reading error caused by antiparallel and parallel resistance overlap. A trade-off between TMR and RA is required, indicating TMR improvement is key. Sidewall redeposition, due to etching, and magnetic material damage, due to reactive etching chemicals, may be affecting resistance and suppressing TMR, and are the subject of further investigation and remediation.

Summary Statement

Magnetic tunnel junctions were tested for tunnel magnetoresistance and resistance-area product and fundamental relationships established, indicating the need to control the adverse effects of fabrication on resistance.

Help Received

Mentored and supervised by the UCLA lab of Dr. Kang Wang.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Kyle A. Groves

Project Number

S1711

Project Title

Advanced Warning for Solar Flares: Utilizing Sudden Ionospheric Disturbances to Detect and Measure Solar Flares

Abstract

Objectives/Goals

To detect and measure the strength of solar flares using the interactions between Very Low Frequencies and the Ionosphere in order to provide early warnings for the harmful effects of solar flares.

Methods/Materials

1. Set up an antenna of sufficient size to reliably detect one or more station of Very Low Frequency wavelengths.
2. Allow the antenna to collect data on strength of VLFs over the course of several months.
3. Analyze this data by measuring daytime peaks in wave signal strength and the base of such peaks, subtracting the base value from the peak value in order to procure the signal strength differential, graphing it alongside class of corresponding flares and finding the correlation.

Results

Class = 1.757*1.0002^(Signal Strength Differential)

This equation has a correlation of .927, which is indicative of a strong empirical correlation, especially considering the number of data points (25 separate solar flares). The percent error for c-class flares was generally around .1, the error for M-class was around .04, and the error for the sole X-class and the higher M-class flares was around .4. There were outliers in the data set, which likely resulted from forms of interference, including fluorescent lights and microwaves.

Conclusions/Discussion

The correlation (.927) was strong enough that it is fair to say that there is an empirical correlation between signal strength differential and the strength of the solar flare. Furthermore, the antenna was able to accurately detect every significant solar flare over a span from December 1 to March 11 (the cutoff for this data). It was also immediately apparent, even without fully examining data, about what class the flares were. This ease of observation means that this apparatus makes it immediately apparent whether or not there could be a flare that could disrupt human activity. Since solar flares do disrupt electric grids as well as communications satellites, it is important to monitor them. Interference is an important consideration. The antenna works best during weekends or school vacations. However, it is important to consider that the antenna can still measure relatively small solar flares during the schooldays, even with interference. Interference is also easily distinguishable from solar flares on graphs. This system of detecting solar flares works almost perfectly, and it works to measure them with a .927 correlation.

Summary Statement

This project uses the relationship between Very Low Frequency waves and Sudden Ionospheric Disturbances to detect solar flares, which can aid in preparations for their harmful effects, including radio blackouts and possible grid failures.

Help Received

the aid, advice, and equipment of Mr. Philip Deutschle and the Salinas Observatory

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Matthew M. Hase-Liu

Project Number

S1712

Project Title

A Novel Study on the Improvement of Electronic Transport Characteristics in a Dye-Sensitized Solar Cell

Abstract

Objectives/Goals

The objective is studying the effects of sealing the device to prevent degradation, using different natural dyes, varying the concentrations of the Anthocyanin dye, annealing the front contacts of the devices at different temperatures, adding a mirror underneath the device to allow unabsorbed light to reflect back for a second pass, and understanding the current-limiting mechanism via analysis of IV measurements.

Methods/Materials

I built a 1-Sun, warm white LED light source for efficiency measurements. IV characteristics were measured with a Syscomp curve tracer. 25 DSSCs were fabricated with an Arbor Scientific Dye Sensitized Refill Kit, and with 5mM H_2PtCl_6 as the Platinum catalyst on the back contacts. Most of the DSSCs were dyed with blackberries. Some DSSCs (a) were side-sealed with epoxy to study the effects on degradation, (b) were dyed with various concentrations of Anthocyanin (from blackberries) dissolved in methanol, (c) had the Titanium Dioxide (TiO_2) annealed at different temperatures, (d) had a mirror mounted on the back contacts to allow unabsorbed light to reflect back for a second pass. Finally, solar power conversion efficiencies were measured and IV curves were analyzed with Excel.

Results

Sealing the devices significantly prolonged the life of the devices. Out of the natural dyes, Anthocyanin dye had the highest efficiency. Increasing the concentration of the Anthocyanin dye also led to higher efficiency. Higher annealing temperatures also demonstrated higher efficiencies and at the highest temperature on my hotplate (455C), the efficiency was improved by around 45%. Use of a reflecting mirror did not show significant improvements in efficiency. There was also excellent agreement of the experimental data with the junction model, which would imply that efficiency is limited by interfacial defects between the TiO_2 and front contact.

Conclusions/Discussion

An optimal device would be cost-effectively sealed to preserve the liquid electrolyte and use high concentrations of dyes that cover most of the visible light spectrum and can easily transfer electrons to the TiO_2. It may be possible to incorporate a material between the TiO_2 and front contact to reduce defects and lead to a higher efficiency.

Summary Statement

This project is a study on the prevention of degradation, understanding of the current-limiting mechanism, and improvement of electronic transport characteristics of a typical dye-sensitized solar cell.

Help Received

Received feedback on poster and presentation from Dr. Rocklin (high school physics teacher)

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Chia-Yun Hu; Guan Xiao Yang

Project Number
S1713

Project Title
Would Sound Waves Promote the Freezing of Water?

Abstract

Objectives/Goals
The objective is to determine whether sound-wave-induced vibrations would promote the freezing rate of pure, distilled water using researches conducted on the Mpemba Effect as a reference.

Methods/Materials
Using 50ml of distilled water per experiment, we used 3000 hertz, sinusoid waves to induce vibration in water. Speaker was placed directly underneath the beaker of water. We decreased the volume of the speaker by one half for every 10 minutes. The surrounding temperature was controlled at -10 degrees Celsius. The freezing rate of the experimental group was observed every 10 minutes and compared to that of the control group, where water was not disturbed in any way.

Results
Both control group trial and the experimental group trials exhibited the same freezing rate. Decrease in temperature was most visible in the first ten minutes. As time progressed, the freezing rate slowed. Both graphs showed exponential decay. The data refuted our hypothesis that high frequency sound waves alone can increase the freezing rate of water.

Conclusions/Discussion
Our data refute the hypothesis rather disappointingly. There were no significant differences between the control and experimental groups. From the result, we can deductively reason that there is not a relationship between vibration and the freezing rate of water. We may conclude that the hydrogen bonds are not in fact responsible for the Mpemba Effect. Hence, it may or may not nullify the conjectures made by the Singaporean scientists that energy loss in water molecules is greater in heated water is due to water molecule expansion.

There is a possibility that our experiment did not support our hypothesis because the sound induced vibration is not strong enough to cause water molecules to lose energy. High frequency sound may carry more sound energy, but doesn#t necessarily mean more vibration to break up the water molecules. Our sources of error include using high frequency sound when there is a option of using high decibel sounds. Other sources of error such as opening the freezer, eyeballing the thermometer to get a rough measurement, all contributed to less accuracy. But fortunately enough, all the data seem pretty consistent.

Summary Statement
Using sound waves to promote the freezing rate of water as a phenomenon parallel to the Mpemba Effect.

Help Received
Used science lab at our high school under the supervision of the 10th grade chemistry teacher, Heng Yuan Shr.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Amely Joly

Project Number
S1714

Project Title
Detecting Diabetes by Polarizing Light

Abstract

Objectives/Goals
Detecting diabetes is performed using various methods: blood tests, urine test strips, lasers, and even contact lenses. Unfortunately, each method hold their own fault; uncomfortable, not environmentally friendly, unreliable, or impractical. My objective was to find a new method to detect diabetes by addressing all these issues. Assuming that sugar can be used to detect diabetes and the physical property of the optical rotation of the glucose, I asked myself: Can the polarization of light in the urine detect diabetes in an ecological way?

Methods/Materials
The method consists of beaming a light source through urine samples with increasing glucose concentration and to measure the change in its angle of polarization. The materials are easy to find and affordable: Light source, light probe, a small container to hold the urine samples, a few mirrors, and polarized filters, all easily assembled into a small and self-contained unit, and connected to a laptop for processing the data.

Results
The experiments show a proportionality between the concentration of glucose in the urine solution and the change in the angle of polarization of the light source. The higher the concentration, the greater the angle of deviation, in accordance with Biot#s law. When this deviation is above a certain value, we can ascertain the patient has diabetes.

Conclusions/Discussion
The research, experiments and initial results are very encouraging in finding a novel method of detecting diabetes in patients without the issues seen in other methods currently used. It is easy to perform, fast, reliable and reusable without any throwaway materials. The next step is to build a portable prototype and to validate the method further by working with doctors and patients.

Summary Statement
A novel and better method to detect diabetes by measuring the change in the angle of a polarized light beaming through a patient#s urine sample.

Help Received
My physics and Chemistry teacher Mr. Julien Astruc, as well as my student colleagues Alice and Eliette.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Taniel V. Keosseian

Project Number
S1715

Project Title
Make Home Cellphone Spectrophotometer to Apply Beer's Law

Abstract

Objectives/Goals
The purpose of this science project is to build a simple and inexpensive spectrophotometer using a cellphone that will work as well as commercial spectrophotometers, and test it by using it to investigate how visible light is absorbed by differently colored solutions. I will also create a calibration plot (Beer's Law plot) of the dye#s absorbency at known concentrations, then use that to determine the concentration of dyes in the PowerAde drinks.

Methods/Materials
I used a white LED bulb powered by a coin battery as my light source. I made eight different concentrated solutions for each of the Red 40, Blue 1, and Yellow 5 food dyes in water. I used water as my reference. I placed each sample solutions, in a cuvette, next to my LED light source, and then put a diffraction grating slide between the samples and the detector, which is my cellphone. The diffraction grating slide diffracted the light into the color spectrum which I captured with my cellphone camera. Then I uploaded the pictures onto my computer and analyzed them in a software program to calculate the ëmax, absorbance, and transmittance of each solution. These data were used to create a Beer#s plot of the dye#s absorbency at known concentrations and used the plot with the absorbance of red, blue, and yellow PowerAde drinks to determine their unknown dye concentrations.

Results
With my simple spectrophotometer I was able to estimate the wavelength of maximum absorbance (lambda max) of commercial Red Dye #40 solution to be around 498nm, Blue Dye #1 solution to be around 606nm, and Yellow Dye #5 solution to be around 440nm which is 2% to 4% in nanometers different from the values given by the FD&C. The absorbance of my dye solution was directly proportional to its concentration. The more concentrated my solution was, the higher the absorbance. I used the calibration plot and the absorbance of the PowerAde drinks and found out the dye concentrations in the PowerAde drinks to be between 0.1%mL and 0.5%mL.

Conclusions/Discussion
My hypothesis proved to be correct. My inexpensive cellphone spectrophotometer was good and affordable and provided good estimates with small margin of error. It helped me find the lambda max, absorbance and transmittance of different dye solutions and PowerAde drinks, and calculate the unknown dye concentration in PowerAde drinks.

Summary Statement
Make affordable spectrophotometer to estimate absorbance of colored solutions and to find the unknown dye concentrations in PowerAde drinks.

Help Received
My teacher reviewed my project and my mom helped me buy the materials and prepare the board.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Melissa Lee; Alisha Malkani

Project Number

S1716

Project Title

Biomechanical Analysis of Throwing Discus

Abstract

Objectives/Goals

The purpose for conducting this experiment was to analyze the several different aspects of discus throwing and ultimately come up with the 'perfect' form for a throw to make the discus go the farthest distance. We wanted to figure out a way to quantify how various parts of the discus throwing technique affects the ultimate distance of the throw. We thought that a torqued back wind-up would be more effective and result in a longer official distance because the torqued back windup would allow the throwing arm to stretch further back and create a greater stretch reflex.

Methods/Materials

We needed a discus, a thrower, a measuring tape, a video camera, a field, a video analysis software, a speed-measuring device, and an anemometer. All of these items contributed to ensuring we factored in all possible variables when analyzing the aspects of throwing the discus and how to optimize the throw.

Results

The positive correlation showed that the greater the speed of release, the farther the discus will go, and the more successful the throw will be. Overall, the average official distance resulting from a static windup throw was farther than that of a torqued back windup throw. The duration of foot contact with the ground does not have much of an effect on the throw. There is a positive correlation between angle of release and official distance, but we did not find the balance point between a small angle of release to allow for the discus to travel farther in less time since it is more parallel to the ground and a large angle of release to allow the discus more flight time.

Conclusions/Discussion

From video analysis, we can see that the throws with a higher speed of release show more separation between the upper and lower body as well as a powerful block of the left portion of the body to stop the momentum of the body and transfer this energy to the discus, causing a farther throw of the discus. In the static windup, there is more upper and lower body separation and more of a stretch reflex, resulting in a farther throw. The complex nature of the relationship between angle of release of the discus and the official distance include a small range of variation and possible non-linear relationship between distance and selected kinematic variables; it is likely due to a lack of the ratio of the release height to the standing height.

Summary Statement

The purpose for conducting this experiment was to analyze the several different aspects of discus throwing and ultimately come up with the 'perfect' form for a throw to make the discus go the farthest distance.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

James A. Lu

Project Number

S1717

Project Title

The Effect of Magnification Ability of a Telescope on Position Angle and Average Separation of Double Stars

Abstract

Objectives/Goals

The objective was to determine if an amateur, store-bought, Zhumell Z8 telescope could collect accurate astrometric measurements to update National double star orbit database, as compared to the accuracy of a professional telescope.

Methods/Materials

A store-bought, Zhumell Z8, 0.20 meter objective mirror-size telescope and a professional, Estrada, 0.56 meter telescope was used to collect separation and position angle astrometric orbit data on the same double star, Mintaka. A Celestron astrometric eyepiece was installed on the telescopes during data collection to overlay a calibrated scale on the double star, and separation in arcseconds was first measured by counting the tick marks on the ruler scale between the two stars. Using the same eyepiece, the slow movement of the double star drifting to the outer protractor scale was used to record position angle in degrees. Position angle and separation measurements were taken 12 times for each telescope. Both telescope data were compared to published Mintaka observation data.

Results

For the store-bought, Zhumell Z8, 0.20 meter telescope, the average position angle for the double star Mintaka was 000.33 degrees and the average separation was 52.79 arcseconds. For the professional 0.56 meter telescope, the average position angle was 359.33 degrees and the average separation was 56.87 arcseconds. The published data, or ground truth, contained a position angle of 000.00 degree and a separation of 52.80 arcseconds.

Conclusions/Discussion

The store-bought Zhumell Z8 telescope was capable of performing astrometry to a very precise level based on the project data. After comparing collected data to published source, it was concluded that the store-bought, 0.20 meter telescope measurement of 000.33 degrees position angle and 52.79 arcseconds separation were as accurate as the professional 0.56 meter telescope in position angle and more accurate in separation due to speckle interference for higher magnification, professional, 0.56 meter telescope. Data supported inference that an amateur, store-bought telescope may be used in lieu of a professional telescope to collect precise, double star orbit data to update National database.

Summary Statement

With only a few thousand of over 100,000 known visual double star orbits plotted, project data supported the use of amateur, store-bought telescopes to collect accurate astrometric data to update National double star database.

Help Received

Amateur astronomers Mr. Reed Estrada and Mr. Chris Estrada, Central Coast Astronomical Society, provided the professional, 0.56 meter, transportable, reflector telescope; as well as guidance on double star observation procedures and techniques. Mr. Mike Antrim provided overall project guidance.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Sydney L. Marler

Project Number
S1718

Project Title
The Effects of Interstellar Medium on the X-Ray Spectral Characteristics of Gamma Ray Bursts

Abstract

Objectives/Goals
Gamma Ray Bursts (GRBs) are episodes of intense extra-galactic expulsion of gamma radiation punctuated by a multi-wavelength afterglow. Approximately 25% of gamma ray bursts do not emit an optical wavelength afterglow and this study investigates the potential effect of interstellar medium as an absorber of the optical light.

Methods/Materials
A sample size of 100 GRBs detected by the NASA Swift Telescope was used for this study. 10 GRBs were immediately discarded for having insufficient data for this study's purposes. 90 GRBs were separated into two different categories; those with No Optical Afterglows (NOAs) and those with Optical Afterglows (OAs). Both categories were spectrally analyzed in the x-ray wavelengths for elements present in the interstellar medium (C VI, Ne IX, Fe XVII, O VII, and O VIII). Every possible combination of ion components were statistically compared as potential GRB OA absorbers. GRBs with NOA were additionally analyzed for patterns in their x-ray spectrum data in order to identify the optical afterglow absorption chemical makeup.

Results
No particular indication of interstellar medium appeared in GRBs with no optical afterglows, nor did other combination of ion components. A significantly strong signature of magnesium appeared in 90% of GRBs with NOA while only appearing in approximately 30% of GRBs with OA, creating a meaningful disparity.

Conclusions/Discussion
From the data, it is likely that the currently hypothesized interstellar medium and its components are not the cause of GRBs with NOA. The chemical presence of Mg I is a strong indicator that GRBs with NOA are likely to be found in central star-forming regions of galaxies. Abundances of this element have been found in regions of galaxies where massive stars are located. Gamma Ray Bursts are the most powerful explosions in the universe and studying what very little is known about them is of paramount importance in determining the potential distribution of life in galaxies, learning about stellar mechanics, and proving controversial topics about the laws of our universe.

Summary Statement
This study examined the phenomena of dark gamma ray bursts using x-ray spectroscopy data.

Help Received
None

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Cali Mendoza; Maxence Weyrich

Project Number

S1719

Project Title

Solar and Cosmic Radiation at and above the Pfotzer Maximum

Abstract

Objectives/Goals

Our objective was to send a weather balloon with data recording equipment into space and make observations on key variables that determine the amount of radiation at and or above the pfotzer maximum. Additionally, our goal was to further understand the location and significance of the pfotzer maximum in space flight.

Methods/Materials

In total we launched three weather balloons over the course of one year. All weather balloons were launched from the same launch area. Both Mission 6 and 8 were launched at 8:00 a.m., while Mission 7 was launched at 1:45 p.m. in order to gather data from the partial solar eclipse that took place during the flight. All the materials are listed within materials document.

Results

Hypothesis #1 was validated to a certain extent, while Hypothesis #2 was proven incorrect.

Hypothesis #1 As the weather balloon rises in altitude there will be an increase in the amount of radiation.

Hypothesis #2 Radiation at a given altitude is directly related to the sunlight intensity present at the given altitude.

Conclusions/Discussion

Our first hypothesis that the radiation increases as the altitude does is partially correct. We found that this hypothesis holds true until the altitude reaches 18,500 meters, at which point the average radiation begins to level off, then decrease. Unfortunately, the weather balloon has a finite altitude limit, and it may not be possible to consistently observe the radiation levels beyond approximately 25,000 meters.

Our second hypothesis that radiation correlates to light intensity was found to be incorrect. Although it is possible to see that there is a dip in background UVB light intensity, there is no direct correlation to the dip in radiation: the radiation did not decrease notably during the solar eclipse of Mission 7 while the UVB intensity saw significant changes. Therefore, it is unlikely that light intensity has a significant effect on the radiation. The decrease in background UVB intensity is more likely caused by an external event not related to the radiation levels. Thus, the radiation experienced at high altitudes comes, for the most part, from events not related to the sun.

Summary Statement

Our goal was to identify the boundaries and potential causes of the photzer maximum and to identify methods in which we can predict its presence based on constants, such as altitude.

Help Received

We had the assistance of Jim Snyder to supply crucial data analysis and printing of the graphs. As well as retrieval of the craft as its distant location.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Anchit Narain

Project Number

S1720

Project Title

Topological Insulators: An Analysis of the Electron-Phonon Coupling Constant of Bi(2)Se(3) Using ARPES Data

Abstract

Objectives/Goals

Gapless surface states on topological insulators (TI#s) are protected from backscattering, making them promising candidates for quantum computing and spintronics applications. Verification of TI#s resistance to backscattering is found in the electron-phonon coupling constant, and the lower this value is, the less the TI is likely to have its spin current altered via scattering effects through interaction with its surroundings. The objective of this research is to verify and expand on the Gweon Group#s recently discovered lowest-ever recorded electron-phonon coupling constant (0.049 ±0.007) for Bi2Se3 on a different sample of the TI by using high resolution, angle-resolved photoemission spectroscopy (ARPES).

Methods/Materials

The Bi2Se3 sample was placed in an ultra high vacuum chamber inside ARPES at SSRL and cleaved using the tape method. Monochromatic UV light was fired at the cleaved sample to eject electrons from the topologically protected surface of the crystal, and the detector collected data on the energies and momenta of these ejected electrons. The incident photon angle was adjusted to get the clearest data on the ejected electrons, and this procedure was repeated from 50 K to 300 K at 50 K intervals. Lorentzian Momentum Distribution Curves were done to mathematically model this ARPES data, and from here, the Fermi velocities and Imaginary Self Energies of the crystal at the various temperatures were extracted to eventually solve for the electron-phonon coupling constant for Bi2Se3.

Results

The electron-phonon coupling constant is solved for as the slope of the best-fit line of the Imaginary Self-Energy vs. Temperature graph. However, unlike previous research of this kind, the slope from this research is negative, with the most recent coupling constant value being -0.203.

Conclusions/Discussion

From a purely mathematical standpoint, this negative value seems to be the lowest ever recorded electron-phonon coupling constant, even lower than the previous Gweon Group result. However, a negative value for this constant is anomalous in the field, and therefore the accuracy of this value must be further scrutinized with attention placed on the methods of coming to this value. Simultaneously, the research also brings up the inquiry of electron doping values varying per sample, and how that may lead to discrepancies between coupling constant values among different samples.

Summary Statement

Verifying and expanding research on the lowest ever recorded electron-phonon coupling constant for the topological insulator Bi2Se3 using ARPES data for possible future applications in spintronics and quantum computing.

Help Received

Participant in Summer Research Program at UC Santa Cruz under supervision of Prof. Gey-Hong Gweon and graduate student Ms. Ahram Kim

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Akshar G. Patel

Project Number
S1721

Project Title
Recycled Light: An Attempt to Create a Solar Light Bulb That Can Be Used with the Absence of Constant Radiation

Abstract

Objectives/Goals
This project was developed on the speculation that water could be refracted through a plastic bottle to provide light inside of a home. Furthered it dwelled upon the understanding that a phosphorescent substance, such as copper doped zinc-sulfide would remit the radiation it absorbed at a lower intensity for up to several hours after the original excitation.

Methods/Materials
The solar bottle bulb was made out of 2-liter soda bottles. The phosphorescent device within the solar bottle bulb was copper-doped zinc sulfide. To resemble a dark room, the solar bottle bulb was placed within a testing chamber composed of cardboard. The emittance of light was measured during the day and the night with an photomoter.

Results
The data collected from each solar bottle bulb was compiled from 72 hours, spanning through a course of 3 days. Through this process I proved the first portion to my hypothesis correct. As the data showed, from 7 AM to 11 AM the solar bottle bulb produced 313 lx of light, comparable to indoor lighting in average houses. As the data shows, the phosphorescent device was not capable of absorbing light to be remitted at a lower intensity when the sun isn#t available to provide a direct source of energy. I hypothesized that, if I utilize phosphorescent technology to enhance the plastic bottle bulb, then I will be able to create a light bulb that harnesses solar energy and is also able to radiate light when the sun isn#t present to provide a source of energy. When tested for a measure of light at 7 PM, the solar bottle bulb showed no evidence or capability of emitting light that could be measure and documented.

Conclusions/Discussion
In conclusion, the experiment established these points:
1. Light could be refracted through water contained within a plastic bottle to function as a replacement for a light bulb.
2. The solar bottle bulb relies on the radiation of the sun. Without direct exposure to the sun#s radiation the effectiveness of the solar bottle bulb is drastically reduced and later fails to function when the sun sets.
3. Phosphorescent devices do have the capabilities of absorbing radiation and remitting it at a lower intensity for an extended period of time, but those principles failed to provide light at

Summary Statement
The focus of the project was to make the solar bottle bulb functionable at night.

Help Received
My friend, Keyur Maru, helped me design my board.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Filip Platek

Project Number
S1722

Project Title
Do Greenhouse Gases Really Trap Heat?

Abstract

Objectives/Goals
The objective of this project was to determine how well Methane and Carbon Dioxide trap heat in a controlled environment. The results of this experiment could provide evidence for or against the theory of global warming/climate change. The goal of this experiment was to quantify how an increase in the concentration of greenhouse gases could affect the average temperature as well as comparing the heat retaining properties of methane against carbon dioxide.

Methods/Materials
To conduct the experiment I build an airtight box out of MDF and glass. The whole box was put together using nails and wood glue. The glass was attached to the front of the box using silicon sealant. On the front side of the box under the glass, two holes were cut out. Gloves were then attached to the holes so that I could have access to the inside of the box while conducting trials. To conduct trials, a balloon was filled with the correct amount of Methane or Carbon Dioxide gas. Then the balloon was cut inside the box, releasing the gas. The box was then sealed and the internal temperature was raised to 40 deg. C using halogen lights. Once the temperature reached 40 degrees, the halogen lights were turned off. The box was then cooled for 18 minutes, with the internal temperature being recorded every 2 minutes.

Results
I found that for almost every concentration, methane was more effective at trapping heat than carbon dioxide. Also, higher concentrations yielded higher temperatures at the end of the tests. My graph gives the impression that at certain points of the cooling phase, the 4% carbon dioxide atmosphere was actually warmer than the 4% methane atmosphere. At the end of the test (18 min) however, the 4% carbon dioxide average actually went below the 2% methane average.

Conclusions/Discussion
In conclusion, the experiment was successful in proving my hypothesis. In the experiment, Methane was more effective at retaining heat than Carbon Dioxide. This supports my hypothesis. The 4% concentration of methane had an average temp of 29.8, thats 1.8 C higher than the control (28.0) and 0.6 C higher than the Carbon Dioxide at the same concentration. A look at the inferential statistics suggests that the data is statistically significant, which supports the idea that climate change is a potential consequence of increasing greenhouse gas emissions.

Summary Statement
The Effect of Increasing CH4 and CO2 Concentrations on Heat Retention in a Closed Atmosphere.

Help Received
Dad helped build an airtight box according to my specifications

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Saranesh Prembabu

Project Number

S1723

Project Title

Coupled Electric and Magnetic Properties in Artificially-Layered Perovskite Thin Films

Abstract

Objectives/Goals

Ferroelectric materials have wide-ranging electronic applications due to their uniquely switchable electrical polarization states. This work studied the effect of compositional variation of the PbTiO(3)/SrRuO(3) superlattice on electrical and magnetic ordering. Specifically, the experiment sought to understand how to modulate ferroelectricity, symmetry breaking, and magnetoelectricity as functions of PbTiO(3) volume fraction and of SrRuO(3) layer thickness.

Methods/Materials

Samples with various compositions grown through off-axis magnetron sputtering were compared with each other and with previously-studied samples through X-ray diffraction and measurements of capacitance, current and polarization at room temperature as well as low-temperature magnetocapacitance in a superconducting solenoid chamber.

Results

Tetragonality increased with volume fraction and SrRuO#(3) layer thickness. PbTiO#(3)-rich n/2 samples showed asymmetric capacitance-voltage hysteresis. The PbTiO#(3)-poor n/2 sample lacked hysteresis, as did the corresponding n/1 sample, but, contrary to expectations, preserved inversion symmetry. Magnetocapacitance was observed on the order of a few percent.

Conclusions/Discussion

It was concluded that the ferroelectric phase transition and self-poling due to symmetry-breaking is highly dependent on stoichiometric ratio, independent of layer thickness. However, the increased SrRuO(#3) layer thickness contributed to significantly higher dielectric screening. Magnetoelectric coupling is suggested and likely a result of interface spin-polarization, and further work remains to fully confirm and understand it. This superlattice and similar structures thus appear promising for various novel electronic applications, particularly those exploiting spin states for highly efficient spintronic memory storage.

Summary Statement

I analyzed how novel and useful properties pertaining to electric and magnetic ordering can arise from the interactions between ferroelectric and metallic layers in an artificial nanocrystal.

Help Received

Used equipment at Stony Brook University under supervision of Dr. Matthew Dawber; Participant in Simons Summer Research Program at Stony Brook University

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Julienne Sauer

Project Number

S1724

Project Title

Quantum Locking Aircraft: Towards the Development of Magnetically Assisted Landing and Take-off Systems via Flux Pinning

Abstract

Objectives/Goals

Despite the incredible amount of automated flight capability in both manned and unmanned aircraft, human oversight is still required, especially during the landing process. This project focuses on the development of a new reliable landing and take-off system for aircraft and unmanned aerial vehicles (drones) using flux pinning.

Quantum locking is the application of flux pinning to create a stable form of levitation which pins a superconductor within a strong magnetic field allowing movement only along regions of constant flux. The advantages of integrating quantum locking into the development of new landing and take-off systems for aircraft have yet to be fully explored.

Methods/Materials

This research project focused on studying the kinetics of a quantum locked superconductor as it travels through a non-uniform magnetic field. A magnetic track consisting of a series of neodymium magnets with different gap sizes was constructed to generate a varying magnetic field along the motion of the superconductor. Changes to the superconductor motion were captured using a high speed camera for later analysis.

Results

It was found that a larger magnetic field variation (larger gap sizes) resulted in a greater reduction of kinetic energy of the superconductor and that the relationship was non-linear. A t-test was used to show that there was significant difference in kinetic energy loss for each tested gap size. Furthermore, computing the correlation coefficient between the tested variables showed that this loss of energy was independent of both the mass and incoming velocity of the superconductor. A more theoretical approach was then taken in order to correlate the magnetic field profiles throughout each gap with the observed reduction of kinetic energy. It was found that loss of energy can be estimated by integrating the magnitude of the rate of change of the magnetic field throughout each gap and that this mathematical relationship matches the observed experimental results closely.

Conclusions/Discussion

Lastly, a prototype test track was constructed to test the capture and slowing of incoming aircraft. Superconductors were attached to a Styrofoam glider plane which successfully landed on the magnetic track. Furthermore, the test track was rocked from side to side to simulate conditions on an aircraft carrier and was still able to safely capture the incoming plane.

Summary Statement

I am developing a new innovative landing system for airplanes and drones that locks an aircraft equipped with cooled superconductors into a strong magnetic field and allows for controlled movement along a magnetic track.

Help Received

Friends and family provided a second set of hands during experimentation; Airgas provided me with liquid nitrogen and safety instructions; and my high school math teacher helped me with data analysis.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Samantha P. Sze

Project Number
S1725

Project Title
Would Elevation Affect the Performance of Objects with Different Masses on a Straight Slope and an Angled Curved Slope?

Abstract

Objectives/Goals
The objective was whether the change in elevation would affect the performance of different masses (5g, 6g, 10g, and 12g) on a Straight Slope and an Angled Curved Slope.

Methods/Materials
Construction paper, foam boards, a 5g marble, a 6g marble, a 10g toy car, a 12g toy car

Results
The lighter marbles performed better at the higher elevation than at the lower elevation. The toy cars did better at the lower elevation than the higher elevation.

Conclusions/Discussion
My hypothesis was partially correct. The change in elevation had little effect on the two marbles. The small toy car was less stable at the higher elevation than the lower elevation. The heavier toy car performed similarly in both elevations, but showed slight improvement in the higher elevation.

Summary Statement
This project is about how the change in elevation affects the performance of objects on a straight slope and an angled curved slope.

Help Received
My mother supervised the construction of the paper and foam road prototypes, while my father supported me financially.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Ethan M. Uetrecht

Project Number

S1726

Project Title

Assessing the Practicality of Asteroid Deflection Strategies Using Simulation

Abstract

Objectives/Goals

In the absence of human intervention, an asteroid impact with Earth is inevitable. In an attempt to predict and prevent possible impacts, scientists are currently detecting and monitoring near-Earth objects (NEOs) and have proposed numerous strategies for deflecting NEOs should they become a real threat. The purpose of this project is to determine the practicality of three selected deflection methods by simulating their overall effectiveness.

Methods/Materials

The Apophis asteroid was chosen for this project because it is a good example of a potential threat to Earth. The three selected deflection methods were the kinetic impact of a space vehicle with the asteroid, solar ablation, and standoff nuclear blast. The trajectory of Apophis was modified to collide with Earth, and each of the three deflection methods was mathematically modeled and its effect on the asteroid was simulated.

Results

The kinetic impact method, which has a technology readiness level (TRL) of nine, was found to be successful when the impact occurred head-on or from behind with at least 5.7 orbits (five years) prior to impact. The ablation method was found to be more effective than kinetic impact but has a TRL of two. The standoff nuclear blast method was found to be most effective at deflecting the asteroid, but will likely cause fragmentation of the asteroid.

Conclusions/Discussion

While each of these methods can be successful depending on the situation, no single method seems to be the best choice for all possible situations. This analysis contributes to understanding which method is appropriate in a given situation.

Summary Statement

This project used simulation to study asteroid deflection strategies to determine which strategy is the most practical for avoiding a collision with Earth.

Help Received

Mr. David Uetrecht mentored me and helped me write the Matlab simulation codes. My teacher, Mr. Peter Starodub, guided me through the research process.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Zoe Zawol

Project Number
S1727

Project Title
The Effect of Strong Magnetic Fields Caused by Broadcast Antennas on the Local Cosmic Ray Flux

Abstract

Objectives/Goals
My objective was to determine how the strong magnetic fields caused by broadcast antennas on Mt Wilson affect the local cosmic ray flux. In a different experiment last year, I detected a cosmic ray flux on Mt Wilson that was anomalously high for that altitude.

Methods/Materials
To perform my experiment, I used a home-made cloud chamber, containing 99% isopropyl alcohol that when chilled created a supersaturated vapor. Ionized cosmic ray particles passing through the vapor caused visible condensation trails that I video recorded against a grid. I also used a tri-axial magnetic field meter and GPS/altitude apps.

I conducted my tests in the very strong magnetic fields at the Mt Wilson broadcast antenna farm. For my control, I selected locations with weak magnetic fields far from Mt Wilson but at the same altitude. Replaying the videos, I counted the trails and calculated the cosmic ray flux per cubic centimeter per minute for each test and control.

Results
Only two out of the fourteen cosmic ray flux test results from the strong magnetic fields showed a flux consistent with the control fluxes whereas all of the other Mt Wilson flux measurements were lower, some even much lower.

Conclusions/Discussion
Based upon this series of tests, the results were opposite from last year's much-higher-than-expected Mt Wilson cosmic ray flux anomaly. I am tempted to conclude that the strong magnetic fields associated with radio broadcast antennas actually reduce the local cosmic ray flux, but believe that additional experiments are needed to conclude this with greater certainty. For example, if cosmic rays are being deflected by the magnetic fields, where are they going? Is it possible that the "missing" cosmic rays are being deflected nearby and can be detected by gathering additional data further away from the broadcast antennas' strong magnetic fields?

Summary Statement
I conducted my experiment to determine the effect of strong magnetic fields caused by broadcast antennas on the local cosmic ray flux.

Help Received
My dad helped purchase materials, bring me to my test locations, and talked with me about my ideas.