CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Nikhil Anand

Project Number
S1601

Project Title
Gauging Black Hole Behavior: Modeling AdS/CFT Correspondence through a Particle Accelerator

Abstract

Objectives/Goals
In this project, electrons were collided to try to model black hole behavior. More specifically, varying magnetic flux densities resulting from these collisions were used to model the varying flux behavior, caused by event horizon perturbations resulting from AdS/CFT Correspondence.

Methods/Materials
One particle accelerator was constructed to collide electrons. The particle accelerator consisted of three DC Power Supplies, one PVC tube (.1 cm thickness), copper wire, a magnetic flux sensor, collision disc (a metallic disc), four electromagnets, an aluminum plate, an ultraviolet laser, and a charge oscillator. A polycarbonate case was also constructed so that a partial vacuum could be maintained. UV laser shone upon aluminum allowed for a source of electrons. Electrons (negatively charged) accelerated through the positively charged tube and collided at the collision site, the metallic disc.

Results
Four trials of particle collisions were made. Each collision, as predicted, produced a vary magnetic flux density. The trials were graphed (time vs. magnetic flux density). These graphs were compared with known varying fluxes of black holes, obtained from NASA's CGRO satellite.

Conclusions/Discussion
Known data about varying fluxes in black holes, obtained from NASA's CGRO satellite, was compared with data obtained through the particle accelerator. The close similarity between the two sources of data indicated that particle collisions can, indeed, be used as models for varying flux black hole behavior (AdS/CFT Correspondence).

Summary Statement
A particle accelerator was built to model specific black hole behavior.

Help Received
Used lab equipment and engineering facility of school.

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Mark D. Canning

Project Number
S1602

Project Title
Underwater Interferometric Seismometer

Abstract

Objectives/Goals
In recent years, due to the great strides in nanotechnology and other fields, it has become a priority to measure microscopic distances. This project was designed to enhance the effectiveness of an interferometer, a device used to measure such distances, with a simple and inexpensive method.

Methods/Materials
A Michelson interferometer was assembled using a 532 nm wavelength green laser, a steel frame, two 50/50 cube beamsplitters, two 25 mm radius mirrors, a 25 mm square mirror, two 22 mm diverging lenses with a -15 mm focal length, and a large reflector. A measurement system was assembled using two photodetectors, two amplifiers, and a data acquisition unit. For each test one mirror was submerged in a liquid, and one mirror was left above the liquid to act as a control. The amount of light shining on the photodetectors was recorded in 0.5 second intervals for each test. This would record any lines of darkness called #fringes# that pass over the photodetectors. The first test was a control to determine if the 2 mirrors had the same sensitivity. The following 5 tests involved submerging the test mirror in 5 different liquids. The data was saved in a spreadsheet format and copied to a computer where it was put through a series of calculations to determine the average amount of time it takes each fringe to pass over the photodetector.

Results
After the data was adjusted for the 12.7% difference in the control test, the first test where the test mirror was submerged in water, there was a 6.9% increase from the reference mirror and the test mirror. In the second test (Karo syrup), there was a 15.8% increase from the reference mirror and the test mirror. In the third test (mineral oil), there was a 18.6% increase from the reference mirror to the test mirror. In the fourth test (olive oil), there was a 9.5% increase from the reference mirror to the test mirror. In the fifth test (methyl alcohol), there was a 27.9% increase from the reference mirror to the test mirror.

Conclusions/Discussion
Overall, the data did support the hypothesis. Submerging the reference mass of an interferometer in liquid showed up to a 28% increase in sensitivity. Some sources of error that may have altered the results of this experiment include vibrations that were not in the center of gravity of the 2 mirrors and the lid used to halt vibrations on the surface of the liquid may have bumped the mirrors and caused them to vibrate.

Summary Statement
To study of the effect of submerging the reference mass of an interferometer in optically clear liquids

Help Received
Father helped with welding, buying parts, and epoxy for construction of interferometer

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Eric Casavant; Alex Marshall

Project Number
S1603

Project Title
Measuring the Speed of Gravity using Ocean Tide Models in Conjunction with Solar and Lunar Position Tracks

Abstract

Objectives/Goals
The speed at which gravity (or the graviton) is exchanged is one of the last unknown fundamental constants of nature.

Methods/Materials
By using ocean tide data in conjunction with solar and lunar position data, we can measure the speed of gravity.

The height of the tide implies a position of the sun and moon, because the tides are primarily caused by solar and lunar gravitational gradients. Let this position be known as the "tidally implied" position. We can then find the position of the moon and sun implied by visual evidence or an ephemeris. Let this be known as the "visually implied" position. Any difference between the tidally implied and visually implied position of the sun and moon can be accounted for by a difference between the speed of light and the speed of gravity.

Results
Our results indicate that gravity is exchanged nearly instantaneously.

Conclusions/Discussion
If our experimental results are correct, we have placed severe limits on Brane Theories and Superstring Theories. However, we would like to collect more data and run further error analyses to reduce our margin or error and increase our certainty.

Summary Statement
We measured the speed of gravity (the speed at which gravitational force is exchanged between two objects).

Help Received
Teacher and Father helped with validation.

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Vianney Cassyleon

Project Number
S1604

Project Title
Greenhouse Gases

Abstract

Objectives/Goals
See which of the most common greenhouse gases has the greatereffect to the light by increasing the temperature of the earth.

Methods/Materials
Material: 1. Glass container 2. 2 lamps 3. Methane 4.Water Vapor 5. Carbon Dioxide 6. Thermometer 7. Hose.

IV. Procedure:
1. Put the Methane or any of the other gases (separately) on the glass container.
2. Stick the thermometer on the container.
3. Place the lamps in front of the container, nut in front of the thermometer on the container.
4. Turn on the lights.
5. Check the temperature of the gas, inside of the container, every certain time.
Note: After you put the water vapor inside of the container, wait until the temperature goes back to normal, to turn on the lights and start checking the temperature.

Results
corbon dioxide and methane absorb more heat than any other greenhousse gas in the earth.

Conclusions/Discussion
VI. Discussion and Conclusion: I found out that Carbon Dioxide absorbs more heat than Methane, the differences between this two gases was between 66% to 90% significantly in the standard Deviation, different from air and water Vapor, which overlap and demonstrated to have not much effect to heat by not increasing the temperature, but just maintaining it balance. When liquid water is evaporated to form Water Vapor it helps to cool the surface of the earth, and it keeps the air warm enough to support life, this was prove with the results I got in my data by water Vapor being lower than air. Methane and Carbon dioxide had a bigger reaction to light, by absorbing the heat, and demonstrating that they do increase the temperature of earth surface significantly. Carbon Dioxide has the majority of distribution on earth's atmosphere with 76% and methane with 16%. In the study that I did to test which greenhouse gas had more effect to heat, I got as a result Carbon Dioxide following by Methane, a result that is different to my hypothesis. Carbon Dioxide is an important gas because it transmits visible light but absorbs strongly in the infrared.

Summary Statement
Greenhouse gases effect to light.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Gwendolyn Chang

Project Number
S1605

Project Title
Use of Magnetic Fields to Prevent Earth Impacts by Near Earth Objects

Abstract

Objectives/Goals
Objective: Make the Near Earth Object change its direction by using magnetic power. The project might also be used to control space traffic by using the same idea of magnetic force.
Hypothesis: The Near Earth Object travels toward Earth at a velocity (V_m), if a transverse force is applied to it, then the NEO will have a transverse velocity (V_t) at right angles to its direction. The NEO will have a velocity with the components (V_m) and (V_t), so that it will change its trajectory to a new direction that is the composite velocity (V_e), and it will miss Earth.

Methods/Materials
Change the trajectory to deflect the asteroid past Earth. In this project, a magnetic field generator (MFG) can be created, and it will use magnetic force to alter its path. Superconductor technology can be used to create a magnetic field generator (MFG). A MFG would be used to change the trajectory of asteroid by magnetic force.

Results
1) In the mechanic science analysis, the action force depends on the action time and the distance of the action from the Earth. The farther action or (and) longer the time, the less force will be required.
2) The action forces are powered by the magnetic field. According to Ampère's law and the formula for magnetic moments says that if the force is a constant, then how strong the magnetic field is depends on the electric current and length of current flowing through the conductor.
3) a) Creating a Magnetic Field Generators (MFG)
b) Creating a second magnetic field on the NEO

Conclusions/Discussion
Through this project the trajectory of any NEO that poses a threat to the Earth was changed. With the superconductor technology development and application, it will bring a bright future to the Magnetic Field Generators (MFG). Humans will launch more satellites to track and send different signals, but as these satellites die and take up space, my project might also clear space junk from interfering with new satellites.

Summary Statement
My projects main focus is using magnetic power to change the trajectory of Near Earth Objects (NEO) to prevent impacts with Earth.

Help Received
Dr. Dave Humphreys, Vesa Junkkarinen, and Barney Rickett were my mentors that proof read my project. I did not use a lab.

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)

Bryce W. Cronkite-Ratcliff

Project Number

S1606

Project Title

The Intermolecular Structure of Water via XRS-based XANES

Abstract

Objectives/Goals

Recent experiments have challenged the traditional tetrahedral bonding picture for bulk liquid water, suggesting instead an asymmetric bonding picture in which the majority of molecules have only two strong Hydrogen bonds. This project expands the body of experimental data on the intermolecular structure of bulk ambient liquid water using XRS-based XANES (see below). Additionally, the structure of water in confined geometries is examined, a topic of fundamental importance to industrial and biological applications.

Methods/Materials

XRS-based XANES, or X-ray Raman-based X-ray Absorption Near-Edge Spectroscopy, is an experimental X-ray technique that essentially allows for soft X-ray spectroscopy with hard X-rays. Experiments were performed at a synchrotron lightsource with incident energy ranges of ~6-7 KeV. Using a 14-crystal analyzer spectrometer, the very small energy losses (~500 eV) necessary to observe the oxygen K-edge were detectable with high energy resolution.

Conclusions/Discussion

Preliminary analysis has been performed at this point in the experiment, but, as detailed analysis and theoretical modeling has yet to be performed, experimental conclusions have not been drawn. Thus far, bulk water spectra seem in keeping with data that suggest the "asymmetric" bonding model. Confined water spectra, somewhat contrary to expectation, show no obvious deviation from bulk water spectra. More analysis and data is needed.

Summary Statement

My project uses novel X-ray techniques to contribute to the understanding of the intermolecular structure of water.

Help Received

I am a junior member of a four-person international research team studying water bonding at SSRL (Stanford Synchrotron Radiation Laboratory). My parents helped proofread the project board.

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Magnus A. Haw

Project Number
S1607

Project Title
Are Black Hole Mass Estimates Too Large?

Abstract

Objectives/Goals
The periodicity of X-ray bursts from Active Galactic Nuclei (AGN) appears to be dependent on the recovery interval between mass-infall events. This recovery interval is proportional to the speed at which information of the event propagates (speed of sound) and the mass of the central black hole. This project seeks to determine whether the assumed speed of information propagation in an accretion disk can affect mass estimations of the central black hole.

Methods/Materials
A computer simulation was developed to model X-ray emissions from AGN for six different speeds of information propagation (c/100, c/10, c/6, c/3, c/2, and c/1, where c is the speed of light). For a real-time equivalent of one month, the simulation was run with each different speed of propagation and a variety of initial energy states. To find the effect on mass estimation, the simulated light curves were analyzed using a mass-variance relationship.

Results
It was found that lower speeds of propagation had longer time intervals between events and resulted in lower estimates of black hole mass. Additionally, Fourier transforms of the light curves implied a linear relation between speed of propagation and x-ray burst periodicity. The variation time scales are comparable to observed data.

Conclusions/Discussion
The results show that the variability of X-ray emissions is dependent on the speed of perturbations within the disk. The results also show that estimates of black hole mass are reduced when based on slower speeds of sound. It follows that current approximations of central object mass are overestimates by at least a factor of three because they assume that perturbations travel at the speed of light c, while the speed of propagation has an upper limit of c/3. Given the generality of the simulation, more accurate estimates of black hole mass can be calculated by correcting for the speed of sound in accretion disks.

Summary Statement
This project used a computer simulation of AGN X-ray emissions to show that the speed of information propagation in an accretion disk can affect mass estimations of the central black hole.

Help Received
This project was suggested by Dr. Ran Sivron to me and two other students, Elliott Jin & Benjamine Liu in August 2007. I worked with these two students on the project until September 2007. I have spoken with Dr. Sivron twice since September and he referred me to scientific papers in this field.

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Scott K. Hempy

Project Number
S1608

Project Title
The Effect of Altitude on the Detection of Cosmic Rays in a Cloud Chamber

Abstract

Objectives/Goals
The purpose of my project was to determine whether I could detect significant differences in the quantity of cosmic rays at three different altitudes by using a diffusion cloud chamber.

Methods/Materials
I built a cloud chamber using a glass aquarium turned upside down. It was placed on a sheet of anodized aluminum which was resting on dry ice. The atmosphere inside the aquarium was supersaturated with felt soaked isopropyl alcohol and cooled by the dry ice. As cosmic rays move through the aquarium ionizing the atoms, condensation occurs and falls to the floor of the device. By drawing two grids on the cardboard floor and counting the condensation trails which dropped in each of the 2 inch x 2 inch grids, for 3-four minute intervals, I recorded the number of rays detected. I chose to test my apparatus at 2000 feet elevation, sea level and underground. Each of these locations would be tested and counted by two people simultaneously counting two different grids, and on three different occasions to ensure legitimate results.

Results
My tests showed that my hypothesis was correct: Higher quantities of cosmic rays were detected at the highest location. At 2000 feet elevation, occurrence rates per minute were 45, 34.2 and 39 on my three attempts. The sea level location had rates per minute of 36.1, 23.7 and 21.7, while underground had rates of 12.3, 19.6 and 34.8. I found the results were very consistent within each of the 3 four minute intervals on a given day. The differences between testing days I suspect are due to the transporting of the chamber.

Conclusions/Discussion
My tests showed that my hypothesis was correct: Higher quantities of cosmic rays were detected at the highest location. At 2000 feet elevation, occurrence rates per minute were 45, 34.2 and 39 on my three attempts. The sea level location had rates per minute of 36.1, 23.7 and 21.7, while underground had rates of 12.3, 19.6 and 34.8. I found the results were very consistent within each of the 3 four minute intervals on a given day. The differences between testing days I suspect are due to the transporting of the chamber.

Summary Statement
The purpose of my project was to determine whether I could detect significant differences in the quantity of cosmic rays at three different altitudes by using a diffusion cloud chamber.

Help Received
My mother was the second counter alongside myself counting the cosmic rays.

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Colin P. Kealey

Project Number
S1609

Project Title
Knot Theory: The Effects of Different String Sizes on the Probability that Complex Knots Will Form

Abstract

Objectives/Goals
The purpose of this research project was to determine if the size of a string affected the probability that a complex knot would form when the string went through a tumbling process, and to be able to apply this principle to the knots formed by DNA in cells

Methods/Materials
The 5 different widths of string (0.5 mm, 1.0mm, 1.5 mm, 2.0mm, and 3.0 mm) were gathered and out of each, three sets of strings of three different lengths (20 cm, 35 cm, and 45 cm) were cut. For each trial, 1 piece of each length of a certain width string was placed in one of 3 Ziploc containers. The three containers were placed in a machine dryer. The dryer was set to #air dry# (no heat used) and ran for 10 minutes. The knots formed by the strings were analyzed by counting the number of crossings and recording it. The knots were placed on a table to be compared to the other knots formed.A total of 45 knots formed after 3 trials.

Results
The 20 cm string with a 0.5mm width had an average crossing number of 0.33. The rest of the widths for the 20 cm string did not cross to form knots. For the 35 cm string, the 0.5 mm, 1.0 mm, 1.5mm, 2.0mm, and the 3.0 mm width strings had average numbers of crossings of 1.00, 0.67, 2.33, 1.67, and 1.33, respectively. The 50 cm strings of widths 0.5 mm, 1.0 mm, 1.5mm, 2.0mm, and 3.0 mm had average numbers of crossings of 2.67, 1.67, 3.33, 2.67, and 0.33, respectively. The percent deviations for each trial ranged from 0% to 133%.

Conclusions/Discussion
The data collected did not allow a definite conclusion to be reached. Although some of the deviations were high, it was apparent that as both the string width and length decreased, the ability to form a knot decreased. By the same token, it appeared that as the string became too long and too wide, the ability to form a knot also decreased. Yet, this cannot be concluded with confidence because of the deviations in the trials and the small range of the string sizes that were used. In order to obtain more accurate and conclusive results, longer string lengths and widths would need to be tested because it appears that a trend does exist, but cannot be seen clearly through the range of string sizes tested. Furthermore, to obtain better results, more trials would need to be conducted, and only one variable should be tested at a time. The size of the containers used should also be a factor considered in future testing.

Summary Statement
Different string sizes were tested to find out what length and width combination formed the most complex knots, but due to flaws in the experimental design, more testing is needed to reach a conclusion.

Help Received
Parents helped take pictures, allowed for the use of dryer, provided funds for materials.

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Edward J. Kronfli, III

Project Number
S1610

Project Title
Fight Fire with Sound?

Abstract

Objectives/Goals
In my project, I wanted to tackle the question: How do you extinguish a fire in space? In electrical or electronic control panels? In an aircraft or a submarine? This is a tricky question as traditional extinguishers do not work in micro-gravity environments, and are messy and they run out. The answer: Sound! I discovered that using sound pressure waves, one can extinguish a sizable flame. I wanted to examine the interactions between sound waves and fire. I wanted to determine which frequency would be most effective in extinguishing a constant flame from a Bunsen burner. This can be used to further study engineering applications for extinguishing fire.

Methods/Materials
In my quest to extinguish fire with sound, I used a ½ inch Bunsen burner, in front of a 12 inch subwoofer, connected to a variable tone generator. Adjacent to that was a scaled board from which to read data. I had run tests in increments of 10Hz from 120Hz to 10Hz at different distances repetitively. Filming the flame was a camera, with a feed to my computer. This camera provided data as to the vertical deflection of the flame. Using this data, I determined the optimal firefighting frequency.

Results
Through my testing and research, I have concluded that 40 Hz is the optimal frequency for extinguish a flame width of ½ inch. I have also concluded that the closer the flame is to the sound source, the more powerful the sound wave is, therefore instantly extinguishing the flame. I noticed that the optimal frequency is related to the width of the flame. I also tested higher frequencies, which had no appreciable effect on the flame. The range of 20-40 Hz and 50-70 Hz also deflected the flame then eventually, at certain distances, extinguished it.

Conclusions/Discussion
The idea of extinguishing fire with sound can be a novel one, however, it is efficient and effective, and has many possible applications in today#s world. For instance, installed in every electrical control panel, can be mounted a subwoofer on a dedicated circuit, designed to turn on whenever fire is detected. It can be programmed to alternate the frequency based on the width of the flame. The effectiveness of a certain frequency needs to be in proportion with the width of the flame. With many possible applications, fighting fire with sound is a promising venue, in which sound pressure waves can be used to save an important control center, or an astronaut#s life.

Summary Statement
My project is about using sound pressure waves to extinguish fire.

Help Received
Father assisted in wiring of electronics and building of experiment tools.

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Brian S. Lee

Project Number
S1611

Project Title
Investigation of Mathematical Models of Harmonic Spring Motion

Abstract

Objectives/Goals
When a mass suspended vertically by a spring is pulled, it moves up and down in a simple way. This periodic motion can be described mathematically in terms of a simple sinusoidal equation. In the real world, however, resistive forces are always present and cause the mass to slow down over the time period. This effect is called damping. The objective of this project is to investigate the mathematical models of harmonic spring motion with and without damping and to study the effect of increased damping.

Methods/Materials
Find a general solution to the mathematical model for undamped harmonic spring motion. Set up spring-mass system and measure spring constant. Pull the mass down and release so that oscillation is up and down. Using CBR 2 and TI-89 with Ranger program, collect data for several cycles. Find a general solution to the mathematical model for damped harmonic spring motion. Add a damping effect to the motion and collect data in a similar manner. Derive the exact solutions using the experimental data. Plot both the experimental and predicted (mathematical model) and compare. Increase damping constant and observe the effect to the solution.

Results
The average spring constant is measured at 23.1 N/m. The general solution of the undamped spring motion model is $y(t) = A\cos(wt + b)$ and its mathematical model is $y(t) = 0.138\cos(6.481t - 3)$. For the damped spring motion model, the general solution is $y(t) = AExp[-ct/(2m)]\cos(wt + b)$ and its mathematical model is $y(t) = 0.21Exp(-0.2t)\cos(5.7t - 9.5)$. Both experimental data and model functions are plotted for analysis. The critical damping constant is 7129.

Conclusions/Discussion
My hypothesis that the mathematical model for undamped spring motion would better approximate the experimental data when compared to the mathematical model for damped spring motion was proven incorrect. My results show that both models appear to approximate the experimental data during the first several cycles, but lose their accuracies over time with little error differences between the two models. Assumption of no damping accounts for the errors in the undamped spring model, and for the damped model, the damping coefficient is the deciding factor. The rate of exponential decay of the measured data is faster than the model. Finally, the sinusoidal oscillatory behavior fades out fast as damping constant is increased and eventually is replaced with steep exponential decay to zero.

Summary Statement
This project is to derive the mathematical models of harmonic spring motion using the experimental data and compare to determine how closely the model functions approximate the actual data.

Help Received
Wolfram Research, Inc. generously offered a trial version of their software Mathematica for this project.

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Max S. Lester

Project Number
S1612

Project Title
Chill: Bounce Higher: The Effect of Temperature on Elasticity

Abstract

Objectives/Goals
My goal was to prove that temperature has an affect on the elasticity of an object. I hypothesized that the colder a ball gets the more elastic it will become and, therefore, will bounce higher.

Methods/Materials
I purchased ping pong balls, small wiffle balls, and clear, rubber super-balls and dropped them to examine how high they bounced. All these balls are of approximately the same size. Since I wanted to examine the effect of temperature on elasticity in balls I decided to put them in different temperatures of water (boiling water, ice water, etc...) then, after a set period of time, I dropped them from my roof to my ping pong table and measured the height of their bounce.

Results
My results were that balls at colder temperatures bounced higher than those at warmer temperatures. Actually, those balls at 77 degrees Celsius bounced the lowest out of all the balls and those at 10 and 5 degrees Celsius bounced the highest. Therefore, this proved that my hypothesis, that colder balls would bounce higher, was correct.

Conclusions/Discussion
The purpose of this experiment was to test the effect of temperature on elasticity. When a ball collides with the floor, it becomes deformed. If the ball is elastic, it will quickly return to its original shape and will spring up from the floor. Therefore, the purpose of my science fair project was to test if the balls would be more elastic, spring back to their normal shape at a quicker rate, and therefore bounce higher as temperatures increased or decreased. My data supports my hypothesis that balls at colder temperatures would bounce higher than those at warmer temperatures.
In the end, my hypothesis that #temperature and elasticity are inversely related: The colder the object gets, the more elastic it will become, until it is so cold the object cannot return to its former shape or state# was supported by my data.

Summary Statement
To test the effect of temperature on elasticity by observing the bounce height of balls at different temperatures.

Help Received
While I dropped the balls from my roof, my parents acted as lab assistants by measuring height of balls bounce and noting result.

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)

Benjamin E. Levy

Project Number

S1613

Project Title

Fridge Magnets: Magnetocaloric Behavior of Gadolinium at Room Temperatures

Abstract

Objectives/Goals

A green option for large-scale cooling is Magnetic Refrigeration, based on an aspect of the magnetocaloric effect (MCE), wherein removal of a magnetic field applied to a ferromagnetic material causes a temperature drop. Harnessing this drop avoids high energy demands and environmentally hazardous gases of conventional cooling. Some materials only show the effect near 0Kelvin, but gadolinium (Gd) is practical in that it displays the MCE at room temperatures. This experiment studied temperature drops in Gd upon demagnetization, repeated over a wide ambient temperature range, in order to define working limits for the MCE in Gd. It was hypothesized that there would be increasingly large temperature drops in the sample as the ambient temperature of the test environment approached the Curie point of the sample, 21ºC, followed by an abrupt disappearance of the effect at temperatures beyond the Curie point (temperature at which ferromagnetic character ceases).

Methods/Materials

A small apparatus was built using a board with battery clips attached 8mm apart, into which cylindrical magnets fit to produce a 0.5 Tesla field. A tiny sample of gadolinium, a reference piece of copper (Cu), and thermocouple wires were sandwiched between the magnets. As the magnets were snapped in and removed, thermal changes at demagnetization were tracked in the Gd and Cu. Runs were repeated at 32 temperature points between 10ºC and 30ºC.

Results

Gd clearly behaved in a magnetocaloric fashion, with a sharp drop in temperature at demagnetization, compared with flat thermal behavior of the Cu control in the same environment. Maximum deviation from ambient (deepest point of temperature drop) for the Gd in each test was placed in a scatter plot, to track how magnitude of cooling intensified as ambient temperature neared the Curie temperature of 21ºC.

Conclusions/Discussion

The size of temperature drops recorded in the Gd increased as the ambient temperature approached the Curie point of the sample, as hypothesized. What had not been anticipated was an observed continuation of the magnetocaloric effect for several degrees above the Curie point. This more generous ambient temperature range for the cooling effect appears to be of practical use, as the heat sink temperature in a magnetic refrigerator would thus not need to be as tightly controlled, resulting in energy savings.

Summary Statement

Study of magnetocaloric cooling in gadolinium at demagnetization from 0.5Tesla near its 21ºC Curie point resulted in an unexpectedly large operating-temperature span, an asset to using Gd for environmentally friendly magnetic refrigeration.

Help Received

Used contact info from journals to email questions to Dr. C. Zimm, Astronautics Technology: Madison, WI, and Prof. K.A. Gschneidner Jr., Ames Laboratories: Iowa State U., who also gave me small Gd foil piece. Dr. C. Nordman of NVE Corp., Minneapolis, explained details of magnetism and thermocouples.

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)

Alekzandir Morton; Thomas Travagli

Project Number

S1614

Project Title

A Galaxy Ablaze from Afar: Infrared Spectrometry of S5 0716+714 Using the Spitzer Space Telescope, a Second-Year Study

Abstract

Objectives/Goals

The objective of this project was to model the spectral energy of blazar S5 0716+714. For the second-year study, the goal was to find a redshift for the target to allow the thermal energy to be modeled using Planck's Law and also to develop a synchrotron radiation model.

Methods/Materials

The Infrared Spectrograph (IRS) Spitzer Space Telescope was used to take a spectrum of the target, and a spectral reduction program, SPICE, was used to extract the spectrum and convert it to a two-dimensional form. The modeling was done using Fathom, a data analysis tool.

Results

A silicate emission feature was detected at 18 microns, and literature showed that this feature appeared at 10 microns in the rest frame. These values were used to calculate a redshift of z = 0.8, which was then used to calculated the rest wavelength of the "bump" seen in the SED. This wavelength was applied to Wien's Law to calculate a temperature for the bump, which was used with Planck's Law to construct a thermal model. The redshift was further used to determine the velocity and distance of the target, yielding values of .53c and 7.14 billion lightyears, respectively.

Conclusions/Discussion

The synchrotron and thermal models were used to approximate the shape of the bump, however an exact match didn't occur. This suggest that other sources of radiation are present. By changing the parameters of the temperature and adding a second synchrotron component, a better approximation of the actual data was observed. For a follow-up project, more data points will be added to the SED to give the models a better shape. This will allow a more accurate model to be developed.

Summary Statement

To model the thermal radiation of blazar S% 0716+714, the Spitzer Space Telescope was used to take a spectrum of the target in order to calculate a redshift to be used in Planck's Law.

Help Received

teacher taught steps for writing proposal for Space Telescope, Mark Lacy taught us the Spitzer data reduction steps

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Kathleen P. Pham

Project Number
S1615

Project Title
Effects of Temperature and Solute Concentration on Index of Refraction

Abstract

Objectives/Goals
My objective was to find the effect of varying temperature and solute concentrations on the index of refraction (IOR) of a solution.

Methods/Materials
Materials:
1 He-Ne laser pointer, 3 microscopic glass slides, 1 gram scale, 2 graduated cylinders, 1 calculator with trig functions

Methods:
A. Constructed an equilateral triangular prism from microscopic glass slides
B. Prepared different solutions to test
C. There were 11 different solutions--1 control (pure water), 5 sugar solutions (ranging from 10% to 50%), 5 salt solutions (ranging from 10% to 50%)
D. Each solution was tested five different times, at five different temperatures (a grand total of 25 times per solution)
E. Measured and recorded distance from undiverted laser beam to diverted laser beam
F. Measured and recorded distance from laser emergence point from prism to undiverted laser beam
G. Calculated angle of minimum deviation to substitute into equation--derived from Snell's Law (calculations shown in logbook)

Results
The data showed a linear increase in the IOR as solute concentration increased. However, as temperature of the solution increased in solutions with the same solute concentration, IOR tended to decrease.

Conclusions/Discussion
Because index of refraction is defined as the ratio between the speed of light in a vacuum and the speed of light in a medium, as the light traveling through the medium increases in speed, the index of refraction decreases. Therefore, as the temperature of a solution increases, the particles in the aqueous solution speed up, making it hard for the light to hit to particles. The light from the laser hits less molecules, taking less time to travel through the solution, and as a direct result, the index of refraction decreases. In the case of solute concentration, however, the more molecules added into a solution (and the bigger the molecules are) the more of a chance the light has of hitting the molecules. This slows down the light as it goes through absorbtion and reemission, causing an increase in the index of refration.

Summary Statement
My project is about the temperature and solute dependence of the index of refraction of various water solutions.

Help Received
Cousin supplied equipment

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Jessica A. Richeri

Project Number
S1616

Project Title
Measuring the Speed of Light

Abstract

Objectives/Goals
The objective is to determine if the densities of different materials change the speed of light. Also to determine if changing the incidence angles or the materials temperatures, would change the velocity of the light through the material.

Methods/Materials
Seven different solutions, with different densities, were created and three other household materials were obtained. I calculated the density and the index of refraction of each material. I created a control group based on the speed of light in air. The laser beam was shot through the longer side of a container with the material at a 30, 45 and 60 degree angle, parallel to the surface. A picture was taken in order to measure the incidence and refracted angle. I use Snells Law formula to calculate the wave velocity in the material. This procedure was repeated for each material at two temperatures, 10C and 30C. Three trials were done for each incidence angle, temperature and material. I graphed Density vs. Velocity, Density vs. Index and Velocity vs. Index for each test. Also, I did a Statistical Analysis of all experimental velocities and graphed the results.

Results
The results show that, as the material gets denser, it takes the laser a longer time to get through that material. The increase of the materials temperature result on an increase of the velocity. By changing the incidence angles, the experimental velocities had only a 3% error, for the same material.

Conclusions/Discussion
After 180 different tests and thousands of pictures, the data supports my hypothesis because its true that as the density of the material increases, the speed of light through the material decreases.

Summary Statement
Calculating the speed of light through materials with different densities.

Help Received
Father supervised taking the various digital pictures.

CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
Nilesh Tripuraneni

Project Number
S1699

Project Title
Novel Characterizations of the Static and Kinetic Behavior of Liquid Marbles: A Potential Utility in Microfluidics?

Abstract

Objectives/Goals
Liquid marbles,first created in 2001, are formed when a liquid such as water, is encapsulated within a skin of super-hydrophobic powder; this protective skin results in the droplet's complete non-wetting of its substrate. My primary aim was to develop a more complete understanding of the static and kinetic behavior of these liquid marbles in addition to investigating their applications in digital microfluidics.

Methods/Materials
Mathematically, I derive a novel geometric description of liquid marbles in their static state by using an energetics framework. A physical model of their kinetic behavior is obtained by using a non-slip rotational model to describe their movement and a simple scaling law to account to for viscous dissipation.Liquid marbles, used in experimentation to corroborate the theoretical calculations, were created using water and micronized Teflon. High-resolution pictures of the marbles were analyzed to verify the geometric predictions obtained from the static model. Similarly, the kinematics of these liquid marbles were experimentally verified by monitoring how liquid marbles behaved on inclined planes.

Results
Less than 5% deviation was found to exist between the theoretically-predicted values and the actual values for both the static and kinetic models. Correspondingly, the derived theory predicts that droplet velocity should scale hyperbolically with size, which appears to explain some of the unusual movement patterns of liquid marbles.

Conclusions/Discussion
It appears that this study has brought a more precise and broad understanding of the static and kinetic behavior of liquid marbles. Additionally, liquid marbles' applications to the field of digital microfluidics have also been hitherto been unexplored; a proof-of-principle demonstration seems to suggest that liquid marbles would form-fit the needs digitial microfluidics - efficiently transporting discrete packets of liquid - and perhaps remedy a few of its problems.

Summary Statement
My project seeks to experimentally and theoretically describe the unusual physics of liquid marbles, in addition to investigating their application in digital microfluidics.

Help Received
Father helped to take pictures; Teacher provided materials.