CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)

Faizan Ahmed; Andrew Hsu; Benjamin Hsu

Project Number

S1501

Project Title

The Polarization of Electrons Based on the Spatial Quantization of Quantum Spin

Abstract

Objectives/Goals

Will electrons subsequently curve based on their respective spatial orientations.

Methods/Materials

An electron gun and a magnet had to first be obtained. Once this was done, some solenoids had to be created to generate the magnetic field (½ Tesla) necessary to split the beam of electrons.

At first, only one set (2 solenoids) were used and the resulting beam was observed. Next, the filters had to be created.

Since the CRT was narrow, the undesired beam was easily bent into the side of the CRT, eliminating the undesired electrons. However, here the experiment differed slightly with the original plan. Instead of filtering out #down# electrons, #up# electrons were filtered out.

Once the initial testing was done, the first filter was tested at 30°, 45°, 60°, 90°, and 180° from the transmission axis. The resulting beam was noted per rotation. When the first filter was complete, the second filter was applied, and after that, the third filter was applied, each time, the filters were rotated through the same five angles. The third filter was treated slightly different: for each angle that allowed an electron beam through in the second filter, the third filter was rotated through its five angle set, allowing the third filter to test its polarization effect on a resultant beam.

Results

With the first filter, all five angles of rotation produced an electron beam. When second filter was rotated from 0° to 90°, an electron beam was able to pass through, but with a rotation of 180°, none traveled through either filters. Each angle between 0° and 180° had a gradual decrease in the intensity of the electron beam that faded to zero as the transmission axis differed. During the light polarization, an angle of 90° produced zero transmission while an angle of 180° produced a transmitted beam.

For the third filter, the angles in the second filter that allowed an electron beam through, electrons were able to makeit through the third filter. However, when the third filter was rotated 180°, relative to the first the orientation, a beam of electrons emerged.

Conclusions/Discussion

In conclusion, the experiment was a success. Using solenoids, it was possible to polarize a beam of electrons into two separate beams. By testing multiple orientations of the magnetic field, certain quantum mechanical effects were observed such as correlation and the Heisenberg Uncertainty Principle.

Summary Statement

The Effect of Various Orientations of Spin Filters on the Spatial Quantization of Electrons

Help Received

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)

Vatche Attarian; Nareg Bozoyan; Ara Thomassian

Project Number

S1502

Project Title

How Does Temperature Affect the Optimal Performance of Fiber Optics?

Abstract

Objectives/Goals

Our science fair project will be conducting an experiment dealing with the transmission of light through fiber optic cables. This project will be titled "The Effect of Temperature On The Optimal Performance of Fiber Optics". The purpose of this experiment is to find out how temperature changes the optimal performance at which light travels through the optical fiber.

According to our research we learned that water shouldn't be exposed to the end of the fiber, that the fiber must be enclosed in a UV stabilized material, and that fibers work best in temperatures near 80 C up to 200 C, yet they don't show loss of efficiency at temperatures as low as -40 Celsius. We hypothesize that the fiber optics will work best at around room temperature and temperatures around 80-150 degrees Celsius.

Methods/Materials

To do this project, get fiber optics, a light source, and a photo detector. When finished with setting up these instruments, first darken the room(minimal light presence)and by using a flashlight, position the light so it transmits light into one end of the cable and stick the other end into the photo detector's detector.(Caution: Do not damage instruments, and do not play around with them too much because you can get electrically shocked.) Once you've done that, switch the measured data to nW on the photo detector and wait until it reads 3.08 nW. When it reads that number, turn on the light source and keep it on until the detector gives you a reading. Once you've learned how to do that, do your trials and record them down. Then change the environment of the fiber optic by adding ice or boiling water to change the temperature. Again, do the same thing while having the new environment introduced to the cable. Record your answers and come up with a conclusion.

Results

Our results were that the hotter temperatures got faster light transmission. We tested the cable at temperatures of 0-100 degrees Celsius and the cable that was introduced to 100 Celsius, worked the best. The average results were approximately 5.94 nW, 6.8 nW, 7.64 nW, 8.89 nW, and 11.11 nW.

Conclusions/Discussion

Our prediction was proven by the results of our experiment. Thus, our prediction is supported by our data. For example, when the fiber optics were exposed to a temperature of 0 degrees Celsius, the average of the optimal performances was 5.943333333 nW. However, at 100 degrees Celsius, the average was 11.11333333 nW.

Summary Statement

We are trying to prove how varying temperatures effect the optimal performance of light. measured with nanowatts.

Help Received

Dr. X gave us a photo detector; Mr. R gave us fiber optic cables

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Stephanie Avila

Project Number
S1503

Project Title
Stellar Nursery: A Study of the Wild Duck Cluster

Abstract

Objectives/Goals
To determine the age and distance of M11 and compare my findings with the results of a summer project, which were obtained by a group I worked with during the summer 2001 COSMOS Math and Science program at UCSC.

Methods/Materials
I used digital images of M11 in the blue and visual filters. I would need a standard star to find the relative magnitudes of the other stars. I searched the internet using google and failing to find anything emailed Stuart, who sent me a standard star map of M11.

Equipped with a map of the standard stars. I began a search which involved manipulating the image to match the view of the standard star map. I choose standard star #899. Due to a pixel error I manually documented the counts of each pixel in the vicinity of the star. Using averages I determined a good estimate of the brightness. Stuart suggested I find three other standardsto determine if the outcome was consistent.

I created graphs of the color index of the stars(blue magnitude-visual magnitude), versus their visual magnitudes. By comparing the graph with a Yale Isochrone model I was able to determine its age and distance.

Results
The standard star #899 was throwing the results off; whereas, the other standards were within 2% agreement. I discounted standard star #899#s data and considered the other three standard stars. The results suggest that M11 is 200 million years old and 1,649 parsecs or 5,375 light years away.

Conclusions/Discussion
The summer results suggested M11 was 275 million years old and 1,900 parsecs or 6,200 light years away. These new results were off by 75 million years and 251 parsecs or 825 light years. The summer data had more stars than the current study, along with more sophisticated software. This may account for the difference.

Summary Statement
This project is focused on discovering the age of the open star cluster M11, through analysis of images using blue and green filters in which standard stars allowed me o create B-V Absolute Magnitude graphs.using

Help Received
Stuart, a graduate student at UCSC, gave me valuable advice as to the purpose of my project. Mr. Sweet edited my work and gave me valuable insights on what could have gone wrong when the numbers did not turn out right.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)

Jessica Black; Eunice Chen

Project Number

S1504

Project Title

The Relationship Between Kinetic Energy of a Dropped Object Impacting Water and Height of Its Resulting Wave

Abstract

Objectives/Goals

The purpose of this project is to determine a relationship between the kinetic energy of a dropped object and the height of the resulting wave.

Methods/Materials

Materials used include a Tupperware container, food dye, a small ball, string, a permanent marker, paper, a ceiling hook, and water.

Our procedure: Fill the container up to 5.8 cm of water, add food dye, cut strips of paper, mark each, place 3 around the container with the mark meeting the water, secure papers by folding over edge, mark at 2, 5, and every 2.5 after up to 50 cm, hang string from hook so that it barely touches water, drop ball from first drop height and allow resulting waves to subside, examine the paper, measure the change of the wave height, and repeat 3 times for each height.

Results

Our results tapered from the hypothesis graph and then wavered. The tapering was caused by elasticity of water. Splashing and increasing kinetic energy of hte ball caused the wavering. Energy was also lost to sound upon impact and possible superposition of waves.

Conclusions/Discussion

We conclude that the energy of a wave related to the kinetic energy of hte ball as 1/x as long as the material and confines of the wave allowed.

Summary Statement

To find a relationship between the kinetic energy of a dropped object impacting water and the height of its resulting wave.

Help Received

No help or aid of any sort was received

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Gregory A. Chanan

Project Number
S1505

Project Title
Dynamics of Penta-Hepta Defects in a Hexagonal Pattern

Abstract

Objectives/Goals
The objective is to determine how two penta-hepta defects in a hexagonal structure will interact, in particular, to test Tsimring's theoretical description in which conjugate defects should attract and annihilate, reforming a perfect hexagonal structure.

Methods/Materials
A hexagonal structure of about 100 bubbles was created by blowing nitrogen gas through a hypodermic needle into a solution of distilled water, glycerin, and Mr. Bubbles. Defects were created by selectively popping bubbles with a needle to produce two separate penta-hepta defects, whose interaction was videotaped for later analysis. The procedure was repeated, varying the positions along the rolls where the bubbles were popped as well as the distance between the defects. The defects' interactions were examined, Tsimring's parameter N was calculated for each pair, and it was determined whether or not they behaved as predicted.

Results
Interactions of the five conjugate pairs of defects were studied. In four of the cases, the defects annihilated as predicted, but in one case the two defects repelled each other.

Conclusions/Discussion
Tsimring's theoretical description of the interaction of penta-hepta defects in a hexagonal lattice is largely correct, but not capable of fully describing the interaction. The interaction may be the result of competing influences such as momentum and the starting conditions of the bubbles, as well as Tsimring's attractive/repulsive force.

Summary Statement
The motion and interaction of pairs of penta-hepta defects in a hexagonal lattice of soap bubbles was studied in the laboratory and compared to theory, with a significant discrepancy between theory and experiment observed.

Help Received
Professor M. Dennin of UCI suggested this experiment and allowed me to use his lab and equipment. Father went over research papers with me and edited my work. Mother helped prepare the display board.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Collin N. Cronkite-Ratcliff

Project Number
S1506

Project Title
As Time Goes By: A Study of Relativistic Time Dilation

Abstract

Objectives/Goals
Einstein's Special Theory of Relativity predicts that time will dilate at very high speeds. In particular, a rapidly moving clock will "slow down". The objective of this project is to observe this effect and compare it with the predictions of Einstein's Theory.

Methods/Materials
The "clocks" used in this experiment are rapidly moving K-shorts observed with the SLD detector at the Stanford Linear Collider. Since K-shorts decay rapidly, their average lifetimes can be used as the "ticking rate" of a standard clock. These "clocks" are grouped in velocity bins so that the average ticking rate can be measured versus velocity.

Results
Time was observed to "slow down" by the factor gamma=Sqrt(1-v^2/c^2), where v is the velocity of the clock and c is the speed of light. The very high clock velocities (up to 0.9998 times the speed of light) available in the data allow large time dilation effects to be seen.

Conclusions/Discussion
Time dilation is directly observed in this project, and is shown to agree with the prediction of Einstein's special theory of relativity.

Summary Statement
This project is a study of time dilation, a relativistic effect in which the ticking rate of a clock (i.e., time itself) is observed to "slow down" as the clock speed approaches the speed of light.

Help Received
Data was obtained from the SLD experiment with help from the SLD staff, particularly Drs. David Muller and Ken Baird; my father helped me understand how to analyze the data.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Satya (Nanu) Nanu Das

Project Number
S1507

Project Title
Does the Universal Gravitation Constant Really Exist?

Abstract

Objectives/Goals
The whole objective or purpose of this experiment was to see if I could witness the gravitation attraction gradient between two masses without using high-tech and laboratory apparatus.(Third Law of Newton)

Methods/Materials
The materials that I used were a foam bar, about 3 meters of nylon monofilament, 2 varying dense test masses (that revealed their attraction tendencies), 2 support masses (to balance bar),insulated phone wire, electric tape, a ladder, a tuna fish can, and two equal aluminum pieces.

Results
The principle behind the torsion balance scale is fairly simple. By suspending a balance arm from an elastic string and placing much denser test masses/supports upon it, the downward pull of gravitation is concentrated on the test masses, leaving the bar free to oscillate amidst the two outer attraction masses (revealing that gravitation constant does actually exist). Although the moment of equivalent gravitation occurs for only a few split seconds, its action is truly magnificent. The dimensional analysis of the water brake (attached onto torsion balance scale) affects the performance of the attraction gradient, because the ratio of the radius : height can add/lessen the degree of stability provided upon the scale. Various support masses give off different results because different objects are composed of materials with varying densities.

Conclusions/Discussion
With the establishment of the attraction gradient, Einstein#s relativity theorem or that gravity is a fundamental consequence of space and time can be proven to be true. The torsion balance scale enables the viewer to see the true effects of micro-gravity without stepping into deep space/ or a vacuum. The invention interested me because it was literally about bending space time, and the framework concept of our universe. Although there is really no way to measure the exact gravitation constant (because of the minuteness of the force) it is most visible to view the horizontal oscillations of the bar. It is in this fashion that one can see the correlation between the density and attraction gradient between various objects.

Summary Statement
It was about proving the existence of the Univeral Gravitation Constant in the most simple method possible(Torsion Balance Scale)

Help Received
No one

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Michael H. Fischer

Project Number
S1508

Project Title
Relativity on the Desktop: Illustrative Models of Einsteinian Physics

Abstract

Objectives/Goals
One of the fundamental principles of modern science is that the speed of light is constant in every inertial frame of reference. In this science project we consider why this principle is true. We approach this question by constructing a scale model universe which we call Solitonland. In this model universe, there exists solitonlight with speed c*. All other physical processes are controlled by the Sine-Gordon equation, a single nonlinear partial differential equation. Using only two special kinds of solution, we show how one can construct kink measuring rods and breather clocks from the material of this universe. We then show explicitly and precisely that the speed of solitonlight, as measured with these soliton rods and clocks, is independent of the inertial system. Thus in Solitonland, that the speed of solitonlight is a universal constant follows from the structure of Solitonland itself rather than as a postulate as it does for the speed of real light in our own physical universe.

Methods/Materials
Experimentally, we construct a physical model of Solitonland in which the speed of solitonlight is drastically slower than the speed of real light enabling us to do relativistic experiments on the desktop.

Results
In these experiments we are able to visualize Lorentz contractions and hear time dilations. Thus we show that a scale model universe can be constructed, both literally out of ordinary material and mathematically in our minds, and studied in a way that sheds light on the relativistic effects seen in our own physical universe. The actual observers themselves need not literally exist in the models; we can imagine what they would measure if they were actually there, the important point being that they make their measurements completely from within the confines of their own universe.

Conclusions/Discussion
We consider the implications of our scale model universe to our own universe. We show that in any universe, either real or imagined, that has certain minimal characteristics which include the existence of light signals and measuring devices that can be used to measure the speed of these signals, the speed of light in that universe will be constant in every inertial frame. Thus, to the extent that this result is a general principle for all universes that satisfy these minimal conditions, the mystery of why the speed of light is a universal constant in our own physical universe should be dispelled.

Summary Statement
This project is concerned with understanding why one of the fundamental principles of modern science is true; thus we consider both theoretically and experimentally why the speed of light is constant in every inertial reference frame.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Troy G. Garabedian

Project Number
S1509

Project Title
Wallpaper Underlayments: A Thermodynamic Study of a New Energy, Time, and Money Saving Idea

Abstract

Objectives/Goals
Recent events in California and elsewhere increase the urgency of additional energy saving devices that will reduce the total demand and save the consumer money.
Here a new idea was given and thermodynamic analysis was done for a novel underlaymnet for wallpaper that could offer additional insulation in a convenient new form.

Methods/Materials
An experiment was planned to design, construct and test both test apparatus and underlayment prototypes and evaluate performace using a Pasco Science Interface 500 computer program. Heat, from an infrared lamp was transferred through six different undelayments and computer recorded as temperature increased in a "model monitor room" fitted with an electronic temperature probe for 300 sec test periods. Wallpaper alone served as a control against experimental underlayments.

Results
Thermodynamic analysis was performed at three levels. First using change in temperature in monitor box where wallpaper control equaled .093 C/sec, compared to the best underlayment, foil bubble wrap, equaling .007 C/sec. Second, using density of air, and change in temperature from above the joules passing through the six inch by six inch underlayment was found indirectly using Q of the air equals M x C x change in temperature. Wallpaper control permitted 40.30 J per 300 second to leak through whereas experimental bubble wrap underlayment permitted only 8.88J. Third, dimensional analysis projected approximate dollar savings on a theoretical 10' x 10' x 10' room, based on a $.11 kilowatt per hour rate. Energy savings from experimental underlayment were $67.27 per year over wallpaper alone. Cost benefit and proposed actual product design are presented to help visualize how the product could be convenient for the consumer.

Conclusions/Discussion
Hypothesis is supported for a novel energy saving wallpaper underlayment that may present potential savings of energy and money for the consumer, and the state.

Summary Statement
I used a two chanber test box and a Pasco computer interface to thermodynamically test many different prototype wallpaper underlayments for a cost effective way to insulate your home when you re-wallpaper.

Help Received
Mr. Lake helped me with some of the thermodynamic equations. Mr. Chortanian let me use the Pasco 500

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Andrew P.C. Gustafson

Project Number
S1510

Project Title
Using Air to Launch a Projectile

Abstract

Objectives/Goals

There are several main principle objectives in this experiment. The main principle was to find if the distance the air cannon would shoot was proportional to the air pressure within the cannon. I concluded that the pressure is not directly proportional to the pressure within the cannon, in the ending of my experiment. Even though the pressure increases and the distance of the projectile increases, it is not directly proportional. I found that air resistance and the friction it had on the projectile had a huge role in the outcome of the distance the projectile went.

Summary Statement

I determined whether pressure was directly proportional to pressure when I launched a projectile using air.

Help Received

No help was given

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Greg T. Halverson

Project Number
S1511

Project Title
Cool Roofs: The "How To" on How to Keep Your House Cool During Summer

Abstract

Objectives/Goals
The problem I chose to investigate was: What is the effect of heat absorption on roof color? My hypothesis was that the darker colors black and brown would be warmer in temperature than the lighter colors beige and white. The objectives of this experiment were to find out which roof color absorbs the least heat and in turn reflects the most heat. The goal of this project is to find out how we can lower energy costs by cooling the temperatures inside the attic of people's homes.

Methods/Materials
I used plywood to build small model houses. Then I took four metal plates and spray painted them black, brown, beige and white. I then used a digital thermometer purchased from Radio Shack and attached it to the display with the clip provided. I drilled little holes in the back of each house model in order to measure the temperature "inside" each house. After the paint and glue had dried, I attached the track lights, which served as my artificial sunlight. I left the lights on for half an hour per color. I then began taking temperatures. I repeated the project and then I averaged the results.

Results
My experimental findings were that the lighter the roof color the less heat it absorbed as shown by the temperatures inside each house model. The following numbers are averaged figures between the two different times I conducted the experiment:

Roof Color	Room Temperature	Attic Temperature	Temperature Rise
Black	73.4	99.5	26.1
Brown	72.9	97.5	24.6
Beige	73.4	91.9	18.5
White	72.9	85.5	12.6

Conclusions/Discussion
In conclusion my results show that lighter colors absorb less heat than darker colors. This information is helpful in daily life because we can use it when we plan to build buildings, roads, houses and even vehicles. We can also use this information to conserve electricity during summer by keeping the attic of a house cooler by having a less absorbent roof color, thereby lowering the use of air conditioning. We can also use this information when we plan what colors we wear in the summer and in the winter.

Summary Statement
My project is about trying to find out which color of roof absorbs the least amount of heat.

Help Received
Father helped install and build house models.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
James P. Harper

Project Number
S1512

Project Title
Conserving Energy: What Should Be Insulating Your Walls?

Abstract

Objectives/Goals
My experiment was designed to answer: Between two concentric cubes of wood designed to approximate an average American home, what medium will yield the best insulation properties? I hypothesized that air would yield the best insulation properties. Air is much less dense than the other materials used in this experiment and since the transfer of heat is the same as the transfer of kinetic energy from one atom to another, the lower density of air would be a better insulator than the other materials.

Methods/Materials
I began researching what insulation and building materials are used in standard construction. A local contractor assisted me in my research. I then designed scale diagrams of two boxes. Each box was built with an outer and inner shell. One box was constructed with plywood, the other with OSB/waferboard. These building materials are both standard in the construction of houses. I inserted a probe into the center of the inner box and subjected my model to controlled environmental tests. I used a freezer, simulating wintertime in the real world. The different kinds of insulation I used were fiberglass, cardboard, newspaper and air. First, I checked the temperature of the environment outside the box. Second, I brought the concentric cubes to room temperature and proceeded to test each box with each insulation in each environment, recording each datum every five minutes. I recorded the external and internal environmental temperatures at the beginning of each experiment.

Results
For each experiment, my data yielded a smooth S-shaped curve. Each experiment took about 2 ½ hours. My results led me to the conclusion that fiberglass is the best standard insulation material of the four I used in testing.

Conclusions/Discussion
The insulation used in standard construction, fiberglass, yields better results, meaning less heat transferred per minute, than just air, newspaper or cardboard. My results did not support my hypothesis. I learned that convection currents, which are supressed by cardboard, newspaper and fiberglass, allow a greater transfer of heat between the internal and external environments. Since air did not inhibit these convection currents, caused by the temperature differential between the two environments, the heat from the center of the cubes transferred outward faster than when the boxes had another insulation.

Summary Statement
This project is concerned with finding out what combination of standard insulation material and standard building material yields the best insulation properties.

Help Received
My father helped me design and test; my mother helped proof writing; Bruce Carmichael lent me his table saw and construction expertise; Mr. Eric Fink provided a thermometer for testing.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Shant Krikorian

Project Number
S1513

Project Title
Millikan's Oil Drop Experiment

Abstract

Objectives/Goals
The purpose of my project was to use Millikan#s oil drop experiment to experimentally determine the value of the electron charge, #e#, to demonstrate the discrete nature of the electron charge, and to determine that the charge is quantized. I hypothesized that an oil drop entering the space between the two copper plates would be affected by the uniform electric, gravitational fields, and the viscous drag (after applying a voltage on the plates). When the oil drop is motionless, mg=neV / d. To find the mass of the oil drop we need to find the terminal velocity, when there is no electric field. From the terminal velocity we can calculate the radius of the oil drop and from the radius we can calculate the volume. Therefore, mass can be found from the equation: mass=density x volume.

Methods/Materials
In this experiment I used a chamber, an atomizer, light oil, a variable DC power supply, a voltmeter, a telescope (with a reticule), a laser light, and a stopwatch. My independent variable in this experiment is, the stopping potential for the oil droplets, measured in volts and my dependent variable is the number of electrons on the oil droplets, measured in integer numbers. Therefore, I will be plotting mgd/ V as a function of the number of electrons on the oil droplet (n) and using the relation: mg=neV / d, when the oil drop is motionless. Thus, the slope of the graph is the value of the electron charge, #e#.

Results
My data/results were close compared to the established value of the electron charge. In my experiment, I found the value of the electron charge to be 1.53 x 10^-19 couloumb, compared to the established value which was 1.6 x 10^-19 couloumb.

Conclusions/Discussion
I did find that the charge was quantized and I found the electron charge to be within 9% of the actual value. Yes, my hypothesis supported my data. I stated that an oil drop entering the space between the two copper plates would be affected by the uniform electric and gravitational fields (after applying a voltage on the plates). When the oil drop is motionless, mg=neV / d, and that#s exactly what happened. My graph and overall results showed a 9% error, due to many factors. In my experiment, I did not take under consideration, barometric pressure, error calculating the radius, density, and speed which all could have changed my results.

Summary Statement
Using Millikan#s Oil Drop Experiment, I found the charge of the electron and proved that it was quantized.

Help Received
Advisor, Dr. Injeyan: gave me helpful hints and ideas to revise my project, he supplied me with different tools, and helped me define and understand different science terms that I was unfamiliar with. My geometry teacher, Ms. Woo: helped me understand and recognize all the equations in this experiment.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Amit Lakhanpal

Project Number
S1514

Project Title
The Mass Profile of the Cluster A2029 Revealed by the Chandra X-Ray Telescope: Implications for Theories of Dark Matter

Abstract

Objectives/Goals
This research aims to resolve a longstanding question of modern astronomy. A large discrepancy between the dynamical mass and luminous mass of cosmic structures has led to the widely held belief that at least 90% of the universe's mass is due to dark matter - a form of matter that exerts a gravitational force but is otherwise unobservable. The identity and characteristics of dark matter are important cosmological questions that have direct bearing on properties of cosmological formation. Is one of the proposed theories of dark matter-Cold Dark Matter (CDM)-supported by the wealth of high-quality X-ray data collected by the Chandra X-ray Observatory? CDM claims that dark matter consists of a presently undiscovered particle that is virtually non-interactive (except gravitationally) and was initially in a near-motionless state. We hypothesize that there will be a close correspondence of the measured radial mass and density profiles with the theoretical predictions from the large-scale simulations of a CDM universe conducted by Moore et al.

Methods/Materials
A computer with a C++ compiler and image data of galaxy cluster Abell 2029 from the Chandra X-Ray Observatory were all the materials needed. Data from A2029 was retrieved from the Chandra Public Data Archive. The unprecedented spatial and spectral resolution of Chandra allow us to plot the radial profiles of the temperature and electron density of the X-ray emitting gas that fills the potential well of A2029 at small radii-less than 200 kpc-with unprecedented precision. Based on the equations of hydrostatic equilibrium, the radial mass profile is calculated and fit to a power law curve of the form M(<r) = k_1(k_2 + r)^{beta}, which gives a mass density profile that goes as rho(r) ~ r^{-alpha} where alpha = 3 - beta. The value of alpha is crucial in differentiating between different models of dark matter and cosmological formation; the Moore simulation of the CDM paradigm predicts that alpha = 1.5.

Results
Alpha (the slope of the radial mass density profile) = 1.28 ± .14; the determination of this value was the goal of this research.

Conclusions/Discussion
We conclude that the CDM paradigm is accurate. With this novel constraint, it is further concluded that the method of determining the contribution of luminous matter to mass in non-dark matter dominated structures is in need of improvement because of discrepant findings of alpha in such situations.

Summary Statement
This research is an X-ray deprojection analysis of Chandra data that provides validation of the Cold Dark Matter Paradigm on cluster scales - 10 to the 15th solar masses.

Help Received
Worked at the University of California, Irvine, under Dr. David A. Buote

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
George X. Lin

Project Number
S1515

Project Title
How Much Force is Exerted onto the Violin Top?

Abstract

Objectives/Goals
My Objective is to find the amount of force exerted on to the violin top while the violin itself is in tune and to see how different kinds of strings effect that amount of force.

Methods/Materials
The materials needed are :Stand for the violin, Large clamp (for holding the stand onto the table), Small clamp (for holing the violin onto the stand), Violin bow, Electric chromatic tuner, Bucket with approximately 16 Kilograms of mass in rocks (which is used to make the experiment easier to follow), Tail gut extension, Electric scale (in Kg.), A violin (4/4 full-size), Camera, Rope, A protractor, Pencil and paper, Set of steel strings (violin), Set of nylon strings (violin), and Set of gut strings (violin). The violin is set onto the stand with the clamps holding it in place while the bucket is tied onto the gut extenstion which the string hooks onto. By using a electric tuner and putting enough rocks into the bucket, one can find the tension of the string required to produce the right tune. Weight that and convert it to Newtons. Use different strings and different sets of strings to find out if there are variations on the force exerting onto the top of the violin.

Results
109.19 Newtons of Force is exerted onto the violin face while using the set of steel strings. 89.21 Newtons of Force is exerted onto the violin face while using the set of nylon strings, and 80.65 Newtons of Force is exerted onto the violin face while using the set of gut strings. Different types of string can put different amounts of force onto the violin face.

Conclusions/Discussion
Different strings exert different amounts of force. Because some violin tops are soft and some are hard, due to the wood, some will have trouble supporting or balancing the force exerted by the strings. If the violin top cannot support that kind of force, its sound cannot be as colorful, nor as deep as it should be because the violin would not vibrate as much as they would if the force pushing up is at a equilibrium with the force pushing down. If the force exerted by the strings matches exactly with what the violin top can support (by using different types of Strings), then the sound will be able to project well and will be wonderful. In conclusion, each violin will need a certain type of string to bring out the beauty of music within it. There are many variables, and each violin is unique.

Summary Statement
My project is about how different strings exert different amounts of force onto the violin face.

Help Received
Father told what books to read; Mr. Duncan help clarify some physics; Mrs. Jesfjeld gave support and kept me going; Mrs. Sigg and Anne Jefferson help with spelling and grammar.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Anirban Mazumdar

Project Number
S1516

Project Title
Microwave Superheating through Attempts at Chemical and Physical Facilitation of Nucleation

Abstract

Objectives/Goals
The objective of this study was to understand how different physical properties and chemical agents affect microwave superheating of water. Since scientific literature has not fully addressed the interactions and dynamics of this phenomenon, and microwave superheating is not well understood, the hope is that this study will contribute towards better understanding of this phenomenon

Methods/Materials
Using the same domestic microwave oven set to "normal" power, several samples in 125ml of tap water at 23ºC were subjected to microwave radiation for 7 minutes and 30 seconds, and observed for evidence of boiling (nucleation) and superheating (an abrupt stop in nucleation followed by an eruption). The tests were repeated using distilled water at 23ºC. The variables included changes in physical properties (different shaped containers, an artificially roughened container, the presence of a smooth probe, the presence of a boiling tab, the presence of an oily layer, and the presence of tea-leaf fragments) and chemical agents (additions of salt, sugar, and detergent to create solutions).

Results
Superheating was prevented physically by the presence of tea leaf fragments, the use of artificially roughened container, and boiling tab. Superheating was prevented chemically by the use of a detergent solution. Superheating occurred with the standard beaker, the wide container, the narrow container, the presence of a smooth probe, the presence of an oily layer, the use of an electrolytic (salt) solution, and the use of a sugar solution

Conclusions/Discussion
By preventing superheating physically, the artificially roughened container, the boiling tab, and the tea leaf fragments all physically facilitated nucleation. Similarly, by preventing superheating chemically, the detergent solution chemically facilitated nucleation. The other variables did not facilitate nucleation significantly. Nucleation therefore is the primary factor in the ability of water to superheat. Analysis of the data also illustrates the potential of chemical agents to alter the ability of water to nucleate, providing implications for the field of chemistry. The data also illustrates the viability of artificial roughening as a practical solution to enhance public safety.

Summary Statement
This project studied the dynamics of superheating of water through attempts to facilitate nucleation by altering various chemical and physical properties and subjecting the samples to microwave radiation using a domestic microwave oven.

Help Received
Used the Microwave Oven of a Neighbor, Mr. Ferazzi helped provide the measurement equipment, parents helped purchase equpment and provided encouragement

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Oliver R. Pilco

Project Number
S1517

Project Title
Radiation Absorption

Abstract

Objectives/Goals
The objective of my project was to determine the characteristics of radiation and to find the best overall shield to stop the penetrating power of my radiation sources (Gamma, beta, and alpha).

Methods/Materials
The radiation sources included Strontium 90 for the Beta source, Cobalt 60 for the Gamma, and Polonium 210 for the Alpha source. A gieger counter was used to measure the counts and analyza the pentrating power of each source, using different shields, thickness, number of layers, and type (lead, aluminum, copper). The geiger counter was also used to determine the absorption coefficient and inverse square law.

Results
Using the data derived from my experiment, lead proved to be the best overall shield. Due to the nature of alpha particles, they were easily stopped by all shields. The inverse square law proved the electrogmagnet charateristics of gamma rays and the linear absoprtion coefficient showed the penetrating power of the three different types of radiation, gamma being the most potent.

Conclusions/Discussion
Gamma rays showed to be the strongest of all three types of radiation. Using the equation derived from the linear absorption coefficient the effectivness of the thickness compared to the strength and type of source can be analyzed. The nature of radiation is also explained through the inverse square law and statistics.

Summary Statement
Analyze the strength of radiation through different types of radiation and they're nature.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Nicholas A. Salas

Project Number
S1518

Project Title
What Affects the Pitch of a Sound?

Abstract

Objectives/Goals
My project was to find out if volume and strain can affect the pitch of a sound.

Methods/Materials
I used 10 beer glasses to see if volume is a factor in pitch change. The first five beer glasses had different amounts of water in them, from 50ml to 150ml, and the last five beer glasses all had the same amount of water, 100ml. I struck each glass to hear a difference in sound, and after I concluded my results I moved on to proving if strain affects pitch. I then took a wooden tea box and put five rubber bands around it. I struck each band and noticed that they all had the same sound. I then made an incision where each band was lain, and each band had a different sized incision, from 1in. to 5in. After I concluded my results I took a music tuner and tuned each glass and rubber band to see if my ear was correct.

Results
The glasses that all had 100ml of water created the same pitch, and the glasses that had different amounts of water created various pitches. Same thing with the rubber bands. The bands that were just lain on the tea box with no incison all created the same pitch, and when the bands each had a different incision, they too created various pitches.

Conclusions/Discussion
I have concluded from this project that Volume affects the pitch of an object by causing the object to either vibrate more slowly or more rapidly. The faster an object is being vibrated, the higher the pitch is. I also concluded that strain affects an object's pitch because if an object is being stretched out, then the vibrations in that object will have a longer distance to travel. The farther an object is being stretched, the more distance it needs to cover, thus causing the object to vibrate much more rapidly, thus creating a higher pitch.

Summary Statement
If Volume and Strain are some of many factors that affect the pitch of a sound.

Help Received
Mr. Rosse gave me ideas on how to improve my board's appearance.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Sonia Samra

Project Number
S1519

Project Title
Opilliones: Harmonic Oscillators

Abstract

Objectives/Goals
My objective was to learn how a spider#s mass effects it#s vibrations. I believe as the spider#s mass increase the vibrations will decrease.

Methods/Materials
Six of the same type spiders with different mass. First spiders were massed. Then a photocell was attached to the computer and on the other side was a laser hitting the cell. The spider was placed inbetween. Every two times the beam was broken that was one vibration. Each spider was tested four times.

Results
The spider with the greatest mass had the least vibrations compared to the least mass spider.

Conclusions/Discussion
My conclusion is that heavier spiders vibrate at a slower rate, this is an example of harmonic motion. My hypothesis was supported by my data. The research on harmonic motion helped me develope a good hypothesis.

Summary Statement
My project is about figuring out how mass effects the harmonic motion of a spider.

Help Received
Fresno State University used scale under supervision of a university student: Sukhdeep Bassi

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
W. Britt Wilson

Project Number
S1520

Project Title
The Effect of Different Surface Materials on the Sliding Friction of Fiberglass

Abstract

Objectives/Goals
The objective is to determine which material has the least sliding friction when dragging a piece of weighted fiberglass across it, and if there is a relationship between the weight on the fiberglass and the amount of friction.

Methods/Materials
A bucket was attached to a piece of fiberglass with fishing line. The fiberglass was placed behind a starting line on each of the five different materials, astroturf, carpet, aluminum, plywood, and plastic. Water was meticulously added to the bucket from a graduated cylinder until the fiberglass (weighted during different trials with 150, 300, 450, 600, and 750 grams) moved two feet across the material. Five trials for each weighted fiberglass were conducted. The amount of water required to move the fiberglass the designated distance for each trial was recorded.

Results
The results show that aluminum and astroturf created the least amount of friction for the weighted fiberglass, with carpet a close third. Plastic ran a more distant fourth and plywood required the most force to move the fiberglass, indicating the most amount of friction.
A strong linear correlation between the weight on the fiberglass and the amount of force required to move the fiberglass across the different materials was found.

Conclusions/Discussion
This experiment was designed to determine which material would be the best surface for sliding a fiberglass boat across when getting it in and out of its slot. The experiment effectively demonstrated that aluminum and astroturf provided the least friction when weighted fiberglass was dragged across it. Overall, the data was very accurate, as indicated by error bars. The numerous trials clearly established the differing slopes of friction coefficients for the different materials.

Summary Statement
Using weight as a measure of frictional force, a piece of fiberglass was pulled across different surface materials to determine which material had the least sliding friction and if the friction coefficients were linear.

Help Received
While collecting data, my dad told me when the fiberglass started moving and when it crossed the finish line so that I could concentrate on pouring the water into the bucket at a constant rate. I also had a peer edit in class.

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Rui Wu

Project Number
S1521

Project Title
The Effects of a Magnetic Field on the Paths of Alpha Radiation Particles

Abstract

Objectives/Goals
My objective is to experimentally find a mathematical expression to model the relationship between magnetic field and radius of an alpha particle under the influence of a magnetic field. An alpha particle in a magnetic field perpendicular to its velocity will move in a circular pattern. I wished to find an equation to describe this pattern. The final equation should be in the form Radius (m) = k (Tm) * v (m/s) / B (T), where R is radius, k is a constant, v is velocity, and B is magnetic field strength.

Methods/Materials
I first set up a diffusion cloud chamber with isopropyl alcohol and dry ice. Then I connected the power supply to 3 resistors in parallel. The circuit was connected to a solenoid around the cloud chamber vertically. Current flow created a magnetic field, which could be measured using the CBL System with the Magnetic Field Sensor. Aerial pictures were taken of alpha particle trails from a Uranium Ore source placed in the center of the chamber. I selected 5 pictures with different degrees of magnetic field and a 6th picture with 0 magnetic field (control). I selected 4 points from every path analyzed. Using inverse matrices I was able to construct a polynomial of degree 3 to model the curve. Then, through differential methods I was able to find a suitable radius to describe the curve. Using algebra, an equation in the form of R = k /B was found. By extracting the velocity of an average U3O8 particle, an equation in the form of R = k * v / B can be found.

Results
Radius is inversely proportional to field and directly proportional to velocity.
Average experimental constant (k) = 0.2900 Tesla meters
Radius = 0.2900 Tm / Magnetic Field
Radius = 2.049 * 10^-8 kg/C * v / B

Conclusions/Discussion
Experimental error was around 5% (from the ideal equation radius = mv/qB). The process used to analyze the curves could be refined to improve accuracy. The inverse relationship between magnetic field and radius was proven. Extraction of velocity was found by using the velocity of an average U3O8 particle. Using my procedure, testing of many other characterstics of particles can be done. Further testing may include using the setup to experimentally test for the mass, charge, velocity, etc. of an unknown particle.

Summary Statement
How the strength of a magnetic field affects how much the path of an alpha particle curves.

Help Received
Father gave suggestions; Used equipment at University High School under supervision of Mr. Robert Ferazzi and Mr. Glenn Malin

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Zhizhang Xia

Project Number
S1522

Project Title
Magnetization of Materials Used in the Construction of Cryostats

Abstract

Objectives/Goals
The two main purposes of this research is to determine the relative magnetic susceptibility of cryostat materials at low temperatures and analyze the magnetic behavior of these materials in relation to the temperature and applied magnetic field. The results can help determine the possible contributions to error in low-temperature experiments dealing with weak magnetic signals.

Methods/Materials
An S.H.E. variable temperature susceptometer was used to measure the magnetization of the materials at temperatures of 2K, 3K, 4K, 5.5K, 7K, 10K, and 12K and at magnetic field strengths of .25 Tesla, .5T, 1T, 1.5T, 2T, 3T, 4T. The materials analyzed include 6061 aluminum alloy, 304 stainless steel, 304 annealed stainless steel, 316 stainless steel, beryllium copper, copper nickel 7030, Evanohm wire, fused silica, Grafoil, Manganin wire, Stycast 2850, Teflon, Vespel, yellow brass. All the samples were cleaned with acetone and metals were etched with nitric or hydrochloric acid. Most were cut into 6mm x 6mm cylinders, though some had irregular shapes, and are suspended with cotton or polyester thread.

Results
At an applied magnetic field of 1 Tesla and a temperature of 2 Kevin, the materials with the greatest relative magnetization to the ones with the lowest are listed as follows: copper nickel 7030, Manganin wire, 316 stainless steel, 304 stainless steel, Evanohm wire, Grafoil, stycast 2850, beryllium copper, 6061 aluminum, Vespel, yellow brass, Teflon, and silicon dioxide. The results are fit to a function with 3 parameters, one for a fixed contribution to magnetization, a linear contribution with respect to the magnetic field, and a hyperbolic tangential contribution with respect to the temperature and magnetic field; a data table is thus generated.

Conclusions/Discussion
Stainless steel, silicon dioxide, 6061 aluminum, and Manganin behave linearly with respect to the applied magnetic field, while most other materials display a hyperbolic tangential behavior. However, the fit parameters can be used to extrapolate the magnetization of the materials at different temperature and magnetic fields with good accuracy. Because many of the metallic materials are relatively very magnetic (though some are surprisingly very weakly magnetic), they should be seriously taken into consideration when using or construction cryostats.

Summary Statement
Analyzing the magnetic susceptibility and behavior of materials at low temperatures and high magnetic fields for error correction or prevention purposes.

Help Received
Used lab equipment at the University of Southern California under the supervision of Prof. Hans Bozler and Prof. Chris Gould; obtained advice, criticism, and various aid from USC students Barry Fink, Fuyuko Bray-Ali, Jinshan Zhang, and Kevin White. Participant in the Southern California Junior Academy of

CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
Derek C. Mohr

Project Number
S1599

Project Title
The Hot Zone: Achieving Virus Incubation Conditions with Phase Change Materials using Thermoelectric Heat Pumps

Abstract

Objectives/Goals
This thermophysics project explores phase change materials coupled with the use of thermoelectric heat pumps to achieve time-temperature profiles suitable for effective incubation of an array of viruses. Medical and humanitarian relief work in developing countries need methods and equipment to incubate viruses using minimal power. Portable battery-powered incubators have insufficient operating time and cannot achieve the high temperatures needed for most virus incubation.

Methods/Materials
Research began 10 months ago by studying virus incubation characteristics and exploring phase change substances that had freeze/melt temperatures suitable for incubation of various virus families. A patent search was accomplished and no similar operating concept was identified. Nine candidate phase change substances were assessed for freeze/melt temperatures, specific heats, latent heats, and time duration of phase change. Thermoelectric heat pumps were employed to achieve the range of virus incubation temperatures. Heat pump power requirements were measured at phase change (solid/liquid) conditions for each substance corresponding to virus family incubation temperatures. Over 105 individual experiments accumulated 1,120 hours of thermodynamic and power measurements.

Results
Virus incubation conditions were acheived in four of five temperature bands for virus families ranging from 34-72 degrees C. With thermoelectric heat pumps, high temperatures and incubation times far exceeded the performance of portable battery-powered incubators. Specific heats (solid/liquid) and latent heats of phase change materials were calculated from direct measurements of thermal properties. Using efficient thermoelectric heat pumps, only small quantities (20 grams or less) of phase change substances achieved specific virus incubation conditions, the total system is functionally a micro-incubator.

Conclusions/Discussion
The heat pump with phase change materials (micro-incubation) concept was successful in achieving incubation conditions for a wide variety of viruses. This design was superior in terms of thermal performance and incubation duration at a fraction of the weight, size, and cost of existing portable battery-powered incubators. This concept, using heat pumps with phase change materials for micro-incubation, has direct applications in support of worldwide medical and humanitarian relief where viruses pose a serious health risk.

Summary Statement
Virus incubation conditions were achieved by the use of thermoelectric heat pumps with phase change materials; potentially benefiting medical and relief operations in developing countries.

Help Received
None