ST. BONAVENTURE UNIVERSITY Founded 1858

Student Guide to the Physics Department

Contact Information

Mr. T. Cooke
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DLR 121A; ext. 2007; jpientka@sbu.edu
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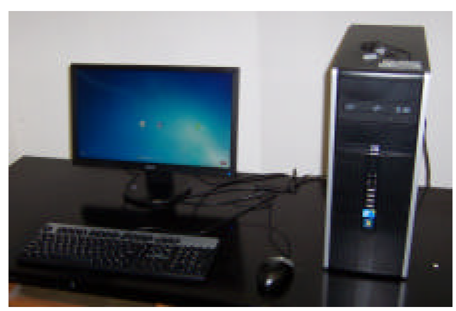
Facilities

Area 9

Area 9 is located in DLR 9. It is used by Physics majors as a study/tutorial room. There are desks and a networked computer in the room. Upperclasspersons have first choice of the desks.

Computer Room (DLR 22)

The departmental computing room is DLR 22. Several new networked workstations are stationed in room 22, reserved for the exclusive use of Physics and Pre-Engineering majors. Students taking courses offered by the Physics Department use them, also. The facility includes inkjet printers.



[See the **Guide to the Physics Department Computing Facilities** for information on the use of the departmental computers.]

Library

The Physics Department does not maintain a library separate from the Friedsam Library.

Class Rooms

DLR 1 is a combination lecture & lab classroom. Physics classes are held in room 1, as well as the Phscl 113 class.
DLR 2 is the Introductory Physics Lab [Phyl 103 & 104] classroom.
Occasionally upper division Physics classes are held in room 2 also.
DLR 3 is the advanced Physics Lab classroom.
DLR 20 & 24 are larger classrooms. Physics classes sometimes meet in these rooms.

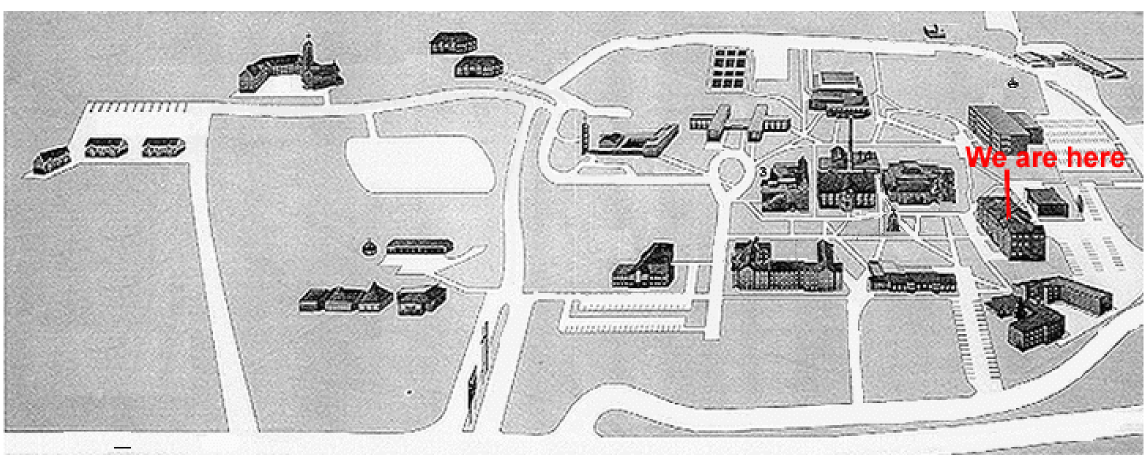
Observatory

The Physics Department operates the SBU Observatory, which is equipped with an 11 inch Schmidt-Cassegrainian telescope. Interested students are permitted to use the observatory facility.
There is an Astronomy Club!

Remarks

Here are some things to do which will increase ones chance of academic success.

i) Hang out in Area 9. Interact with ones peers. Also, information about registration, as well as other announcements, may be posted in Area 9.
ii) Know ones academic advisor.
iii) Consult with the professors early on, especially in the Phys 103 & 104 classes to get comfortable early with consulting the course instructor(s).
iv) Ask questions. About anything.
v) Keep an eye on the departmental bulletin boards—announcements, homework and exam solutions may be posted.
vi) Keep an eye on the course pages in Moodle—course information may be posted there.



Note: this old map does not show the new Walsh Science Center addition to De La Roche Hall.

Guide to the Physics Department Computing Facilities

Rev 7.0

A. Organization

1. The computers in room 22 are newly acquired HP workstations. They share the inkjet printer in the room. They are all connected to the campus network.

2. The computers stationed in room 2 are used in the Phys 103/104 Introductory Physics Lab classes. These units form a wireless workgroup, sharing a printer.

3. A networked computer is located in room 9 for the general use and convenience of Physics majors.

B. Software

1. Web browser: The units have Internet Explorer installed.

2. *MS Outlook*: The SBU MS-Outlook e-mail service is accessed through the web browser(s). The web address is https://*webmail.sbu.edu/exchange*.

3. *MySBU*: The *my.sbu.edu* web portal is accessible from the units in room 22 & Area 9 & room 2.

4. Applications: Some or all the units have the following applications installed: *MS-Word & Excel & PowerPoint*; *Derive; AutoSketch*; *MathCad*; *MatLab*.

C. Remarks

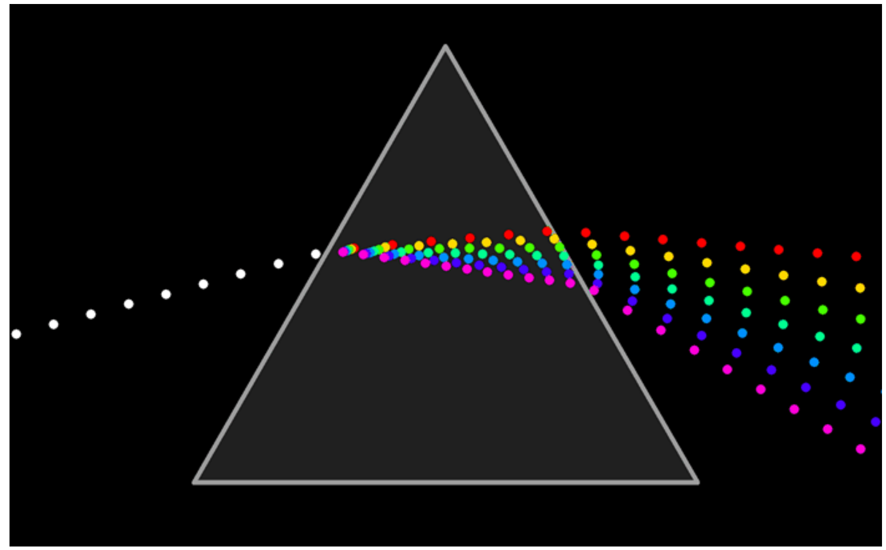
1. Since many persons use these computers, it is not advisable for a student to leave his or her files on the hard drives nor on the desktop. In any case, the hard drives are not large. Use the on-line storage space provided by Tech. Services or a USB drive to save your files.

2. From time to time, a class will be occupying room 22. Watch for posted notices, and plan accordingly.

ST. BONAVENTURE
UNIVERSITY

Click to advance

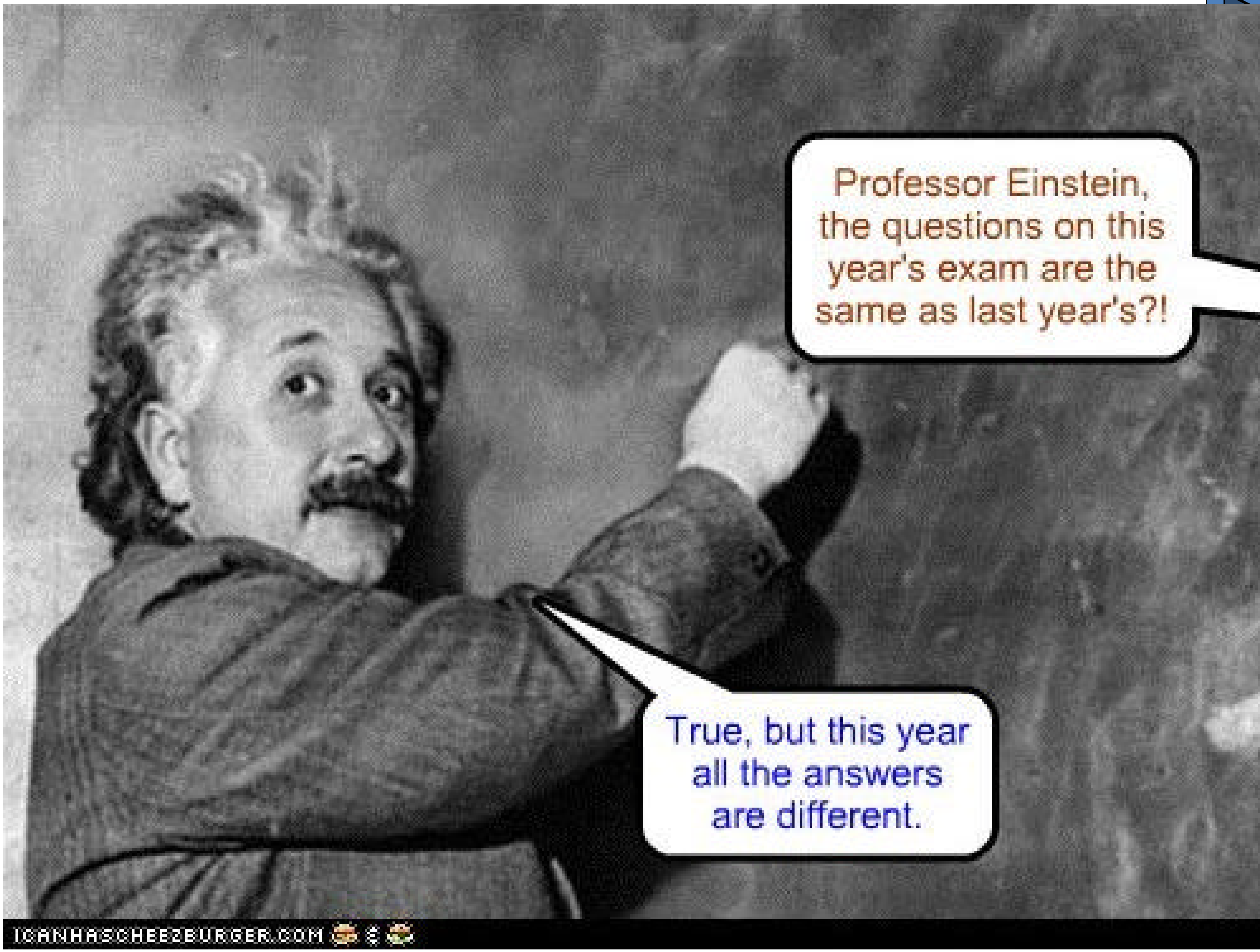
Physics Department



APS physics

SIGMA PI SIGMA
The Physics Honor Society

IEEE
Advancing Technology for Humanity


Professor Einstein, the questions on this year's exam are the same as last year's?!
True, but this year all the answers are different.
ICANHASCHEEZBURGER.COM

Physics

The program in **Physics** provides a thorough grounding in fundamental physics, developing the skills essential for graduate study in physics or engineering, for industry, for government service, and for teaching.

Engineering Physics

The program in **Engineering Physics** provides a thorough grounding in fundamental physics, while also providing exposure to engineering disciplines, particularly mechanical and electrical engineering. Engineering physics students develop the skills essential for graduate study in physics or engineering, for industry, for government service, and for teaching.

DEGREE REQUIREMENTS

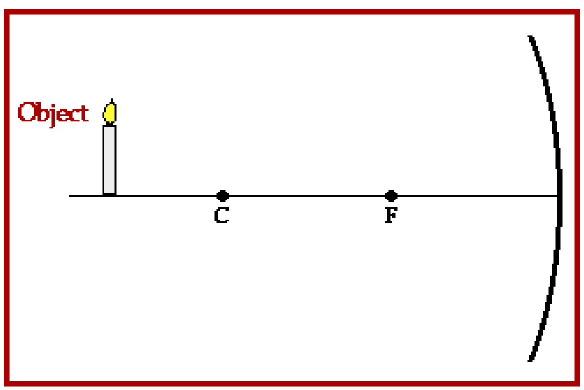
B.S. – Physics (Engineering Physics)

	Credits		*Credits*
Required Academic Credits		**Required Physics & Engineering Courses**	
Physics	32	Introductory Physics	6
Engineering	9	Introductory Physics Lab	2
Mathematics	18	Analytical Mechanics	3
Chemistry	8	Electricity & Magnetism	6
Foreign Language 202*	3	Thermodynamics	3
Intellectual Journey	3	Experimental Physics	3
University Forum	2	Modern Physics & Introduction to Quantum Mechanics	3
CLAR Courses	25	Computational Physics	3
Composition & Critical Thinking	6	Quantum Mechanics/ Physics Elective	3
Electives	12	Physics 490	0
		Introduction to MatLab®	3
		Engineering Mechanics	3
		Electronics	3
	Total 120		

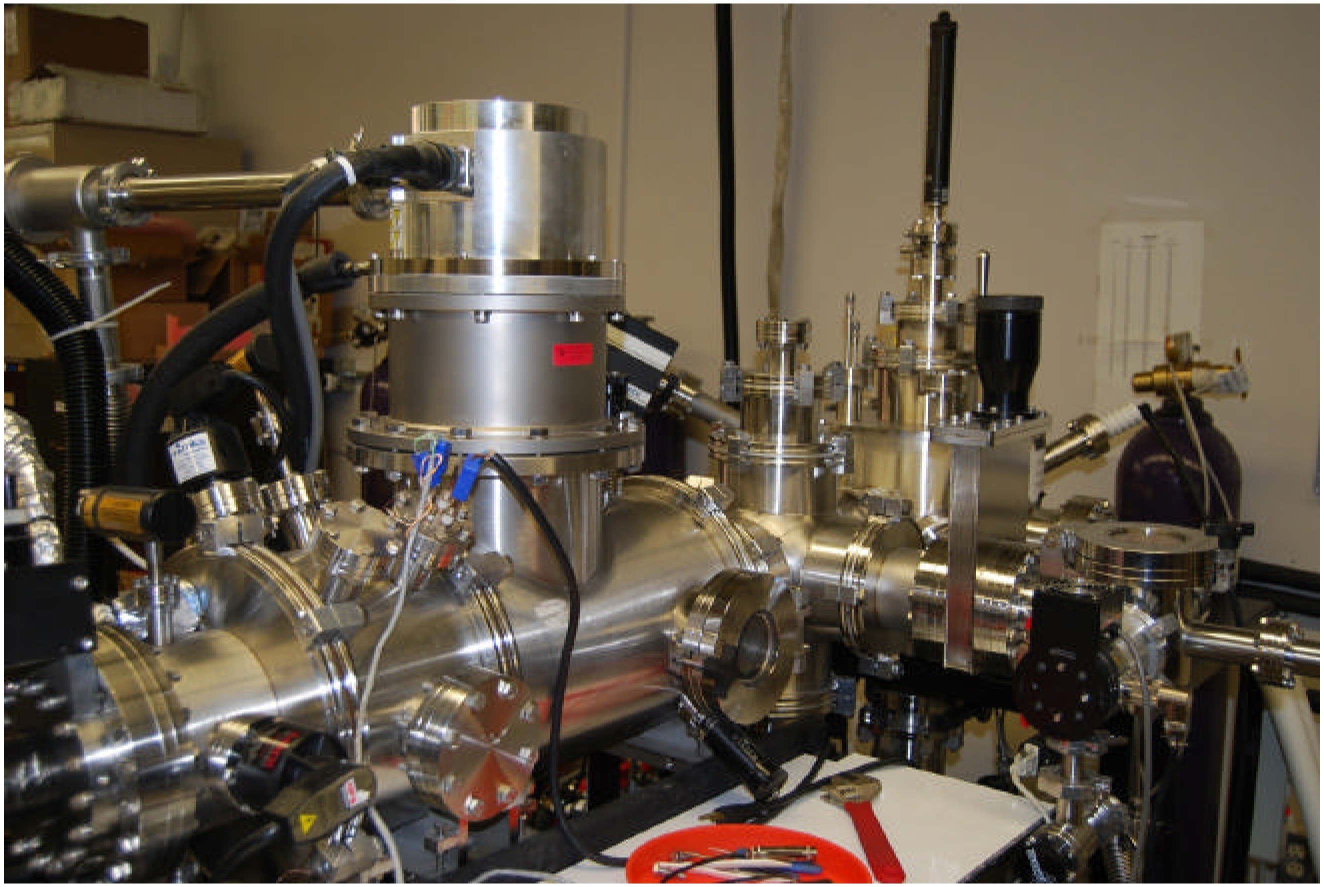
Real Experience

Through Internships and through the NSF-funded Research Experience for Undergraduates Program

Here are some sample REUs:



Magnetic Nanoparticles

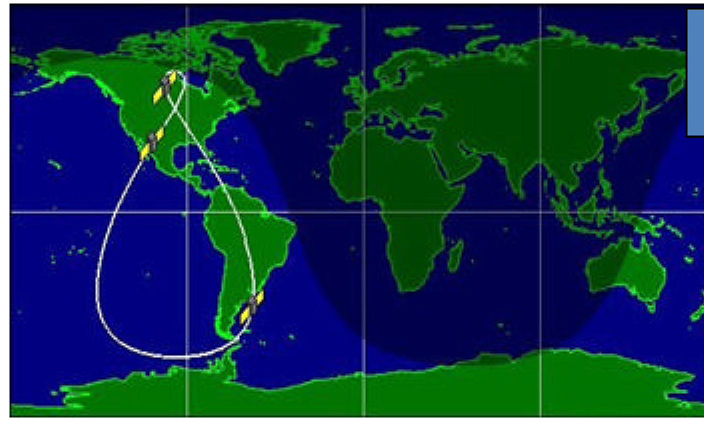


University of Idaho

Jacob Donius

M. Kaur, H. Han, Y. Qiang

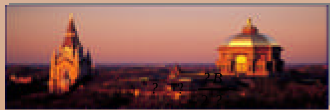
Sirius Satellite Orbit



Boxes: Closed and Open

My Project

- Measuring the performance of a representative sample of Sirius radios with respect to their ability to detect a good quality signal(volume and clarity) as a function of location as recorded by GPS
- Built seven boxes with seven different types of Sirius radios to test serviceability
  - Used different models and years of the radios so the information gathered would apply to the entire driving public
  - Had to build boxes so that all seven radios could run at the same time and test how well each was getting service when driven through the streets before FM5 starts transmitting and again after it is in operation



Ferromagnetic Resonance Measurements on Thin GaMnAs Films

By Kevin Miller

Department of Physics, Saint Bonaventure University, Saint Bonaventure, NY 14778

Introduction and Motivation

- Ferromagnetic semiconductors have been under intense investigation because of the likelihood of their "spintronic" applications
- Understanding of magnetic anisotropy in these materials is of critical importance
- Our motivation is to see whether the magnetic anisotropy of $Ga_{1-x}Mn_xAs$ depends on layer thickness
- For this purpose we use ferromagnetic resonance (FMR), which is a powerful method for studying magnetic anisotropy in thin ferromagnetic semiconductor films

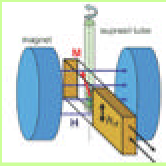
Semiconductors and Spintronics

Electron has spin and charge

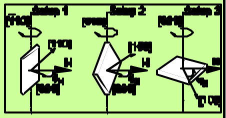
Coupling electron spin and charge leads to faster processing speeds and greater data storage (These devices take advantage of electron spin for memory

Experimental setup

EPR spectrometer



Microwave at 9.4 GHz



Rotating the sample to get the angular dependence of FMR at 4K and raising the temperature until T_c to get the temperarure dependence of FMR

Theoretical Model

- Stoner-Wohlfarth model

$$F = \frac{1}{2}M\left[-2H(\cos\theta\cos\theta_H + \sin\theta\sin\theta_H\cos(\varphi-\varphi_H)) + 4\pi M\cos^2\theta - H_{2\perp}\cos^2\theta - \frac{1}{2}H_{4\perp}\cos^4\theta - \frac{1}{2}H_{4\parallel}\frac{1}{4}(3+\cos4\varphi)\sin^4\theta - H_{2\parallel}\sin^2\theta\sin^2\left(\varphi-\frac{\pi}{4}\right)\right]$$

$H_{2\perp}$ – Perpendicular uniaxial anisotropy

$H_{2//}$ – In-plane uniaxial anisotropy

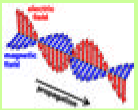
$H_{4\perp}$ – Perpendicular cubic anisotropy

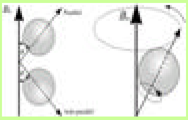
$H_{4//}$ – In-plane cubic anisotropy

$$\left(\frac{\omega}{\gamma}\right)^2 = \frac{1}{M_S^2\sin^2\theta}\left[\frac{\partial^2 F}{\partial\theta^2}\frac{\partial^2 F}{\partial\varphi^2} - \left(\frac{\partial^2 F}{\partial\theta\partial\varphi}\right)^2\right] \qquad \frac{\partial F}{\partial\theta} = 0 \qquad \frac{\partial F}{\partial\varphi} = 0$$

Theory Behind FMR

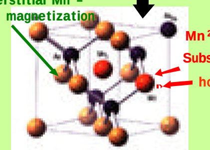
Probes Magnetic moment of electron
Microwaves Shot at Sample to disturb alignment of magnetization



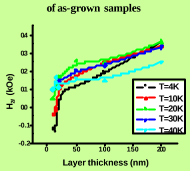


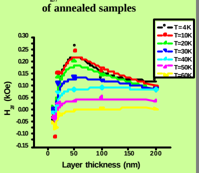
Mn Substitution and Mn Interstitials

Zinc Blende Structure



In-plane uniaxial anisotropy $H_{2//}$ of as-grown and annealed samples

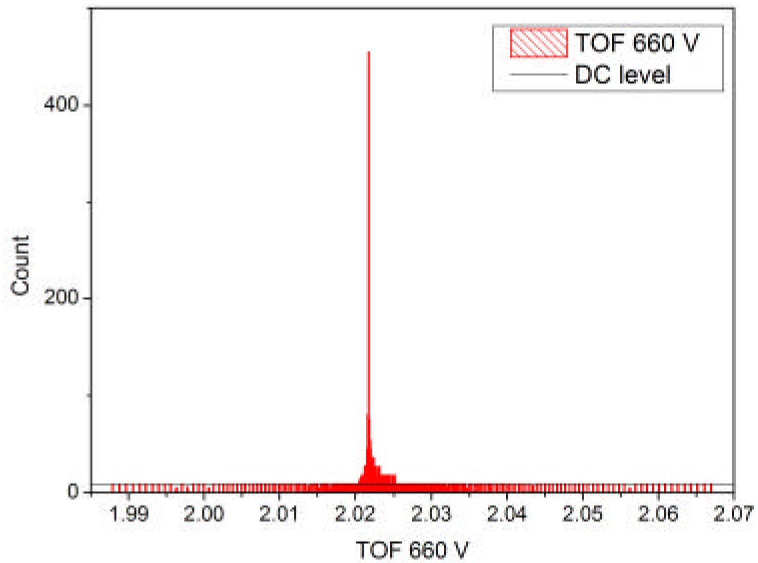


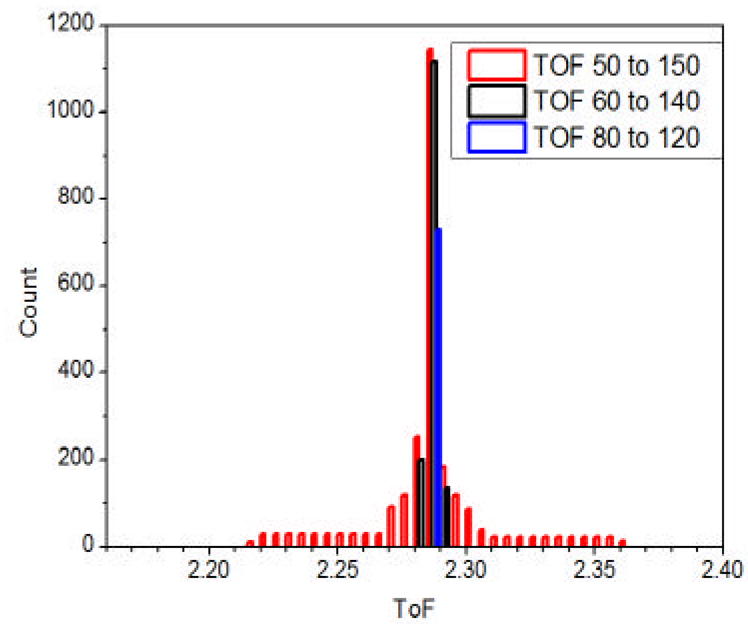


Conclusions

Surface anisotropy plays an important role in thin GaMnAs samples
In-plane uniaxial anisotropy strongly depends on sample thickness
Curie Temperature around 170K, Room Temperature is 293K
FMR remains a powerful technique

Pulse Duration





Ion Beam Bunching

By: Mary Harner, Itzik Ben-Itzhak, Kevin Carnes, and Ben Berry
Kansas State University

NEGATIVE MAGNETOCAPACITANCE IN SCHOTTKY BARRIER

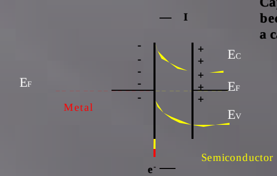
Department of Physics at St. Bonaventure University
Research performed at the University of Florida, Summer 2007

OBJECTIVES FOR RESEARCH

WHAT IS A SCHOTTKY BARRIER?

- A Schottky barrier is formed here between a metal and a semiconductor. In this research a gallium arsenide sample was used as the semiconductor.

Capacitance is measured because, as you can see, a capacitor is formed.



SO WHY DID WE LOOK AT SCHOTTKY BARRIERS?

- They are common in semiconductor based industry.
- You can do a lot more with them because they are nonlinear and function like a one way valve.
- The sensitivity of Schottky devices to externally applied magnetic fields has not been studied.

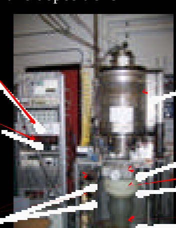
FABRICATION OF SAMPLE

Sonicator

- Used to clean the sample

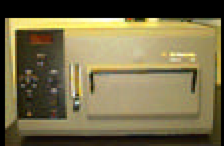
The "Miller"

- Used to make depositions



- After being cut the gallium arsenide sample is first cleaned in a sonicator. Then the "Miller" system is used to make depositions of palladium, germanium, titanium, and gold. A rapid thermal annealing oven anneals the sample. After a second deposition of gold, the physical properties measurement system is used in conjuncture with the program Lab View to take data.

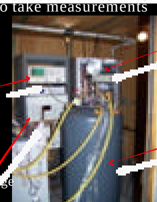
Rapid Thermal Annealing Oven



- Sample annealed at 400 C for 15 seconds

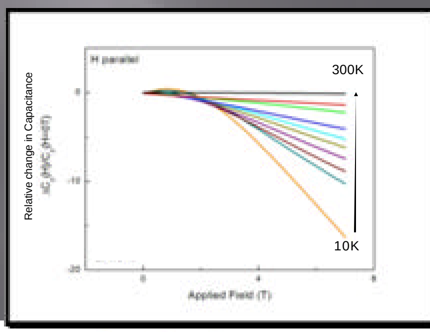
Physical Properties Measurement System

- Used to take measurements



NEGATIVE MAGNETOCAPACITANCE

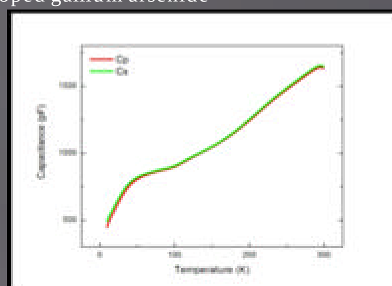
- Magnetocapacitance refers to the idea that the capacitance is dependent on the magnetic field. Negative refers to the negative slope, as seen below.
- Negative magnetocapacitance without directional dependence was found to be the same in three samples.



FINISHED SAMPLE

CAPACITANCE SHOWED FREEZE OUT

silicon doped gallium arsenide

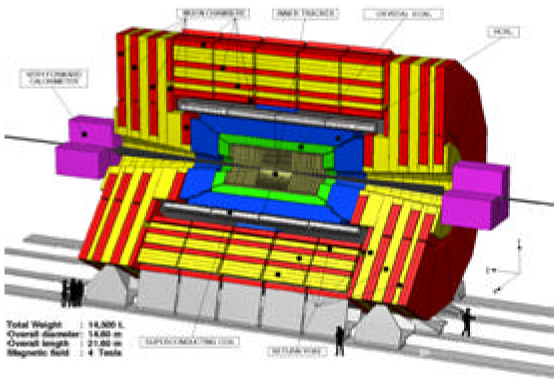


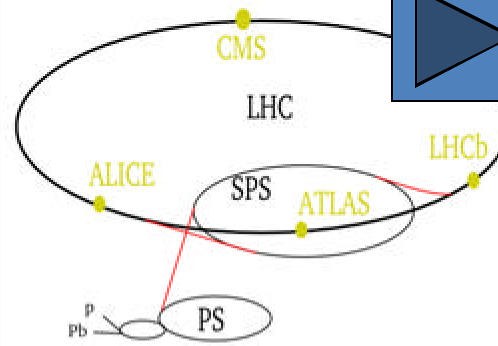
CONCLUSIONS FROM RESEARCH

- Negative magnetocapacitance
- No directional dependence
- The hope is that this may be useful for understanding the nature of Schottky barriers.
- Understanding the sensitivity of Schottky devices to externally applied magnetic fields could impact computer circuitry.

Histogramming algorithm for muon standalone reconstruction in the CMS detector

Troy Mulholland '11
REU Advisor: Dr. Ivan Furic
Department of Physics, University of Florida



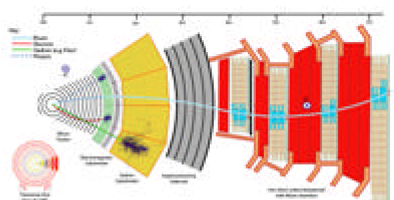


INTRODUCTION

- The Large Hadron Collider is set to produce 7 TeV proton beam energies by this summer.
- This beam energy is 7 times the previous record set by the Tevatron; however, this increase in energy introduces the obstacle of particle showering.
- The present muon reconstruction algorithms can be easily confused by additional detections generated by a shower.
- We propose a histogramming algorithm to account for the additional showering effects.

THE MUON CHAMBERS

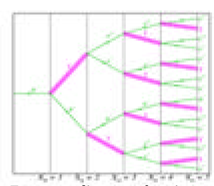
- The muon chambers are composed of 4 stations separated by iron shielding.
- Each station has 3 superlayers: 2 measure perpendicular to the beam and 1 measures the parallel coordinate.
- Each superlayer has 12 rows of drift tubes.



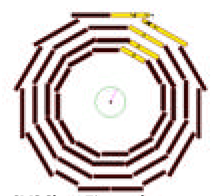
Cross-sectional view of the detector with muon chambers in view

PARTICLE SHOWERING

- A highly energetic particle through a medium will emit a photon through a process called Bremmstrahlung. The photon then interacts with matter producing an electron positron pair through a process called pair production.
- The muon has enough momentum so that it is not deflected by this process; however, the secondary electrons and positrons will induce detections in the drift tubes



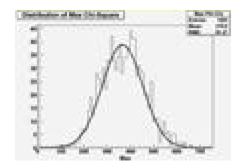
Feynman diagram showing a muon showering



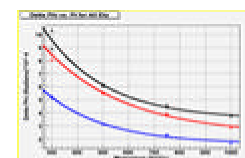
CMS Show Fireworks showing a muon showering

PERFORMANCE AND SEEDING

- A good event records a maximum of 200 or higher. If we extract the maxima from several events, we can study the efficiency of the algorithm. The curve is Gaussian showing a 97% chance the event will record a maximum of 200 or higher.
- In order to implement the algorithm for future studies, we need to know the direction and momentum of the particle. This is called a seed. The direction is known from the maximum of the event; the momentum is found by obtaining the change in phi angle across the stations.



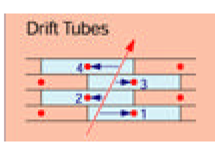
Maxima from 1000 events recorded and plotted above



Change in phi angle across the stations

THE DRIFT TUBES

- The drift tubes are composed of a long hollow negatively charged tube with a positively charged wire running along its center.
- Charged particles strip electrons off of atoms of the gas in the tube creating a small current we detect. This is called a "hit"

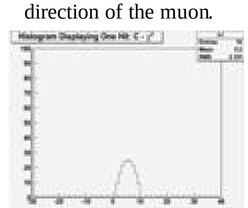


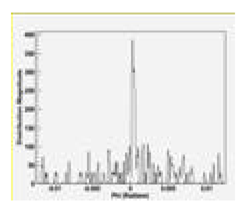
For simplicity, the drawing to the left depicts the drift tubes having a rectangular cross section; however, the actual drift tubes in CMS have a hexagonal cross section

THE ALGORITHM

- The program was written in the C++ programming language using ROOT and CMS Software.
- By computing ?^{2} for each detection and plotting only when C - ?^{2} is positive, we spread out the resolution of the detection.
- When this is iterated over all hits, a spike results in the direction of the muon.

Example of one hit fit with the algorithm





Example of one event fit with the algorithm

CONCLUSION

- Higher LHC energies bring a closer look into new physics; however, they also bring the likelihood of muon showering.
- Our algorithm uses a histogramming technique to account for this showering.
- Future studies include putting the algorithm into a fitter so that further performance and efficiency studies can be done. Also, the same histogramming technique can be done to reconstruct muons in the cathode strip chambers of the endcap region of the detector.

Period Decrease in the Near-Contact Binary System UU Lyncis

Olivia Mulherin[1,2] and Eric G. Hintz[2]
St. Bonaventure University[1], NY and Brigham Young University[2], UT (REU Program)

Abstract

The near-contact binary UU Lyncis has a known decreasing period as the stars move closer together. We report 10 new times of primary minimum for this system from photometric data gathered from the BYU David Derrick 0.4-m telescope and BYU West Mountain Observatory 0.9-m telescope. Using this data we refine the period change for the system and examine a small oscillatory variation in the O-C diagram. The modified period change and interpretations of the small variations will be reported.

Figure 1. UU Lyncis, center, contains F-type and K-type components. RA is 09 15 31.00 and Dec is +42 42 12.0

Table 1. Data collected from BYU. The table includes observed and calculated primary times of minimum, as well as epoch.

E	O	Type	C	O-C
60911	54221.72914	CCD	54221.65	0.07646
61705	54593.68555	CCD	54593.61	0.07659
62433	54934.72275	CCD	54934.65	0.07578
62446	54940.81331	CCD	54940.74	0.07638
62448	54941.74979	CCD	54941.67	0.07594
62527	54978.75790	CCD	54978.68	0.07580
63225	55305.74279	CCD	55305.67	0.07645
63227	55306.68019	CCD	55306.6	0.07693
63242	55313.70576	CCD	55313.63	0.07562
66264	56729.60600	CCD	56729.31	0.29337

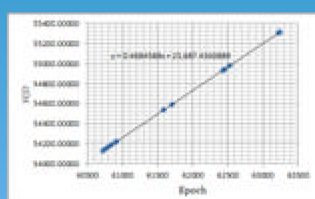


Figure 2. Graphing HJD Observed vs. Epoch allows us to a calculate refined period for UU Lyncis. This uses only the data points in Figure 1. The period of UU Lyncis is .4684588 days.

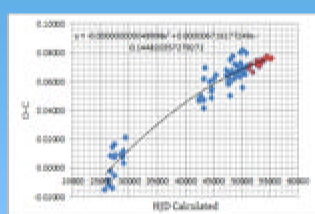


Figure 3 Graph of O-C Diagram vs. HJD Calculated using period found in Fig. 3. Red points show small oscillatory variation in diagram. The rate of change of the period is -4.8998e-11.

Observation and Photometry

The photometric data for UU Lyncis has been gathered from the BYU David Derrick 0.4-m telescope and BYU West Mountain Observatory 0.9-m telescope. Observations were taken using B and V filters. All of the data was reduced using IRAF's aperture photometry package. We used differential photometry to measure the magnitude of UU Lyncis.

Analysis

Using only the newest data points listed in Table 1., we refined the period for UU Lyncis in Figure 2., and created a new O-C diagram in Figure 3. For comparison, we also refined the period and created an O-C diagram using both the new and previously published data points in Figure 4. and Figure 5. The red points on the O-C diagrams include 10 new primary times of light minimum found at BYU, and appear to be sinusoidal. We tested this oscillatory variation for general relativistic effects using the post-Newtonian method for solving the two-body problem in general relativity, but the results were negligible. The next step is to observe UU Lyncis for a third star by taking and observing new data frames for a visible third star, and by observing its light curve's for transients . Figure 6. shows a light curve created using data from May 5, 2010, where a primary minimum occurred. The time where the minimum occurred appears to be flattened, and could mean that UU Lyncis experienced a total eclipse. The phase curve in Figure 7. shows that UU Lyncis's components are orbiting around each other quickly; there are smooth, curved transitions from eclipse to eclipse.

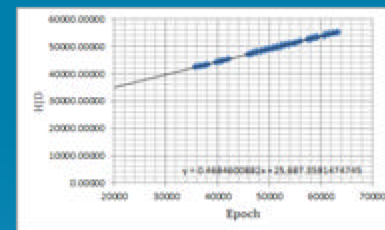


Figure 4. A graph of HJD Observed vs. Epoch using all data points for UU Lyncis. The period of UU Lyncis using all data points is .468460 days.

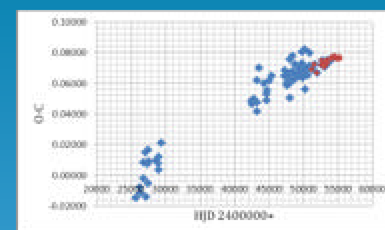


Figure 5. Graph of O-C Diagram vs. HJD Calculated using period found in Fig. 5. Red points show small oscillatory variation in diagram. The rate of change of the period is -4.4687e-11.

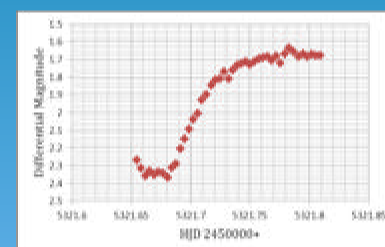


Figure 6. Light curve for UU Lyncis on May 5, 2010. Also seen in phase curve below. The flattened minimum could mean that UU Lyncis experienced a total eclipse.

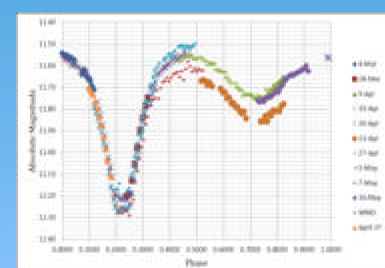
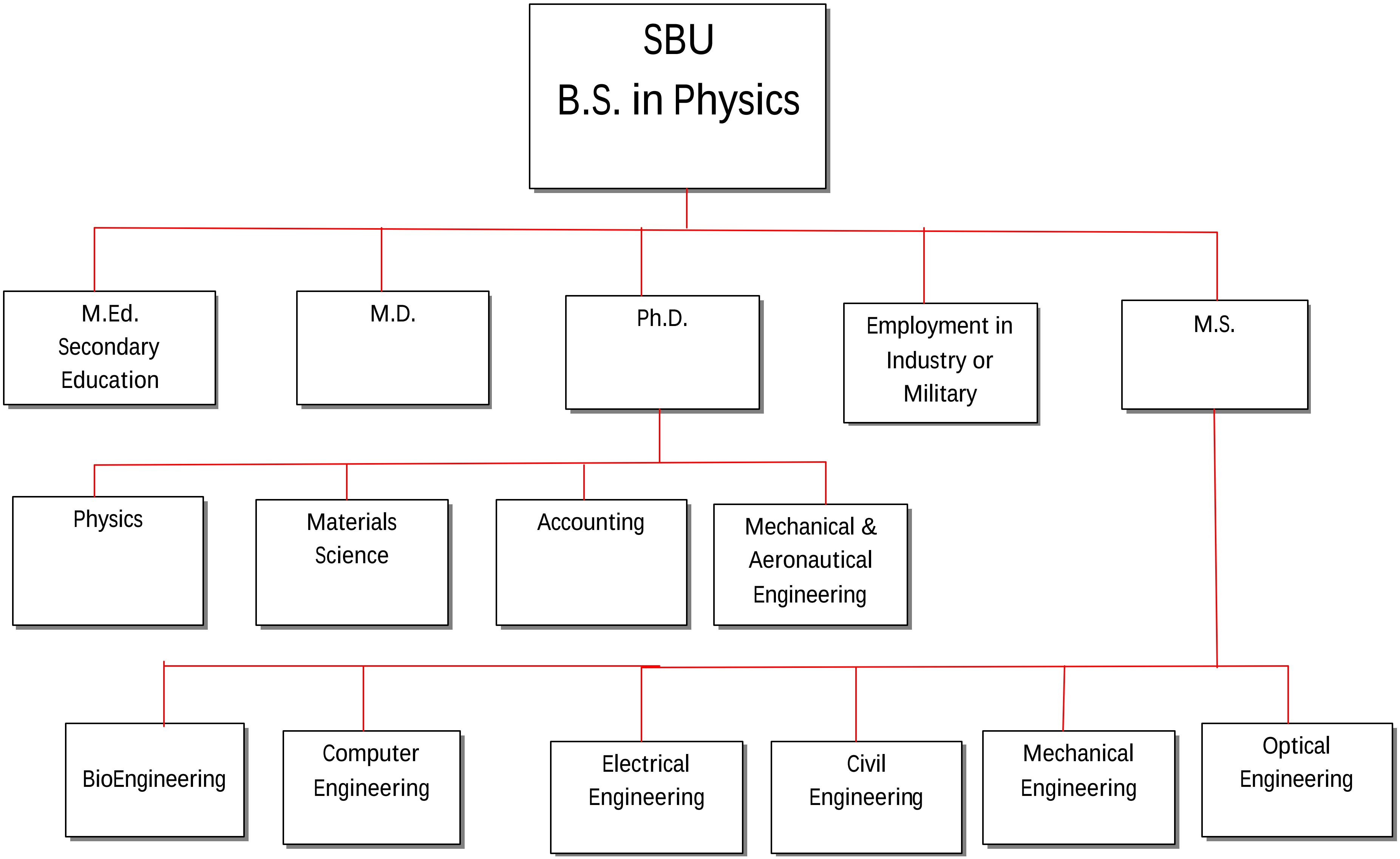


Figure 7. Phase curve for UU Lyncis for nights in 2010 using B and V filters

Where have we gone from here?



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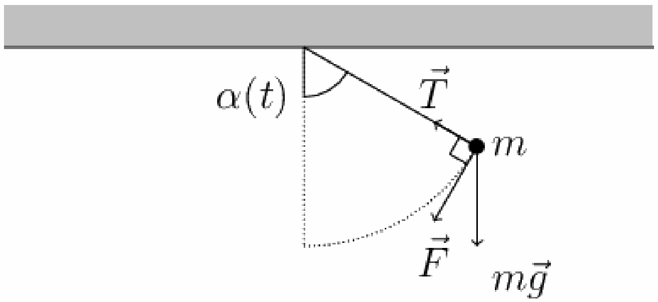

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