

# Graduate Orientation

Department of Physics  
Southern Illinois University Carbondale

By

Leo Silbert  
Saikat Talapatra

# Overview

## FACULTY

Ali, Naushad  
Byrd, Mark  
Chitambar, Eric  
Jayasekera, Thushari  
Mazumdar, Dipanjan  
Migone, Aldo  
Silbert, Leo  
Talapatra, Saikat

## Lecturers

Hendley, April  
K.V.Sajesh  
West, Rick

## UNDERGRADUATE

Bachelors of Science in  
Physics (~50 majors)

## GRADUATE

Masters of Science in  
Physics (15-20 students)

Doctor of Philosophy in  
Applied Physics (10-15  
students)

## STAFF

Baer, Robert  
McCann, Suzanne  
Pleasure, Sally  
McPhail, Patrick

## RESEARCHERS

Dubenko, Igor  
Fortescue, Ben

## Graduate Committee

### Prof. Talapatra (Chair)

Prof. Byrd  
Prof. Chitambar  
Prof. Migone  
Prof. Silbert

## Undergraduate Committee

### Prof. Jayasekera (Chair)

Prof. Byrd  
Prof. Chitambar  
Prof. Mazumdar  
Prof. Silbert

# Research Thrust

## APPLIED

Energy  
Environment  
Bio materials  
Sensors  
Lubricants  
Sequestered gas risk assessment

## NANOTECHNOLOGY

Semiconducting Nanowires  
Carbon Nanotubes & Graphene  
Bio-Hybrid Nanocomposites  
Nanosensors

## LOW TEMP/COND MATT.

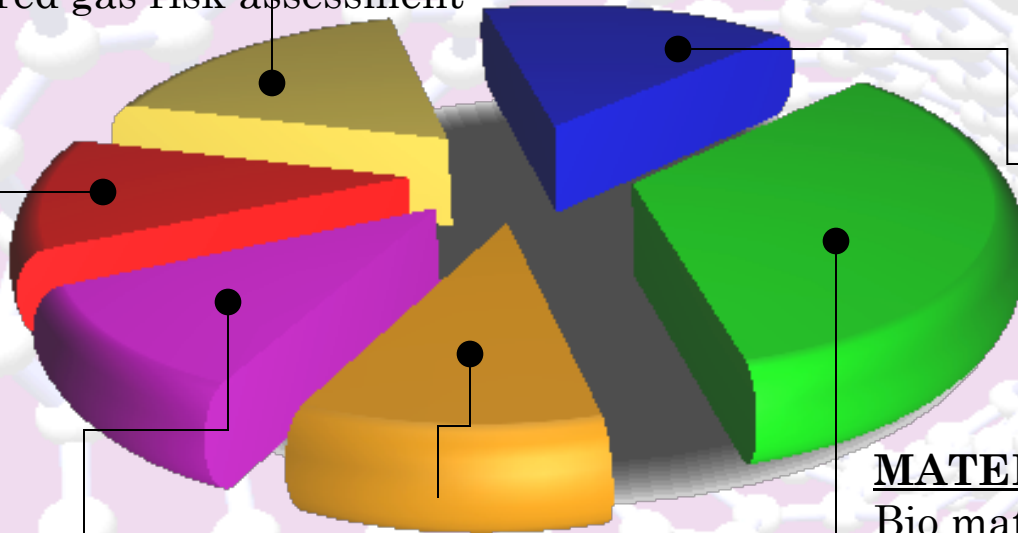
Phase Transitions  
Electrical Transport  
Magnetism  
Superconductivity  
Magnetocaloric Effect

## MATERIALS PHYSICS

Bio materials  
Composites  
Metal Oxides  
Magnetic  
Thin films  
Tribology

## THEORY & SIMULATIONS

Quantum Computation  
Quantum Information  
Amorphous Systems  
Molecular Dynamics  
Density Functional Theory





# Research

\$ 1,739,223 (Total 2009-10)  
\$ 1,518,064 (Federal)

## Year 2009

- *Patents: 2*
- *Publications: 36*
- *Presentations: 61 (Invited: 15)*
- *RA supported: 10*
- *Post-doc & researchers: 6*
- *Undergraduate researchers: ~ 6*
- *High school visitors: 2*

## Awards

- *APS Fellows*
- *John Wheatly Award (APS)*
- *NSF CAREER*
- *Goldwater Fellows*
- *Grad School Diss. Fellowship (2)*
- *Outstanding Diss. Awards (3)*
- *Dissertation Research Assistantship (1)*
- *NSF EAPSI Fellow (1)*

Quantum Computing

Theory & Modeling

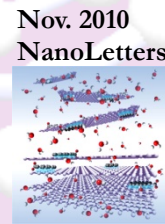
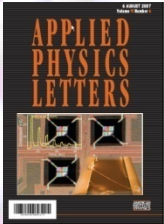
Nanotechnology

Composites & Bio-hybrids

Nanomaterials

Energy

- Intra departmental
- Inter departmental
- Across campus
- National Labs
- Across countries



# Experimental Groups & Facilities

Prof. Naushad Ali

Magnetoresistance & Magnetic Refrigeration

## Research Interests:

1. Use of Synchrotron Radiation in Magnetic and Superconductivity Studies
2. Colossal Magnetoresistance
3. Photoinduced Magnetization and Molecular Magnets
4. Permanent Magnetic Materials
5. Electrical, Magnetic, and Thermal Properties of Magnetically ordered Rare Earth Compounds
6. Study of Spin-Glass and Re-entrant Magnetic Phase Transitions
7. Valence Fluctuations, Heavy Fermion and Kondo Lattice in  $\text{YbSi}_2$ ,  $\text{CeSi}_x$ ,  $\text{UPt}_{1-x}\text{Pd}_1$  and like systems
8. Evolution of Mn Magnetic Moments in  $\text{RMn}_2$  (R=Rare Earth  $\text{Y}_{1-x}\text{R}_x\text{Mn}_2$  Systems)

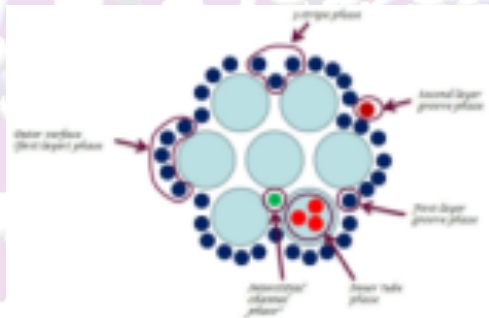


# Experimental Groups & Facilities

Prof. Aldo Migone  
Adsorption Phenomena

## Research Interests:

1. Gas Adsorption on Carbon Nanohorns
2. Gas Adsorption on Carbon Nanotubes
3. Kinetics of Gas Adsorption on Carbon Nanotubes
4. Gas Adsorption on Metal-Organic Frameworks



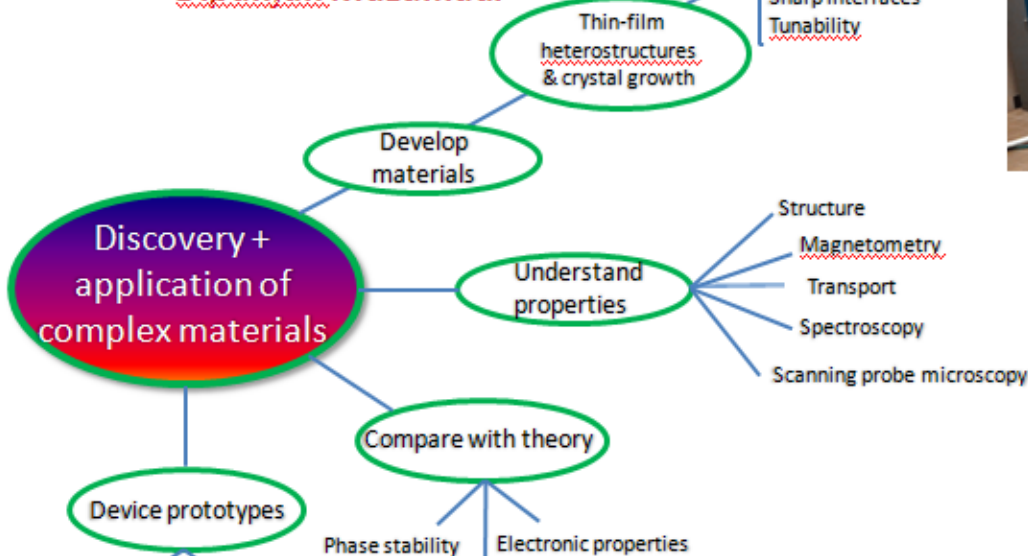


# Experimental Groups & Facilities

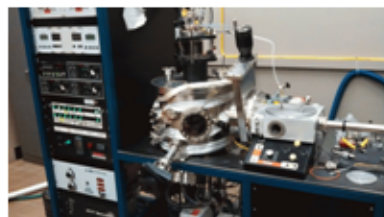
## Complex Materials and Heterostructures

Dipanjani Mazumdar

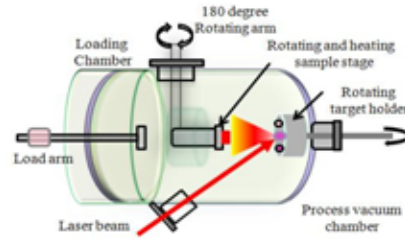
- Atomic level control
- Metastable phases
- Scaling behavior
- Sharp interfaces
- Tunability



### Sputtering

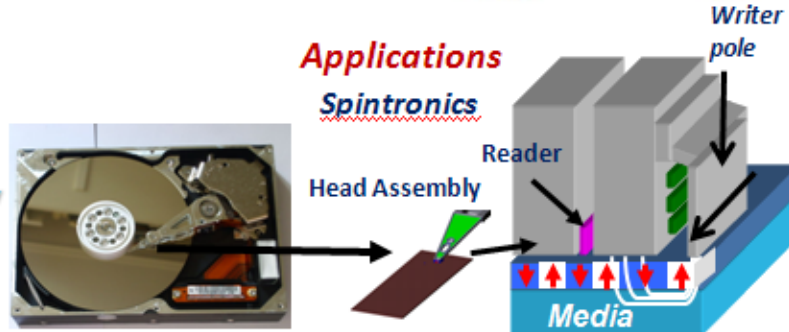


### Pulsed laser deposition



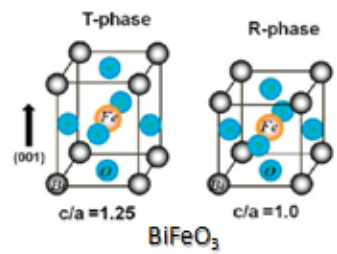
### Applications

#### Spintronics

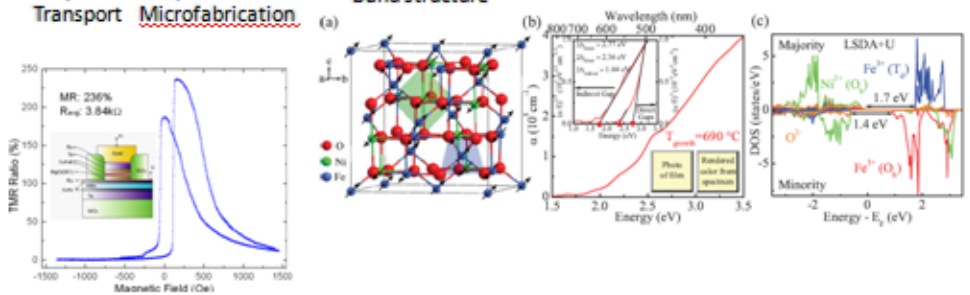
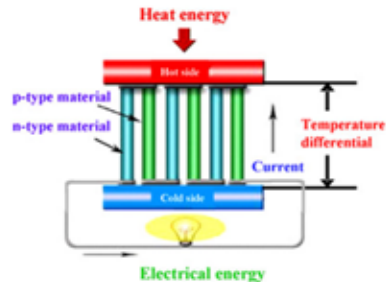


Hard drive reader is a spintronic device

### Photovoltaics

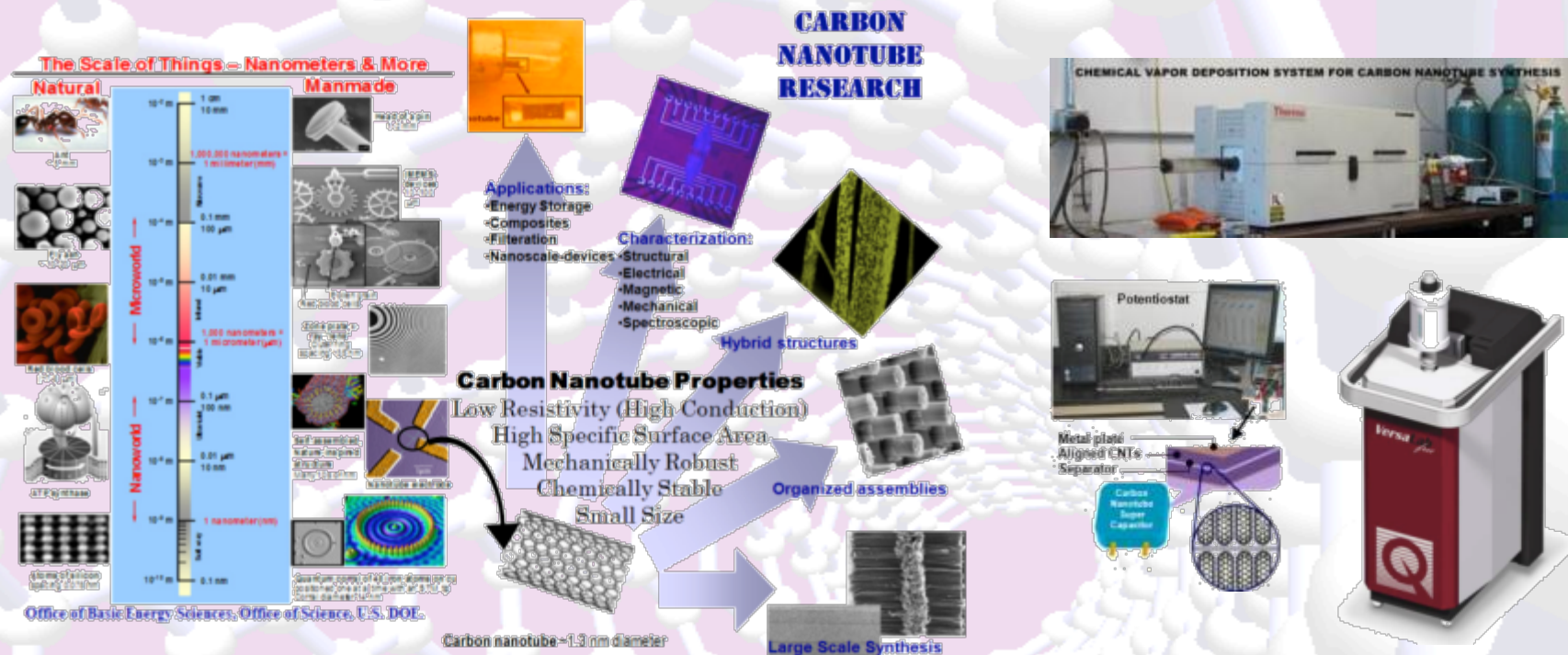


### Thermoelectrics



# Experimental Groups & Facilities

Prof. Saikat Talapatra



## Departmental Support

Physics Electronics Shop (Mr. Bob Baer)

Physics Machine Shop (Mr. Patrick McPhail)

Computer Labs

## Central Facilities

[Central Research Shop](#)

[Elemental Analysis Services](#)

[Genomics & Robotics Services](#)

[IMAGE](#) (advanced microscopy; computer graphics and photography, including conference posters)

[Mass Spectrometry Facility](#)

[NMR Facility](#)



Southern  
Illinois University  
Carbondale



# Theoretical & Computational Facilities



8 Node Intel Dual Xeon 2.8 Ghz

Faculty:

Prof. Byrd

Prof. Chitambar

Prof. Jayasekera

Prof. Silbert

A new computer cluster with approximately 36 nodes will be available by the end of the semester.



20 node Intel P  
IV 2.4 Ghz



24 Node Intel dual  
Xeon 2.8Ghz.

Windows + Linux dual boot machines, Mathematica License, etc...

# Theoretical & Computational Groups

Quantum Computing  
Prof. Mark Byrd

**Research interests:**

Quantum Computing  
Quantum Error Correction  
Quantum Information  
Quantum Control and  
Simulating Quantum Systems with Quantum Systems

**For More Information:**

E-mail: mbyrd at physics dot siu dot edu

Web: <http://www.physics.siu.edu/byrd/>

Personal web page <http://www.physics.siu.edu/~mbyrd>

Group web page <http://www.physics.siu.edu/qc>

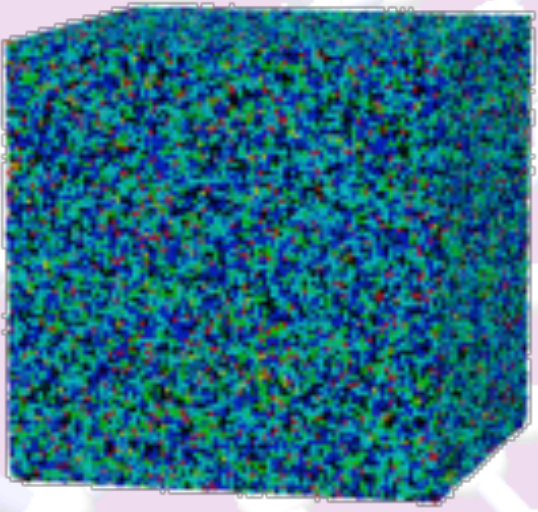
See also [Qunet](#) ●

Theoretical Soft Condensed Matter Physics  
Prof. Leo Silbert

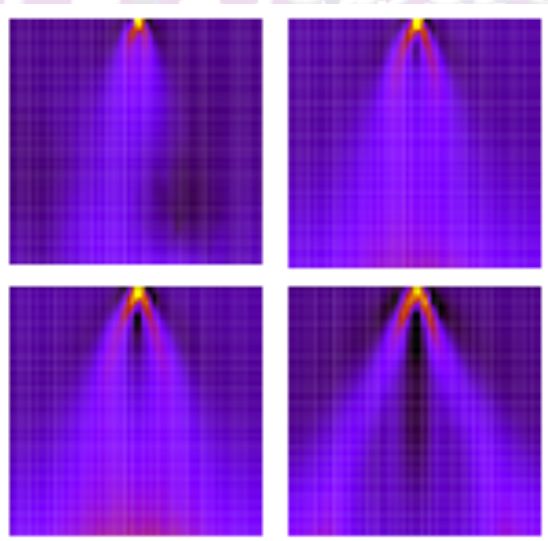
Research Interests:

structure ↔ mechanical properties ↔ dynamics ↔ driving mechanisms  
molecular dynamics simulations, liquid state theory, critical phenomena, elasticity theory

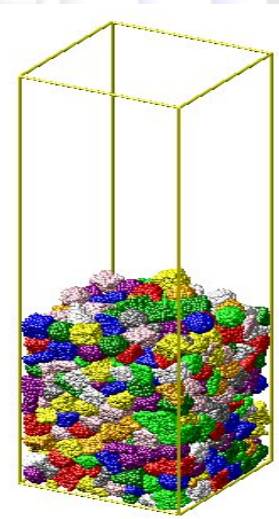
Jamming



Mechanical Response



Granular Materials





# Theoretical & Computational Groups

Nanotechnology with High Performance Computing

Prof. Thushari Jayasekera

Computational Materials Physics at SIUC

**What is it and Why?** Novel experimental techniques allow us to create materials at the nanoscale, where device properties are engineered by changing the atomic arrangement. Atomistic simulations are important at this scale, to explain existing experimental observations and/or predict new possible experiments for device applications.

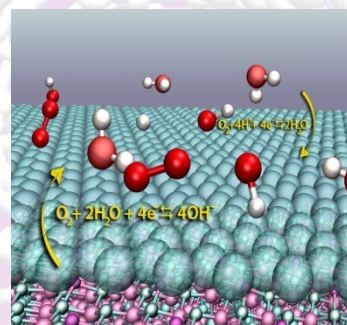
## Techniques

First Principles Density Functional Theory  
Density Functional Perturbation Theory  
Green's Function Technique, R-Matrix Theory  
Molecular Dynamics

## Current Research Projects

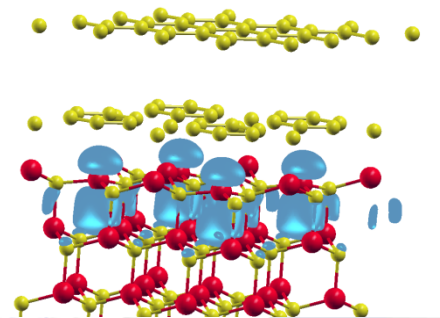
Electronic Structure Analysis, Thermal Management and Electron Transport of Epitaxial Graphene based Devices

## Our Recent Findings



Epitaxial Graphene goes n-p transition in the presence of Water molecules

Jayasekera *et.al*, PRB, 84, 035442 (2011)



Substrate Chemistry can be used to engineer the Electronic bands in Epitaxial Graphene

Jayasekera *et. al*, PRL, 104, 146801 (2010)

## Computational Challenge

In order to understand experimental observations, we need to simulate systems with a large number of atoms (with few hundred of atoms). Calculations become very intense. **Parallel Computing is Required**

## Computer Resources

A computer cluster with approximately 36 nodes will be available by the end of the semester.

# Theoretical & Computational Groups

Quantum Information Theory  
Prof. Eric Chitambar

## Area of research

Quantum information theory: As a relatively new field in science, quantum information involves the study of how quantum mechanical properties can be used in information processing tasks.

Research deals with the theory of quantum entanglement and its mathematical structure. In particular, :

- (i) what different forms of entanglement can exist in multipartite systems,
- (ii) in what meaningful ways can entanglement be quantified or measured,
- (iii) how can entanglement be manipulated by parties separated in different labs,
- (iv) what types of quantum correlations exist beyond entanglement.

A primary goal is to better understand how non locality and entanglement differ as resources in quantum information processing. This objective extends toward the construction of new protocols for quantum communication and cryptography that utilize the complex structure of multipartite quantum systems.

Additional areas of interest include computational complexity theory and physics education.

# Funding Support



National Science Foundation



US Department of Energy



Airforce Office of Scientific Research



Office of Research Development & Administration  
College of Science



Army Research Office





# So, **you** want to do a Physics postgraduate degree?

You have the following options:

Degree Options

**Mater's:** usually ~~2 years~~ **30 months**

**PhD program:** usually ~~4 years~~ **60 months** (from Master's)

**PhD program:** usually ~~4 years~~ **72 months** (direct admit)

Research degrees involve:

**classes:** 1-2 years graduate physics courses

**original research:** under guidance of faculty advisor

**thesis:** write up results into research papers

Coming soonish...

**Non-Thesis Master's degree involves:**

**classes:** 2 years graduate classes + lab experience

# What are the requirements?

[www.physics.siu.edu/programs](http://www.physics.siu.edu/programs)

## Class Requirements

Master's program: PHYS 500, 510, 520, 530

PhD program: PHYS 500,510,520,530,545,565,elective

**Remember:** your graduate school days are the last time anyone will provide you with direct instruction

When you are ready to defend your thesis:  
Give a **public defense in Neckers 440 at 4:00pm on a Friday**  
(Master's: 1 week / PhD: 2 weeks, before committee defense)

# Who pays for all of this?

## Graduate Assistantships

### TA (Teaching Assistantship)

- teaching undergraduate courses/labs
- grading undergraduate classes
- Help Desk

### RA (Research Assistantship)

- funded through internal/external grants/scholarships
- funding agencies expect returns
- your advisor is responsible to funding agency

**You are an integral part of the education experience for undergraduate students – be a mentor to your undergraduates**



# TA & Grading

## Consistency, Consistency, Consistency!!!

### PHYS 253/255 A

#### WEIGHTS:

Lab Report	60%
Pre-Lab	5%
Quizzes	20%
Exam	15%

#### SCHEME:

90.0 - 100 %	= A
80.0 - 89.9 %	= B
70.0 - 79.9 %	= C
60.0 - 69.9 %	= D
0.0 - 59.9 %	= F

#### ALL TAs - WHAT TO MAKE SURE OF....:

- ...each student is playing a role in the experiment
- ...walk around during the labs, quizzes, and pre-quizzes
- ...quizzes and labs graded in timely manner
- ...be clear when grading

# TA & Grading

## Consistency, Consistency, Consistency!!!

**PHYS 253/255 B**

<b>WEIGHTS:</b>	Lab Report	75%	<b>SCHEME:</b>	90.0 - 100 % = A
	Pre-Lab	5%		80.0 - 89.9 % = B
	Quizzes	20%		70.0 - 79.9 % = C
				60.0 - 69.9 % = D
				0.0 - 59.9 % = F

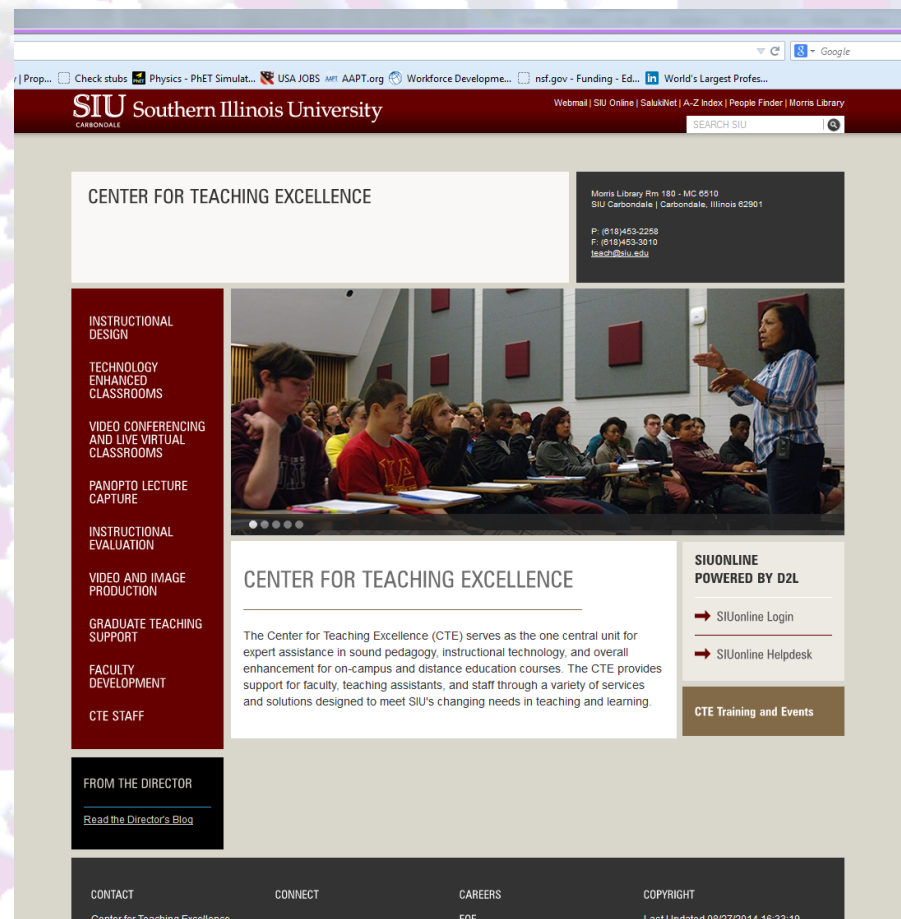
<b>FOLLOW THE RUBRIC</b>	SECTION	POINTS
	Apparatus and Introduction	15
	Results	25
	Discussion and Conclusions	25
	Error Analysis	20
	End of Lab Questions	15

WHAT TO **MAKE SURE OF IN B-LAB....**:

- ...use originality check in D2L
- ...read the student conduct code on plagiarism
- ...bring up any conduct code issue with the lab coordinator

# SIU Online (D2L) – What to Learn

- 253/5 A – assigning groups
- Grading within D2L
  - No need for adobe
  - Adding comments
- You can get help!!! -**Center For Teaching Excellence**
  - Delivery of content and learning activities in D2L
  - Instructional education
  - Graduate teaching support



The screenshot shows the SIU Southern Illinois University website. The header includes the SIU logo and navigation links. The main content area features a sidebar with a list of services: INSTRUCTIONAL DESIGN, TECHNOLOGY ENHANCED CLASSROOMS, VIDEO CONFERENCING AND LIVE VIRTUAL CLASSROOMS, PANOPTO LECTURE CAPTURE, INSTRUCTIONAL EVALUATION, VIDEO AND IMAGE PRODUCTION, GRADUATE TEACHING SUPPORT, FACULTY DEVELOPMENT, and CTE STAFF. The main content area has a large image of a classroom and a section titled 'CENTER FOR TEACHING EXCELLENCE' with a description of the center's mission. There are also links for 'SIUonline Login', 'SIUonline Helpdesk', and 'CTE Training and Events'.



# Time Management

- organize your responsibilities:
  - classes
  - research
  - teaching
- discipline yourself to work at each responsibility
- graduate homework is for learning technical skills and enhance understanding
- keep your advisor up-to-date with your progress

# What else can **you** do?

## General Knowledge

- join APS [www.aps.org](http://www.aps.org)
- sign up for daily updates from [www.arxiv.org](http://www.arxiv.org)
- browse journals once a week/month
- convince your advisor that conferences are useful

## Networking

- maximize time with colleagues at conferences
- volunteer presentations at local/national level

Participate in departmental and institutional  
student organizations

Thank You !

Questions ?