

Physics 496

Introduction to Research

Lecture 1.1: Research 101

Research is not like classes

In classes you learn about what's already known.

In research you are striving to create new knowledge.

In classes there are correct, known answers to problems.

In research you have to figure out the right question first and then struggle to show that your answer is correct.



“Physics” comprises many areas

- Astrophysics & cosmology
 - Study the largest structures in the universe, where they came from, how they evolved. Where did the universe itself come from?
- Atomic, molecular and optical physics
 - Studies of atoms. Fundamentals of quantum mechanics. Quantum information.
- Biophysics
 - Physics of biological molecules (protein folding, DNA...)
- Condensed matter physics
 - Physics of materials, superconductivity, device physics. Quantum information.
- High-energy physics
 - Fundamental constituents of matter and fundamental forces.
- Nuclear physics
 - Physics of nuclei (duh). At UIUC this also includes “medium energy” physics: quark-gluon plasma, muon g-2...

There are no walls between one area and another.

Life changes when you start doing research

- There may be no set schedule imposed on you from “outside.” Does that mean
 - a. You should work *all the time*?
 - b. You don’t have to work much at all?
 - c. Neither of the above.
- You are breaking new ground. Use your imagination and creativity in finding solutions. Part of science is *art*.
- Don’t be shy.
 - Talk to others and get advice. Ask about what they do.
 - Learn when to go for help.
- Be skeptical of your results and figure out ways to test them. Then...
- Believe in your results and learn to convince others they are right.
- ALWAYS within the context of appropriate ethical practices

Be open-minded about your area

This is a time to explore and learn. If you already have an idea of what area you want to work in, try to forget it this semester.

Apart from the different areas listed on slide 3, there is the question of theory or experiment. You've all been theorists so far—most of you won't be in the end.

Different strokes...

- Find something you're good at.
- Have fun.
- Don't settle for something that turns out not to be fun for you!

Resources for your exploration

- *Reading:* Physics Today (become APS member)
 - <http://focus.aps.org/>
- *Listening:* Colloquia; Saturday Physics.
 - Seminars when you may be ready to jump in.
- *Looking:* [Department Research web site](#)
- *Discussing:* Talk to profs & friends about their work

Find out what others are doing

American Physical Society (APS) <http://www.aps.org>
especially <http://physics.aps.org>

Divisions

[Atomic, Molecular & Optical Physics \(DAMOP\)](#), [Astrophysics \(DAP\)](#), [Biological Physics \(DBP\)](#), [Chemical Physics \(DCP\)](#), [Computational Physics \(DCOMP\)](#), [Condensed Matter Physics \(DCMP\)](#), [Fluid Dynamics \(DFD\)](#), [Laser Science \(DLS\)](#), [Materials Physics \(DMP\)](#), [Nuclear Physics \(DNP\)](#), [Particles and Fields \(DPF\)](#), [Physics of Beams \(DPB\)](#), [Plasma Physics \(DPP\)](#), [Polymer Physics \(DPOLY\)](#)

Forums

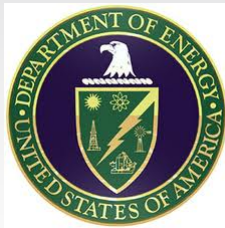
[Education \(Fed\)](#), [Graduate Student Affairs \(FGSA\)](#), [History of Physics \(FHP\)](#), [Industrial and Applied Physics \(FIAP\)](#), [International Physics \(FIP\)](#), [Physics and Society \(FPS\)](#), [Forum on Outreach and Informing the Public \(FOEP\)](#)

Topical groups

Energy research, Quantum information....
These groups have newsletters, homepages, lots of output.
You need to be an APS member.
It's free for students for the first year ... and you get *Physics Today*

Paying the bills

Your research advisor will have funding from the government:



Funding can cover equipment, travel, publication costs, salaries/stipends, tuition—and fringe benefits (health, retirement..) and overhead to the University (lights, heat, power...)

Professors typically spend a lot of time writing proposals for funding. Often these are in response to a Request for Proposals (RFP) in specific areas.