Seminar on Current Problems in Physics
(Physics 494)

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Phys 494 course aims:

• Explore a research topic in physics in depth!

• Learning objectives:
  • Talks and presentations
  • Technical writing
  • Preparation of figures and captions
  • Review and critique scientific work

• Hear about many interesting topics in modern physics through student presentations
Phys 494 Grading

• Grading:
  • Add up points from assignments = raw grade
  • I will assign talk dates at the end of the second week.

• And…
  • There is no final exam.
  • A grade of 0.0 for not completing paper, figure & talk
  • Attendance is required
General advice for Phys 494

• Participation in class discussions is required and hence you should attend.

• You are encouraged to attend the Physics Colloquium.

• Select a research topic early.

• Start your literature research early.

• Schedule your talk early in the quarter.

• Begin preparing your paper as early as possible.
Many slides and materials from D. Hertzog & co

- Credit (but no blame) to D. Hertzog *et al.*

- His style is not my own (taste matters)

- Basic rules for presenting scientific results are pretty consistent…

- … you *can* break the rules… but know what they are.

- I’ll try to draw attention to cases where David and I disagree.
Persuasion in *science*???

Yes, we really do use persuasion in science

The power of logical organization

Establishing credibility

The ethics of persuasion

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*In science, the credit goes to the man who convinces the world, not to the man to whom the idea first occurs.*

—Sir Francis Darwin
The first “persuader” was not an advertiser, he was a scientist.

- **logos**
  - facts, reason, evidence

- **ethos**
  - trust, reliability

- **pathos**
  - enthusiasm, excitement
Build a logical case (*logos*)

First, decide what conclusion you want your “audience” to reach.

Make a list of all the important points that the audience must know.

Marshall supporting facts and explanatory information.

Arrange the main points and supporting details in a logical order, so that each moves the audience incrementally closer to the desired conclusion (outline!)

Create “sign posts” to guide the reader.
Use the four-step text builder to incorporate logical structure in your writing

1. State the main point.
2. Explain it.
3. Give an example of it.
4. Summarize it in a way that logically transitions to the next main point.

Use the same construction method for paragraphs, subsections, and sections of your paper or talk.
Logical exposition reveals the relationship between ideas and data

Use precise, descriptive language

State assumptions and inferences explicitly and provide supporting detail

Provide transitional statements to tie ideas together

Position arguments strategically
Add authority to your arguments (ethos)

Establish your credibility by demonstrating your familiarity with the problem (background and introduction section)

Cite the work and opinion of experts (references)

Don’t overstate your claims or force your data (results section)

Anticipate questions and objections and candidly discuss opposing views (discussion section)
Present all sides of an argument

Be candid about shortcomings, limitations, or weaknesses

Increase your credibility by demonstrating your objectivity

Neutralize objections by anticipating and answering them

Evenhandedness is particularly important if your method or results are controversial
Reciting “facts” is not sufficient (pathos)

Facts must be assembled into arguments

Adapt to your audience; consider understanding, perceptions, and motivation
Don’t underestimate the persuasive power of illustration

“As for a picture, if it isn’t worth a thousand words, the hell with it.”

Ad Reinhardt, artist
What is Research?

Up to now in school, you’ve concentrated on learning all that is known in science. In research, you strive to *discover* what is not.
Science is the New Frontier for Discovery!

**Areas of Exploration in Physics:**

- **Astrophysics** - Physical processes of planets, stars, galaxies,…

- **Atomic and Molecular Physics** - Physics of atomic or molecular systems

- **Biophysics** - Physical processes of biological molecules

- **Condensed Matter** - Physics of materials, solid phases of matter

- **Quantum Information** - Study/Exploitation of quantum ‘wierdness’

- **Nuclear/Medium Energy Physics** - Physics of atomic nucleus, muons, protons, neutrons, other particles

- **Particle/High Energy Physics** - Study of the fundamental constituents of matter
Research has a different style than the academic life you’re used to!

**Less structured**
There are no timescales for getting the right answers, no solution manuals, and no true ‘authority’ figures (more on this later)!

**“You’re looking for a white what, Ahab?”**
Can be akin to a quest or a mission, tedious and frustrating at times, but sprinkled with moments of exhilaration

**More ‘creative’**
To “go where no one has gone before” in science, it helps to be able to think outside the box

**Requires personal interactions**
You need to deal with collaborators, reviewers, program directors of funding agencies, etc., etc.

**Requires a certain degree of salesmanship**
Science has been called the “marketplace of ideas,” and you need to be able to sell your results and ideas effectively
Some thoughts on choosing a research topic

Which one are you?

New $e^+e^-$ Data
New $\tau$-only Data

$\alpha_\mu \times 10^{10}$
Exploring the “research” side of your brain

How do I choose a research area?

You must begin to educate yourself by

Reading: Physics Today (become APS member)
http://focus.aps.org/

Listening: Colloquia; Saturday Physics;

Discussing: Talk to friends about their work

How do I know if the research is interesting?

Is it interesting to me?

Time: I will have to spend a lot of time doing this

Effort: All research is “hard”

Enjoyment: I’ll do better if I like what I am doing
Is the work interesting …

Is it interesting *to others*?

Does your work affect others?

How large is the “circle of influence” of what you do?

Does anyone care?

**Bottom line:** You must ultimately develop your own judgment about what is interesting and important!

Unimportant research vs. Unappreciated research

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Ray Davis—Nobel prize for measuring solar $\nu$ deficit

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What are other people doing?

American Physical Society (APS)

Main structure: Divisions

Topical groups
- gravity, hadron physics, precision measurement, lots more

These groups have newsletters, homepages, lots of output

You need to be an APS member. We’ll supply forms.
- It’s free for students for the first year
- … and you get Physics Today

http://www.aps.org

Nobel prize winners for BEC
How to find out what are other people doing

Meetings, reports and long-range plans

- NSAC (nuclear science advisory comm.) 10 yr plan
- HEPAP (high-energy physics advisory panel) 20 yr plan
- NSF (National Science Foundation) strategic plan
- NAS (National Academy of Science) strategic plan
- DOE (Department of Energy) strategic plan
- Astrophysics decadal plans for new instruments

New major instrumentation construction

- LIGO (Laser Interferometer Gravitational-Wave Observatory)
- SNS (Spallation Neutron Source; materials science)

Initiatives and Trends

- Nano-technology (very hot area in many departments)
- Biophysics (exploding, cross disciplinary field)
- Major computer developments - lattice QCD, etc. modeling
- Atomic physics: Bose-Einstein Condensation
- Quantum Information
Financial Support is loosely tied to “Interest”

Now, this is hot!!

National Science Foundation
Department of Energy
NASA
National Institutes of Health

See what the “Request for Proposals” brings (RFP)
Flow of funds and people gives a feeling of where new thrusts will be for the emerging, young scientist
What do you do now??

Start exploring your options

Try a research area and see if you like it

   Embrace this new direction in your life!  Dive in!

Experiment or Theory??

Different styles:  big collaborative project or small individual project

Ultimately, you should pursue research that most interests you