Seminar on Current Problems in Physics

(Physics 494)

w/ Paul A. Wiggins

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 Technical Communications

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Persuasion in *science*????

- Yes, we really do use persuasion in science
- The power of logical organization
- Establishing credibility

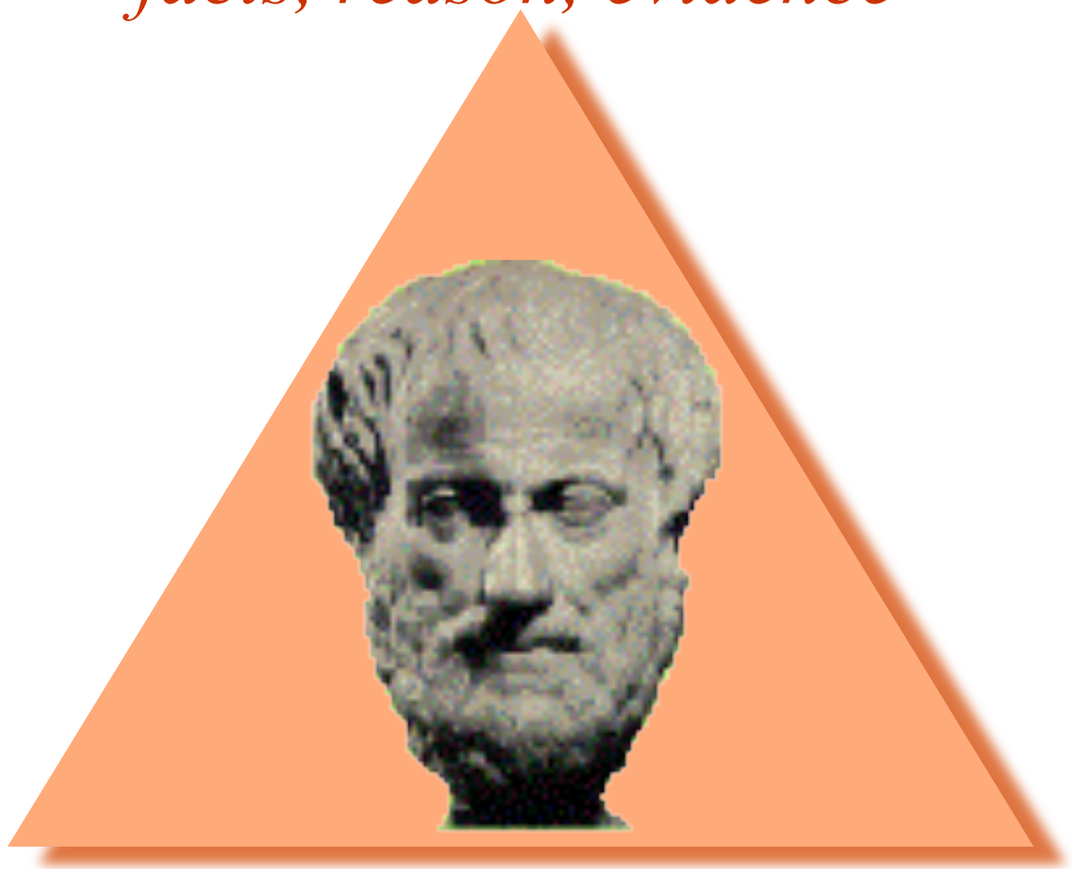
The ethics of persuasion

> **In science, the credit goes to the ~~man~~ person who convinces the world, not to the ~~man~~ person 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*)

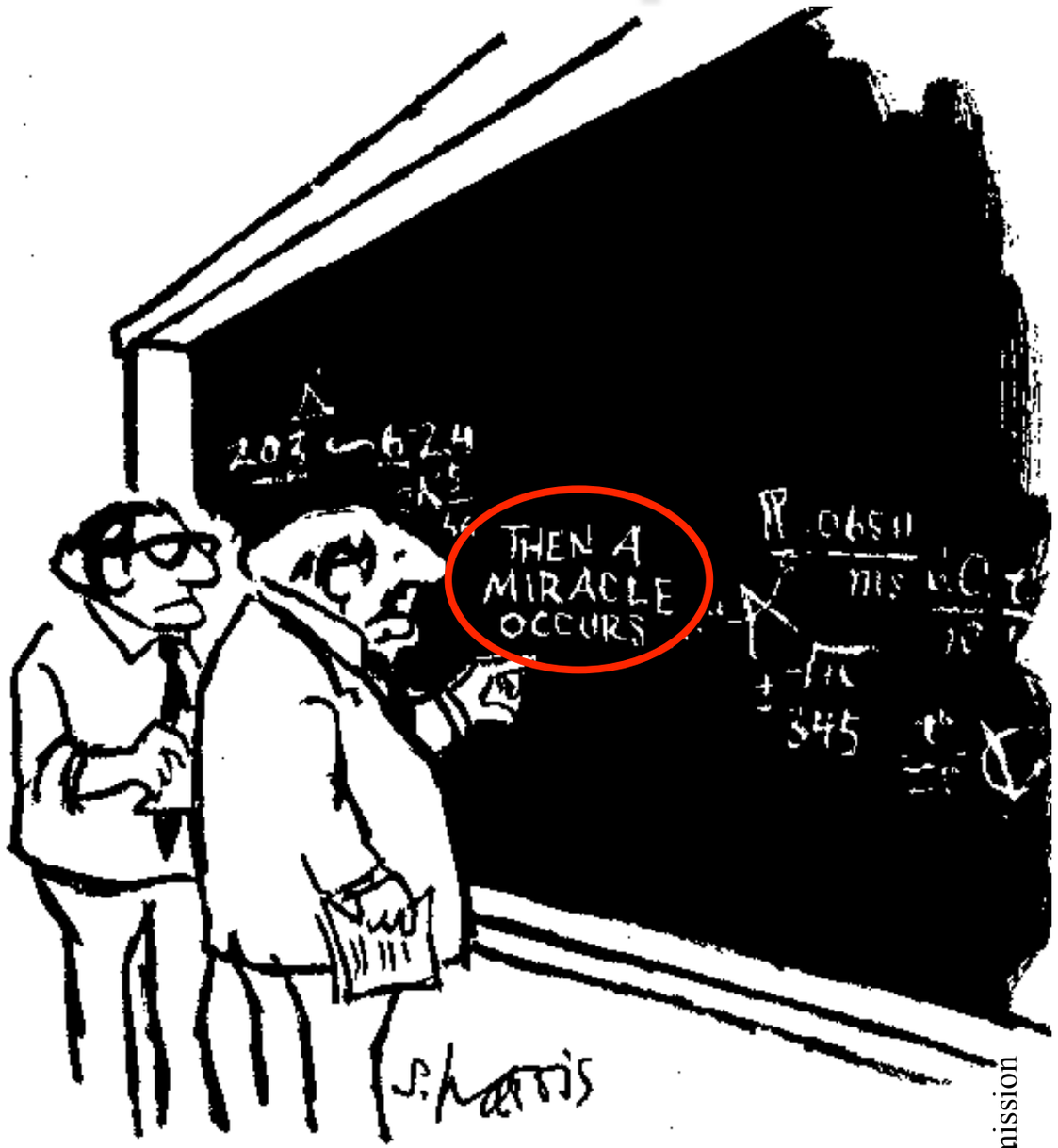
- First, decide what conclusion you want your "audience" to reach
- Make a list of all the important points that the audience must know
- Marshall supporting facts and explanatory information
- Arrange the main points and supporting details in a logical order, so that each moves the audience incrementally 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



Used with permission

- Use precise, descriptive language
- State assumptions and inferences explicitly and provide supporting detail
- Provide transitional statements to tie ideas together
- Position arguments strategically

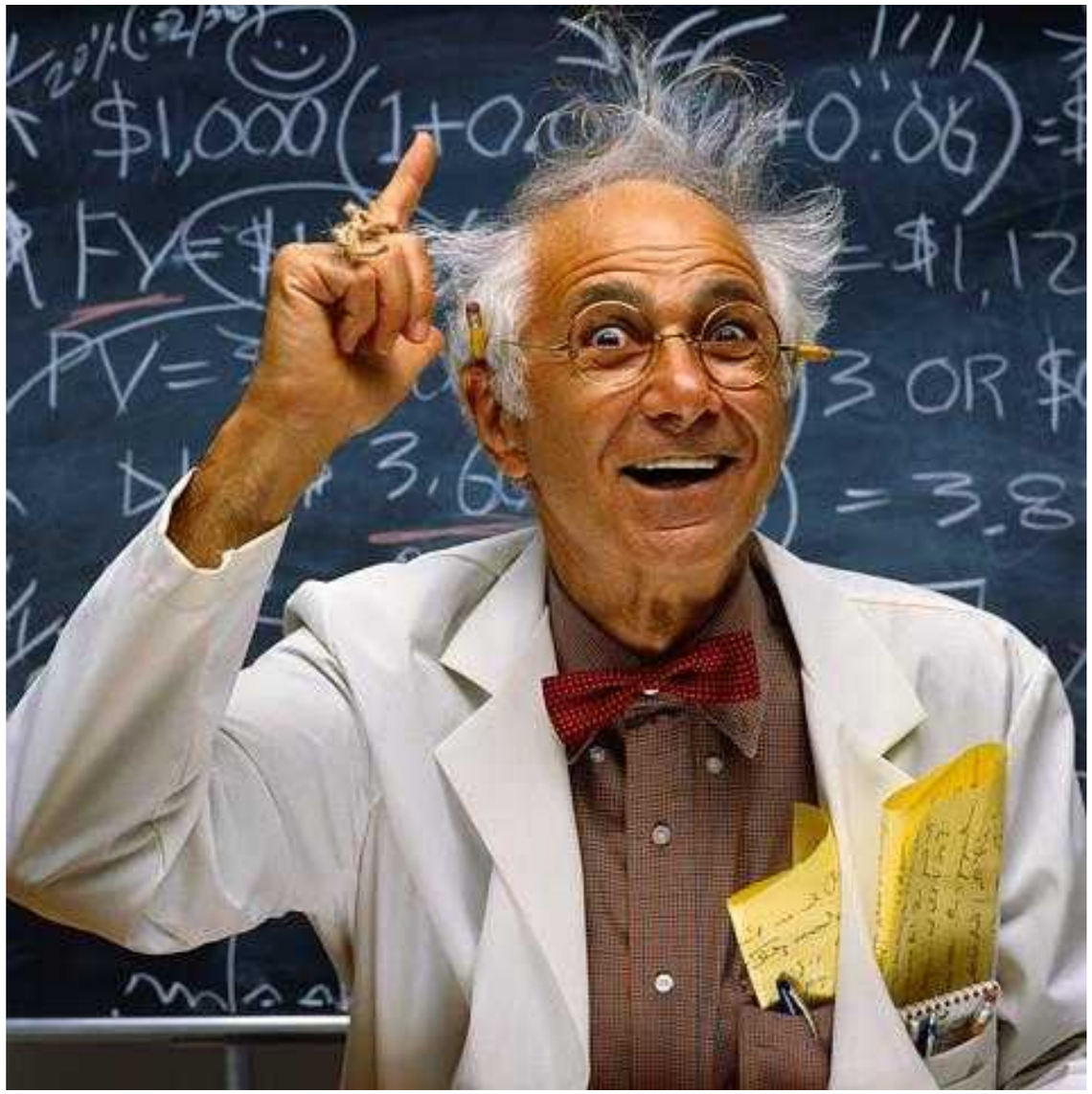
Add authority to your arguments (*ethos*)

- 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

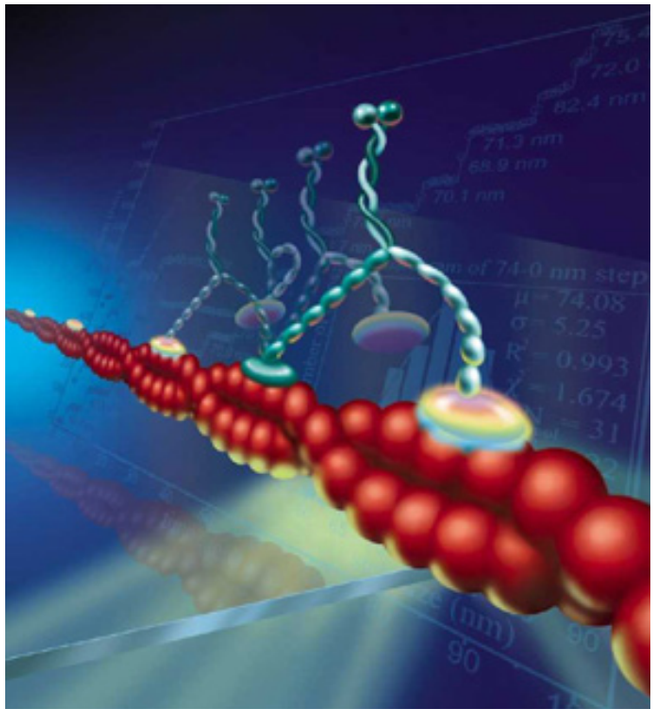
Reciting "facts" is not sufficient (*pathos*)



Facts must be assembled into arguments

Adapt to your audience; consider understanding, perceptions, and motivation

Don’t underestimate the persuasive power of illustration



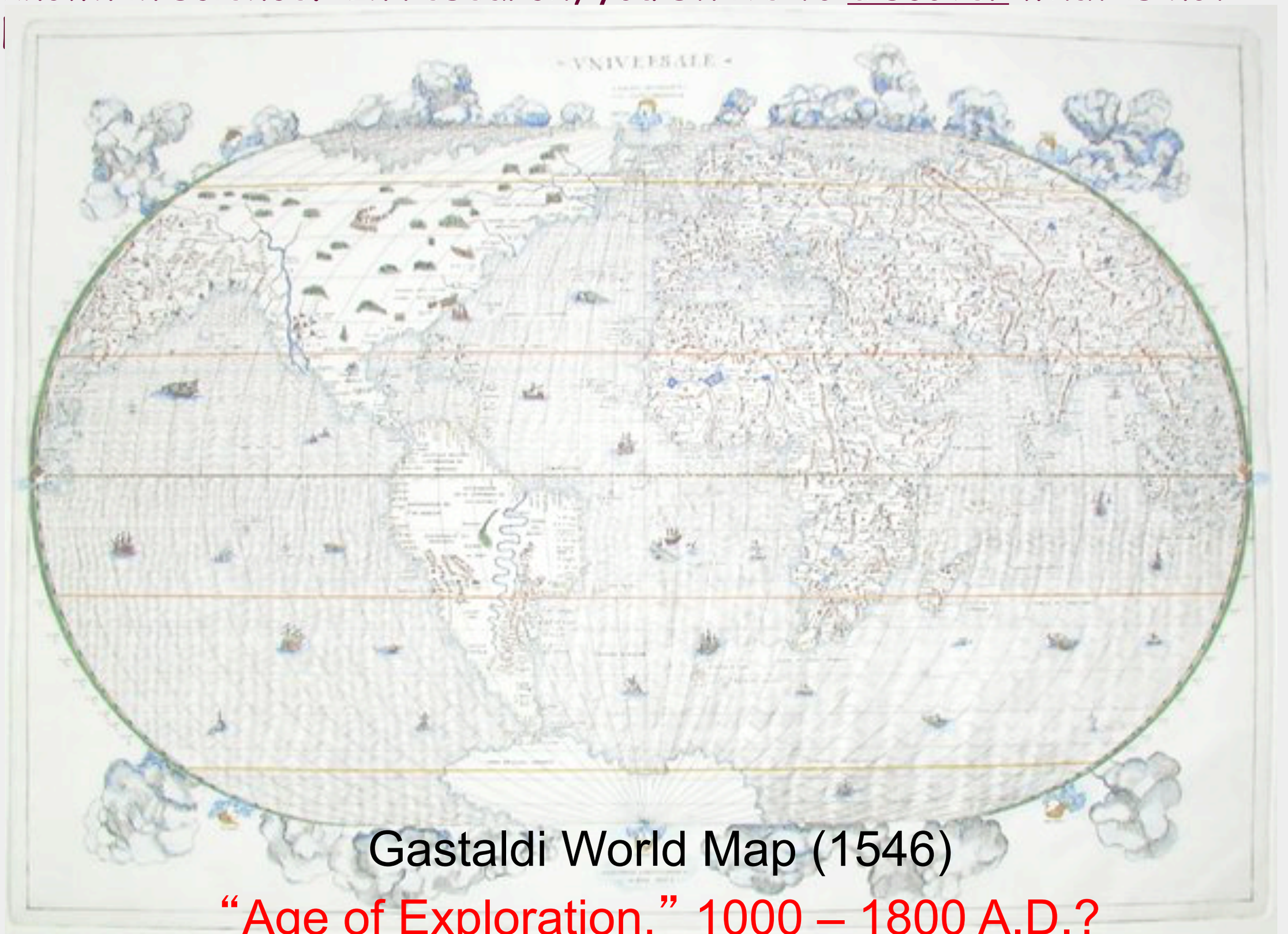
Courtesy P.R. Selvin

“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



Gastaldi World Map (1546)

"Age of Exploration," 1000 – 1800 A.D.?

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

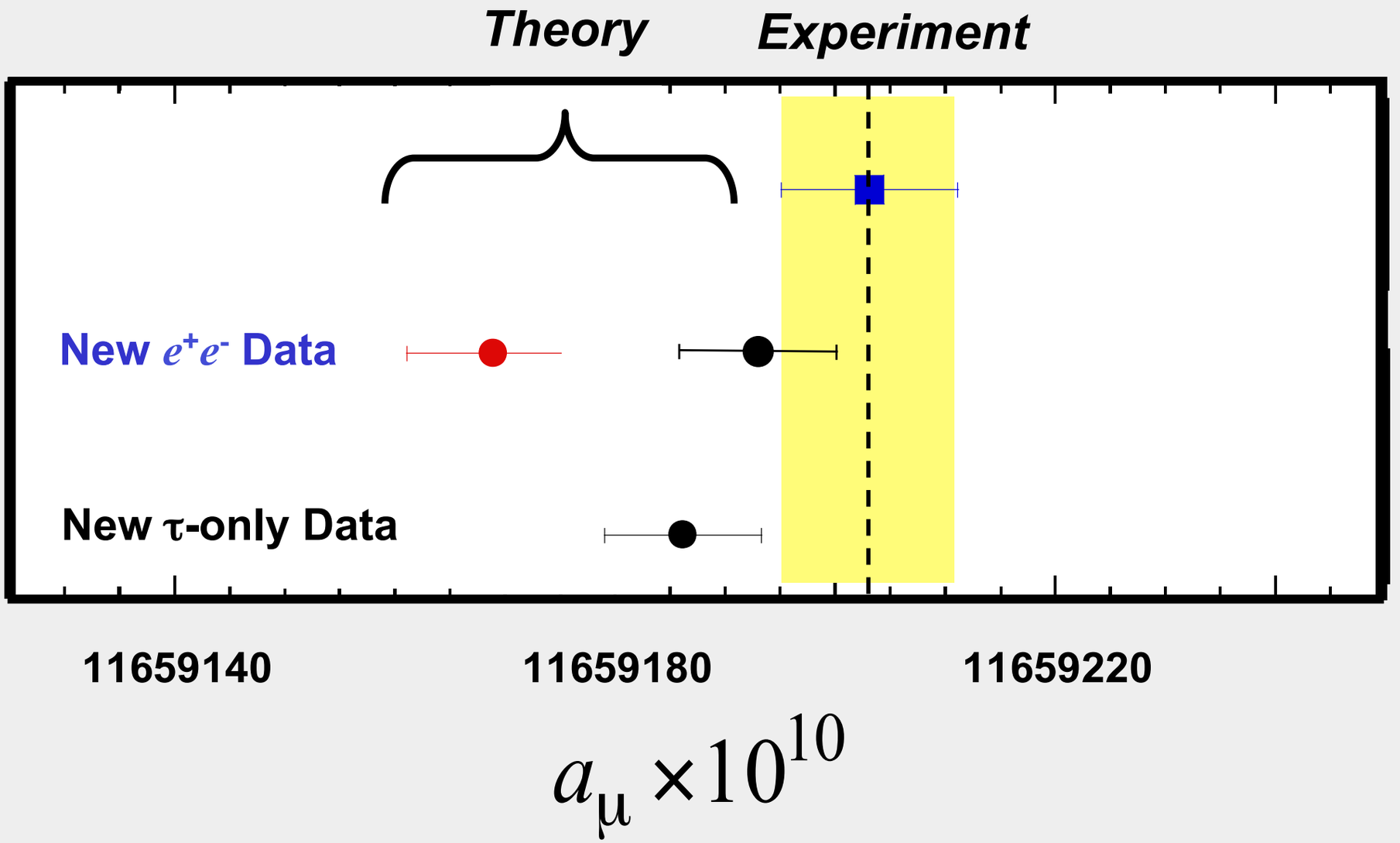
You need to deal with collaborators, reviewers, program directors of funding agencies, etc., etc.

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?



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?

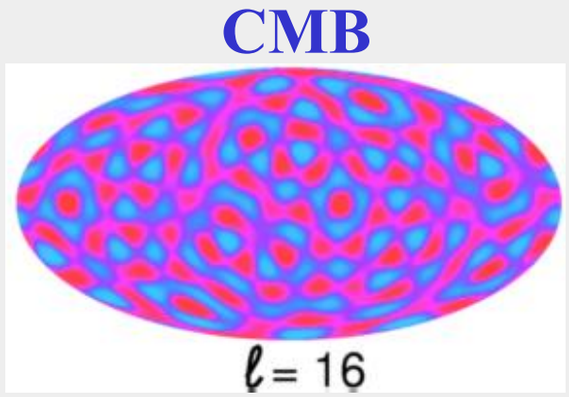
Is it interesting *to me*?

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

Ray Davis—Nobel prize for measuring solar ν deficit

What are other people doing?

American Physical Society (APS)

Main structure: Divisions

Astro, Atomic-Mol-Opt, Bio, Chem, Nucl, Part, CM, etc.

Topical groups

gravity, hadron physics, precision measurement, lots more

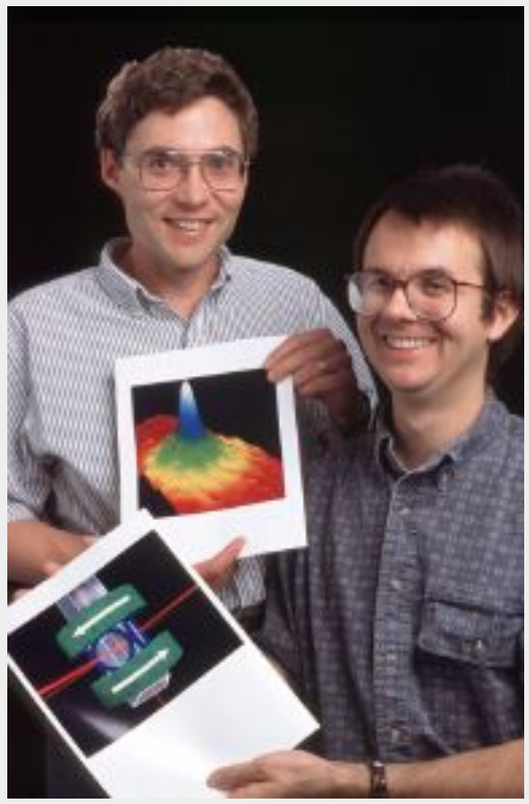
These groups have newsletters, homepages, lots of output

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

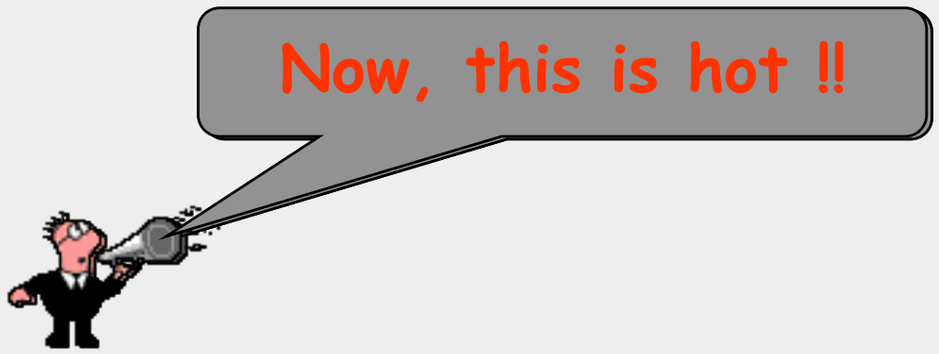
New major instrumentation construction

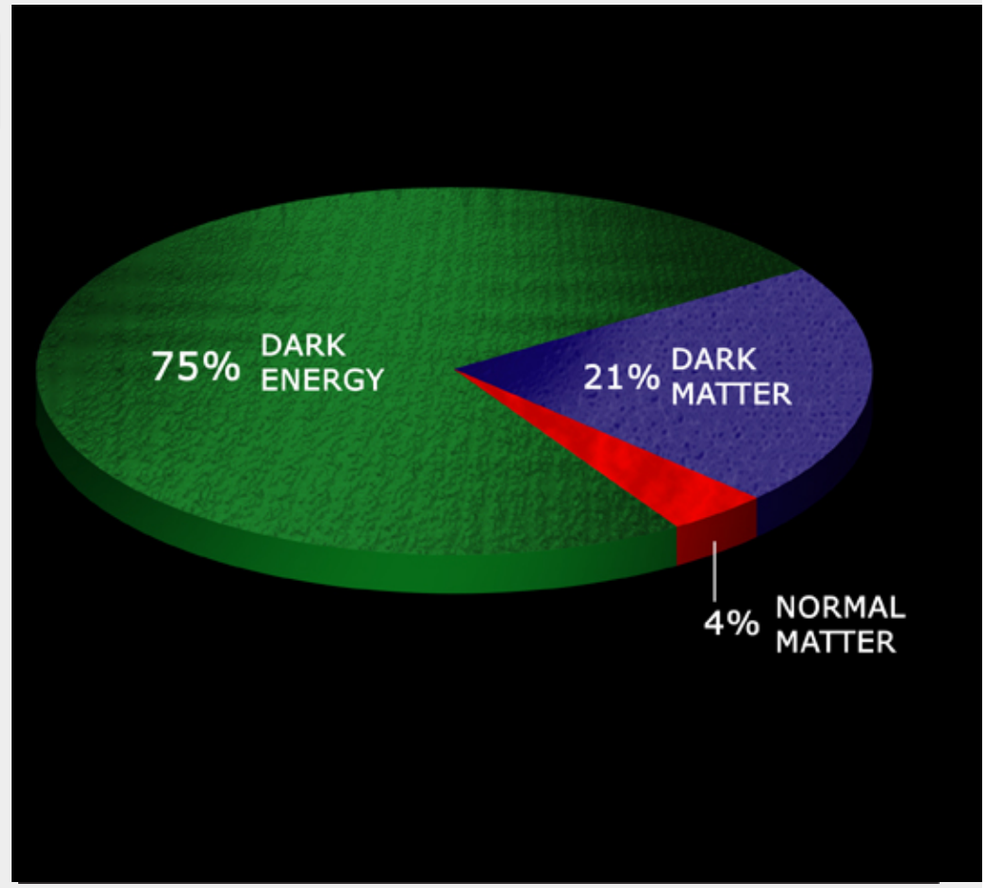
- LIGO (Laser Interferometer Gravitational-Wave Observatory)
- SNS (Spallation Neutron Source; materials science)

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”





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