

“Men and women are not content to comfort themselves with tales of gods and giants, or to confine their thoughts to the daily affairs of life; they also build telescopes and satellites and accelerators, and sit at desks for endless hours working out the meaning of the data they gather.”

... Steven Weinberg
(Nobel Prize in Physics 1979)

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Welcome to

PHY100 - The Magic of Physics !

“Any sufficiently advanced technology is indistinguishable from magic.”

... Arthur C. Clarke
(16 December 1917 – 19 March 2008)

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Your Instructor

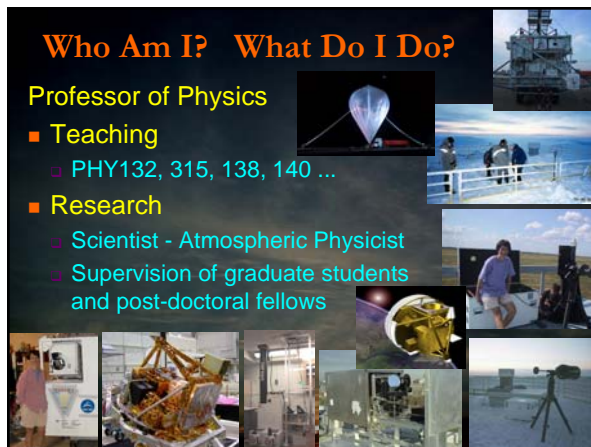
- **Prof. Kimberly Strong**
- My office: MP710A
- My telephone: (416) 946-3217
- Email: strong@atmosph.physics.utoronto.ca
- Office hours: 3-4 PM Tuesdays and Thursdays, by appointment, or just drop by

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Who Am I? What Do I Do?

Professor of Physics

- Teaching
 - PHY132, 315, 138, 140 ...
- Research
 - Scientist - Atmospheric Physicist
 - Supervision of graduate students and post-doctoral fellows



Who Are You?

What is your year?

1. 1
2. 2
3. 3
4. 4
5. Other

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What Is Your Major?

1. Physical sciences / mathematics
2. Social sciences
3. Humanities
4. Commerce
5. Other

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Why Are You Taking PHY100?

1. To fulfill a breadth requirement
2. Required for another reason
3. Recommended by someone
4. General interest based on course description

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What Do You Want to Learn Here?

1. An overview of all (most?!) of physics, including both classical and modern
2. Classical physics
3. Modern physics
4. None of the above

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PHY100 - Some Information

- Homepage
 - <http://www.atmosp.physics.utoronto.ca/people/strong/phy100/phy100.html>
- Textbook
 - *Physics: Concepts and Connections*, Fifth Edition, Art Hobson, Pearson Education (2010)
- Classes
 - Tuesdays and Thursdays, 11:10-12:00, MP202
- Tutorials
 - Begin next week: January 15, 16, 17

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Tutorials – One per Week

- Six groups / four time slots to choose from:
 - TUT 0101 12-1 Tuesday (room RW142)
 - TUT 0102 12-1 Tuesday (room LM155)
 - TUT 0201 12-1 Wednesday (room SS2128)
 - TUT 0301 1-2 Wednesday (room RW142)
 - TUT 0401 12-1 Thursday (room RW142)
 - TUT 0402 12-1 Thursday (room UC177)
- Tutorial groups are capped at 33 students
- Last day to register on ROSI is January 20
- **Please enroll before tutorials start on Tuesday, January 15**
- I will post room and TA assignments by January 15

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Assignments and Marking

- 10% Tutorial Attendance and Quizzes (starting next week!)
- 20% Five Homework Assignments (due 11:00 AM, Thursdays: January 31, February 14, March 7, March 21, April 4)
- 10% Writing Assignment 1 (due 11:00 AM, Thursday, February 28)
- 20% Writing Assignment 2 (due 11:00 AM, Thursday, April 4)
- 40% Final Exam

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Current Assignments ...

For today:

- Read Hobson, Sections 1.1, 1.6, 1.8, 3.1, 3.2

For Lecture 2:

- Read Sections 3.3, 3.4, 3.5

Enroll in tutorial section by 9 AM, Tuesday, January 15th

- Go to your first tutorials next week

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Accessibility

- The University of Toronto is committed to accessibility.
- Students with disabilities are welcome in this class. You are free to safely disclose your disabilities to me or not, as you choose
- If you require accommodations for a disability, or have any accessibility concerns about the course, the classroom or course materials, please contact Accessibility Services as soon as possible: disability.services@utoronto.ca, or <http://studentlife.utoronto.ca/accessibility>.

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What Is Science?

- It deals with observing and understanding the natural world
- We develop theories based on observations
- We explain how and why things happen, and predict what will happen next
- The scientific process addresses the question of **“How do we know?”**

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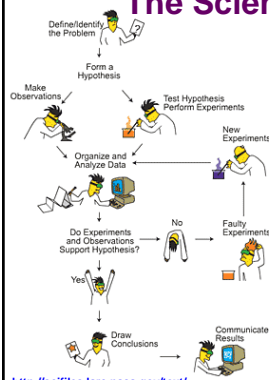
Why Learn or Do Science?

- To gain an expanded awareness of the universe
- To address the problems of modern society and their solutions
- To understand everyday technology

Physics: The study of universal phenomena
 (“Physics as a whole is the study of what the world is made of, how it works, and why things in the world behave the way they do.” Steven Pollock, in *Particle Physics for Non-Physicists— A Tour of the Microcosmos*, 2003)

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The Scientific Process



http://scifiles.larc.nasa.gov/text/educators/tools/pbl/scientific_method.html

From Hobson, page 22:

“Science is a process, a way of learning, rather than a set of conclusions. It is the process of using evidence (experiments and observations) and reason (hypotheses and theories that correlate the evidence) to develop testable knowledge about the natural world. This basis in evidence and reason distinguishes science from other forms of knowledge based on belief, intuition, personal authority, or authoritative books.”

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The Scientific Process - 1

- Science is based on direct experience and on rational thought.
- Direct experience includes observation, measurement, and experimentation.
- A **theory** is a well-confirmed set of ideas that explains what we observe.
- A **law** or **principle** is an idea within a more general theory.
- A **model** is the visualization of a theory.

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The Scientific Process - 2

- A reasonable but unconfirmed idea is called a **hypothesis**.
- Once the idea is confirmed, it becomes a theory.
 - A theory has predictive power.
- But theories are not absolutely certain!
 - A theory has a range of validity – predictions that have been tested – and its validity in other areas needs to be tested as well.

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Science and Pseudoscience

- **Science:** "A set of methods designed to describe and interpret observed and inferred phenomena, past or present, and aimed at building a testable body of knowledge open to rejection or confirmation" (Shermer, 1997, p. 17).
- **Pseudoscience:** "Claims presented so that they appear [to be] scientific even though they lack supporting evidence and plausibility" (Shermer, 1997, p. 33). Non-science posing as science.
- **Pathological science:** "... cases where there is no dishonesty involved but where people are tricked into false results by a lack of understanding about what human beings can do to themselves in the way of being led astray by subjective effects, wishful thinking or threshold interactions" (Langmuir, 1953, 1989)

Michael Shermer, *Why People Believe Weird Things: Pseudoscience, Superstition, and Other Confusions of Our Time*. New York: W. H. Freeman and Company, 1997.
Irving Langmuir, *Pathological Science*, *Physics Today*, October 1989. Based on a talk given in 1953 and first published in 1968.
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Why Should We Be Concerned About Pseudoscience?

- From a practical point of view, the distinction is important for guiding decisions in both private and public life
- Since science is our most reliable source of knowledge in many areas, we need to distinguish scientific knowledge from its look-alikes
 - Examples: healthcare, expert testimony, environmental policies, science education, transportation, communications, agriculture, ...
- Lack of public concern with the advancement of science
- Public's "misunderstanding" of science
- Public's preoccupation with the occult, paranormal, astrology
- Use of pseudoscience in marketing to exaggerate the scientific status of various claims, teachings, and products

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Let's Think of Some Examples

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Let's Think of Some Examples

• Alchemy	• Faith healing	• Moon affecting human behaviour
• Aliens and UFOs	• Flat Earth	• Paranormal phenomena (ESP, ghosts, telepathy, witches, reincarnation,...)
• Anti-aging creams	• Homeopathy	• Parapsychology
• Astrology	• Intelligent design	• Perpetual motion machines
• Bermuda Triangle	• Levitation	• Phrenology
• Cryptozoology (yeti, sasquatch, Loch Ness monster,...)	• Long-range economic forecasting	• Quantum mysticism
• Crystal healing	• Long-range weather forecasting (Farmer's Almanac)	• Seances
• Dianetics	• Emotional life of plants	
• Face on Mars	• Magnet therapy	

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[American] Belief in the Paranormal

Figure 7-8: Belief in paranormal phenomena: 1990, 2001, and 2005

Phenomenon	1990 (%)	2001 (%)	2005 (%)
ESP or extrasensory perception	~35	~45	~55
Mediums can be fooled	~35	~35	~35
Claims or claims of dead people can come back to haunt people and situations	~35	~35	~35
Telepathy, or communication between minds without using the traditional five senses	~35	~35	~35
Clairvoyance, or the power of the mind to know the past and predict the future	~35	~35	~35
People can hear from or communicate mentally with someone who has died	~35	~35	~35
History, or the position of the stars and planets, can affect people's lives	~35	~35	~35
Witchcraft	~35	~35	~35
Reincarnation, or the return of the soul in a new body after death	~35	~35	~35
Channeling, or allowing a spirit being to "speak" through yourself or a human body during a trance	~35	~35	~35

Taken from the US National Science Board's *Science and Engineering Indicators 2006*

Chapter 7: Science and Technology: Public Attitudes and Understanding

http://www.nsf.gov/statistics/seind06/c7/c7s2.htm

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Aristotle (384-322 BC)

- Defined "natural philosophy" – a branch of philosophy examining the phenomena of the natural world, including physics, biology and other natural sciences
- First to devise methods for understanding the world based on detailed observation and cataloging of phenomenon
- Knowledge (i.e., science) is fundamentally empirical – knowledge arises via sensory experience and evidence
- Developed earliest theories of motion

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Aristotelian Physics: A Commonsense View

Aristotle distinguished three kinds of motion.

1. Natural motion: falling objects and liquids, rising air and flames
2. Violent motion: needing a constant push or pull to continue
3. Celestial motion: motion of the moon, planets, sun, and stars

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Let's Try Some Experiments...

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