ISP209 Mystery of the Physical World

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Course Details

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- Course Schedule
- Reading Assignments
- Lecture Notes
What is Physics?

Physics - (from the Greek, φυσικός (phusikos), "natural", and φύσις (phusis), "nature") is the science of Nature in the broadest sense. Physicists study the behavior and properties of matter in a wide variety of contexts, ranging from the sub-nuclear particles from which all ordinary matter is made (particle physics) to the behavior of the material Universe as a whole (cosmology).

http://en.wikipedia.org/wiki/Physics

Physics by Aristotle written 350 B.C.
“When the objects of an inquiry, in any department, have principles, conditions, or elements, it is through acquaintance with these that knowledge, that is to say scientific knowledge, is attained. For we do not think that we know a thing until we are acquainted with its primary conditions or first principles, and have carried our analysis as far as its simplest elements. Plainly therefore in the science of Nature, as in other branches of study, our first task will be to try to determine what relates to its principles.”
Far away from Earth, what does space look like?

Deep field study with the Hubble Telescope

http://hubblesite.org/

http://www.algebra.com/algebra/about/history/Hubble-Deep-Field.wikipedia
Hubble Deep Field

- The Universe is an amazing place
- The Milky Way Galaxy has about 200 billion stars in it.
- There are approximately 200 billion other galaxies in the Universe
- We don’t know if there are other Universes
- We don’t know how many dimensions our universe has
- We don’t know what most of our universe is made of

Scientific Notation

• The Universe appears to be described by mathematics: example Newton’s Universal Law of Gravity

• Power output of the Sun:
  $382,700,000,000,000,000,000,000,000,000$ Watts = $3.827 \times 10^{26}$ W (in LONCAPA we would write this $3.827E26$ W)

• The biggest and smallest physical numbers
  – Largest: There are about $10^{80}$ protons in the Universe
  – Smallest: Plank Length $10^{-35}$ meters
Large and Small Numbers – Scientific Notation

- $10 \times 10 \times 10 \times 10 = 10^4 = 1 \cdot 10^4$
- $10 \times 10 \times \ldots \ (n \text{ times}) = 10^n$
- To multiply, *add exponents*
  - $10,000 \times 100,000 = 1,000,000,000$
  - $10^4 \times 10^5 = 10^{4+5} = 10^9$
- $3.45 = 0.345 \times 10^1 = 0.00345 \times 10^3$
More About Large Numbers

- \( 1,000,000,000/10,000 = 100,000 \)
- \( 10^9/10^4 = 10^9 \cdot 10^{-4} = 10^{9+(-4)} = 10^5 \)
- \( 3.45 = 0.345 \times 10^1 = 34.5 \times 10^{-1} \)
- To divide, *subtract exponents*
- \( 1000/100 = 10^3/10^2 = 10^{3-2} = 10^1 = 10 \)
- Anything to the first power equals itself
- Example: \( 3^1 = 3 \)
Exponent of “0” gives 1

- $\frac{100}{100} = \frac{10^2}{10^2} = 10^{2-2} = 10^0 = 1$
- Anything to the zero power equals 1
Does Anybody Need Really Big Numbers?

- $10^{100} = \text{“googol”}$
- $10^{10^{100}} = 10^{\text{googol}} = \text{googolplex}$
- Statistical Physics: calculations involving a mole of gas (1 mole has $6.022 \cdot 10^{23}$ atoms)
  - Need to know total possible energy states
  - Roughly $10^{\text{number of molecules}} = 10^{10^{23}}$
  - Not a googolplex, but respectable
- String Theory predicts there may be $10^{500}$ parallel universes
- The symbol for infinity is $\infty$
The H-ITT Clicker System

• You must purchase and bring your clicker to each lecture.
• A sample clicker problem:
  – What is the approximate age of the Earth?
    • A) 4.5 million years
    • B) 140 million years
    • C) 1.4 billion years
    • D) 4.5 billion years
    • E) 140 billion years
  – Did you know the answer?
    • A) – yes B) – no
• How to read your clicker number… under the battery is the 6 digit clicker number
• Register your clicker - [here]
The Scientific Method

• Science
  – **Scientific Method**
  – Fact – hypothesis – theory – model (combination of theories to describe how something works, e.g. how a supernova explosion occurs)
  – inference (property inferred from theories and models)
  – Theories can be proven wrong. No theory can ever be proven true.
  – We always search for a theory that works better in describing nature. If two theories work equally well we use [Occam’s Razor](https://en.wikipedia.org/wiki/Occam%27s_razor) to distinguish.

• Pseudoscience (not bad, just not science)
  – The hypothesis is not at risk. If data does not agree with the hypothesis, then the data is assumed to be wrong. Some facts are ignored.
  – Exploit the controversies and inadequacies in a competing theory.
  – Portrayed as an underdog being punished by the scientific establishment.
  – Reliance on fear and other emotions, or reliance on a lack of knowledge
  – People who do pseudoscience usually do not publish in normal scientific journals.
Significant Figures

• If a numerical answer is required for the homework you are expected to answer with 3 significant figures (actually a range of 2 to 7) will be accepted.

• Examples
  – 1.24 has 3 significant figures
  – 500 has 1 significant figure (500. has 3)
  – 0.500 has 3 significant figures
  – 2.3 x 10^{56} has 2 significant figures

• 3.2 means the real number is between 3.15 and 3.24999…

• To reduce the number of SF round up or down
  – 5.67898 given to 3 SF is 5.68
  – 3.34997\times 10^{-2} given to 2 SF is 3.3\times 10^{-2} or (3.3E-2)