MICHIGAN STATE
UNIVERSITY

ISP209 Mystery of the Physical World

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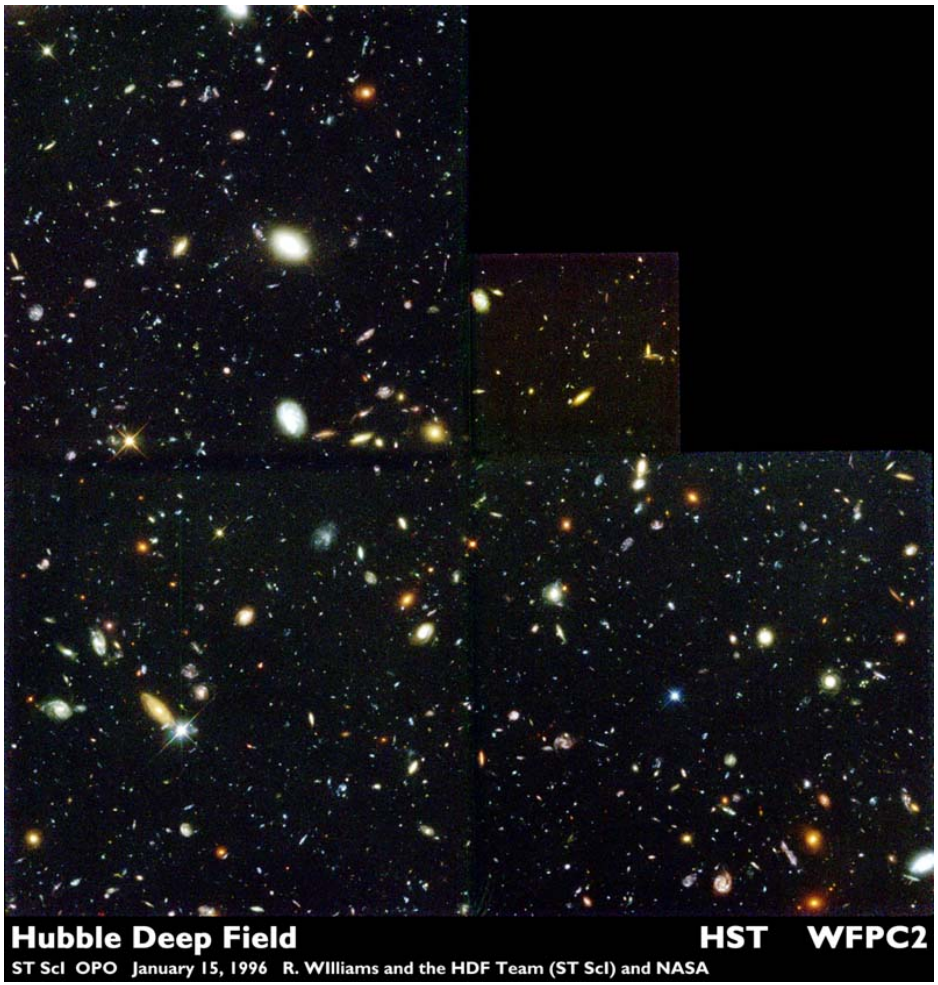
Course Details

- Course Syllabus
- Course Schedule
- Reading Assignments
- Lecture Notes

The H-ITT Clicker System

- You much purchase and bring your clicker to each lecture.
- Examples:
  - 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

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

Scientific Notation

- The Universe appears to be described by mathematics: example Newton's Universal Law of Gravity
- Power output of the Sun: 380,000,000,000,000,000,000,000,000 Watts = 3.82×10^{26} W (in LONCAPA we would write this 3.82E26 W)
- The biggest and smallest physical numbers
  - Largest: There are about 10^{80} protons in the Universe
  - Smallest: Plank Length 10^{-35} meters

Large Numbers

- $10 \times 10 \times 10 \times 10 = 10^4$
- $10 \times 10 \times \ldots$ (n times) $= 10^n$
- To multiply, *add exponents*
  - $10{,}000 \times 100{,}000 = 1{,}000{,}000{,}000$
  - $10^4 \times 10^5 = 10^{4+5} = 10^9$

More About Large Numbers

- $1{,}000{,}000{,}000/10{,}000 = 100{,}000$
- $10^9/10^4 = 10^5 = 10^{9-4}$
- To divide, *subtract exponents*
- $1000/100 = 10^3/10^2 = 10^{3-2} = 10^1 = 10$
- Anything to the first power equals itself

Exponent of "0" gives 1

- $100/100 = 10^2/10^2 = 10^{2-2} = 10^0 = 1$
- Anything to the zero power equals 1

Negative Exponents

- $1000/100{,}000 = 10^3/10^5 = 10^{3-5} = 10^{-2} = 1/100 = .01$
- $10^n \times 10^{-n} = 10^{n-n} = 10^0 = 1$
- $10^{-n} = 1/10^n$

Does Anybody Need Really Big Numbers?

- 10^{100} = "googol"
- $10^{10^{100}} = 10^{\text{googol}}$ = googolplex
- Statistical Physics: calculations involving a mole of gas
  - Need to know total possible energy states
  - Roughly $10^{\text{number of molecules}} = 10^{10^{26}}$
  - Not a googolplex, but respectable
- The symbol for infinity is ∞ .

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 5) will be accepted.
- Rock Joke
- Examples
  - 1.24 has 3 significant figures
  - 500 has 1 significant figure (500. has 3)
  - 0.500 has 3 significant figures
  - 2.3×10^{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
  - 3.34997×10^{-2} given to 2 SF is 3.3×10^{-2} or (3.3E-2)

Videos and Books

- *The Ascent of Man* – Jacob Brownowski, BBC from the 1970s
- *Cosmos* – Carl Sagan PBS from the 1980s
- *The Elegant Universe* – Brian Greene PBS from 2003
- All are available in book form. If you want serious extra credit or an honors option, see me.

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.
- 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.
- Two Examples: ONE TWO