



ISP209 Mystery of the Physical World

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Course Details

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What is Physics?

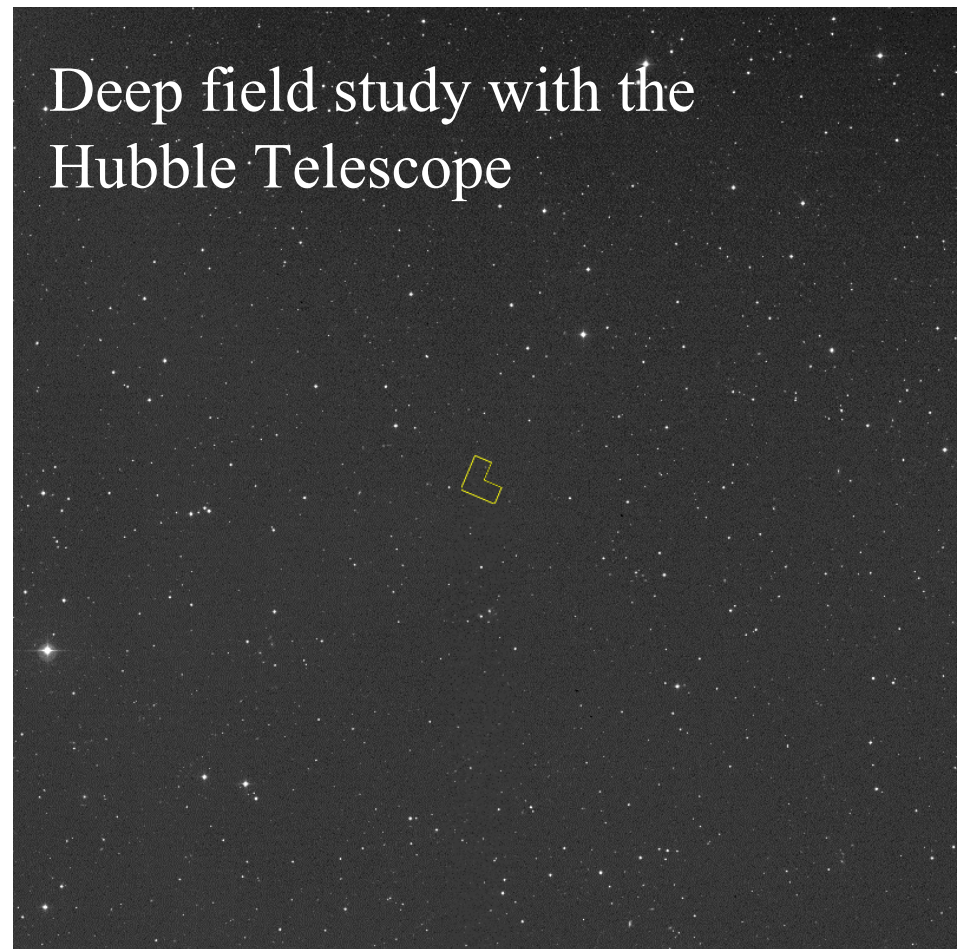
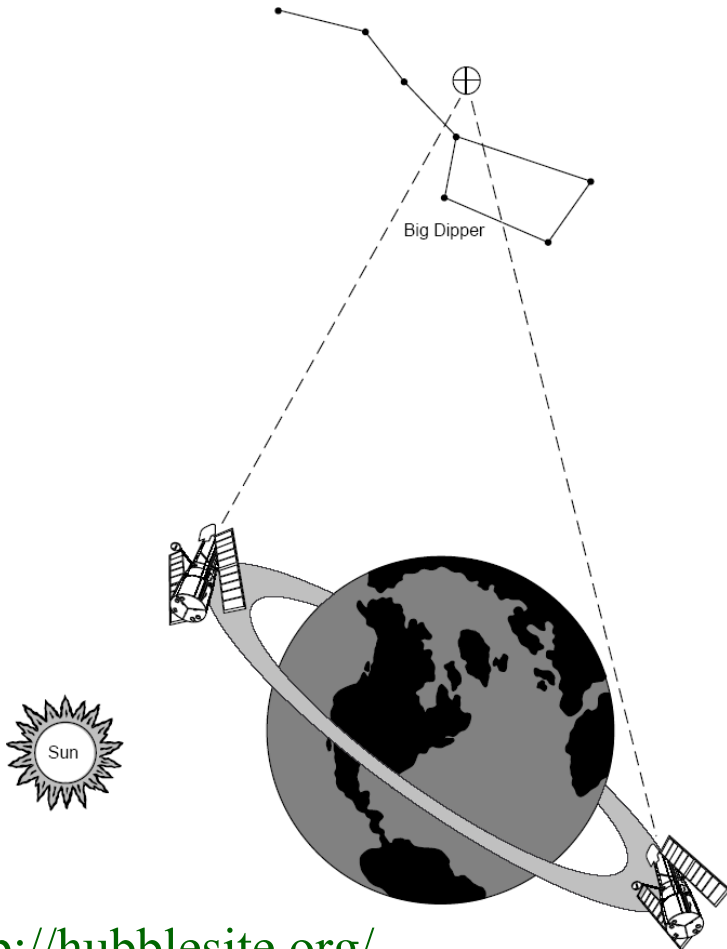
Physics - (from the Greek, φυσικός (phusikos), "natural", and φύσις (phusis), "the order of nature") is the science of Nature. Physicists study the behavior (*Why did it do that?*) and properties (*What is it made of?*) of matter in a wide variety of contexts, ranging from sub-nuclear particles from 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 in 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.”

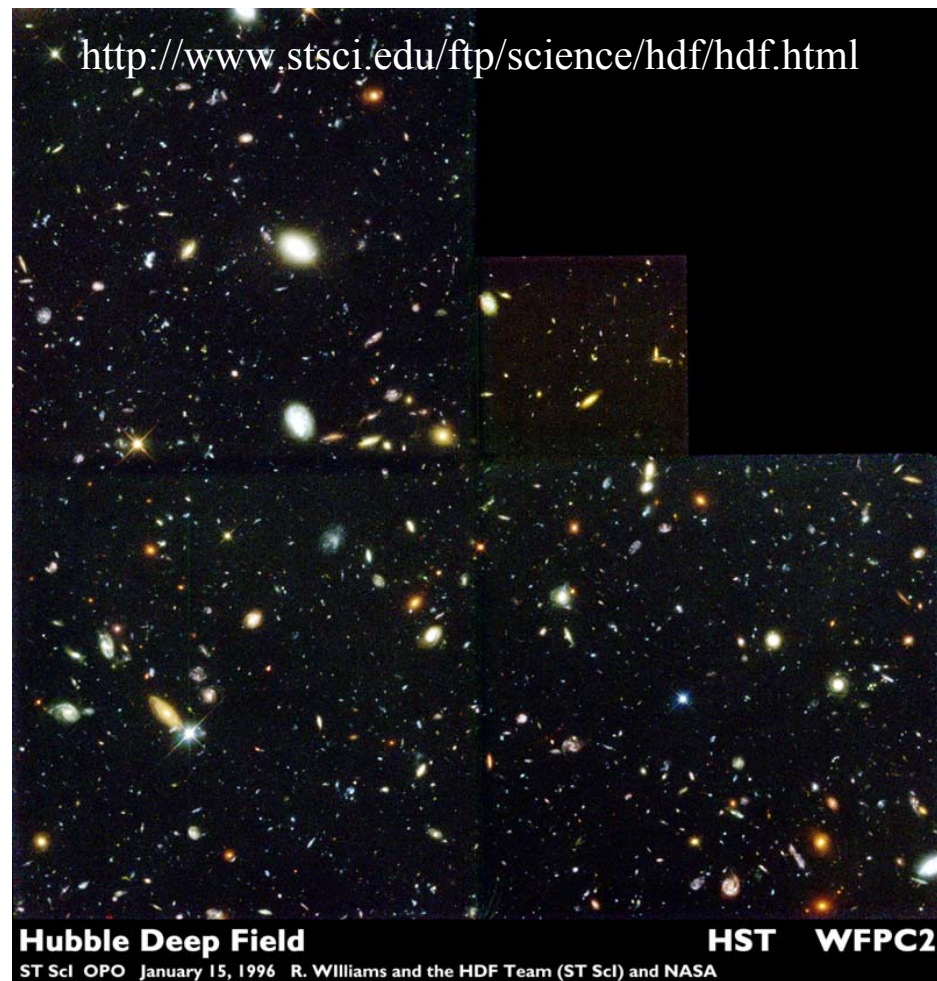
Far away from Earth, what does space look like?



<http://hubblesite.org/>

Hubble Deep Field – The start of what we don't know.

<http://www.stsci.edu/ftp/science/hdf/hdf.html>



- 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 (4 at least)
- We don't know what most of our universe is made of



The i-Clicker System

- You must purchase and bring your i-clicker to each lecture.
- How to read your clicker number... under UPC code by the battery case
- Register your clicker



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 Watts =
 3.827×10^{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

- $10000 = 10 \times 10 \times 10 \times 10 = 10^4 = 1 \cdot 10^4$
- $10 \times 10 \times \dots$ (n times) $= 10^n$
- To multiply, *add exponents*
 - $10,000 \times 100,000 = 1,000,000,000$
 - $10^4 \times 10^5 = 10^{4+5} = 10^9$
- $3.45 = 0.345 \times 10^1 = 0.00345 \times 10^3$



More About Large Numbers

- $1,000,000,000/10,000 = 100,000$
- $10^9/10^4 = 10^9 \cdot 10^{-4} = 10^{9+(-4)} = 10^5$
- To divide, *subtract exponents*
- $3.45 = 34.5 \times 10^{-1} = 3450 \times 10^{-3}$
- $1000/100 = 10^3/10^2 = 10^{3-2} = 10^1 = 10$
- Anything to the first power equals itself
- Example: $3^1 = 3$



Exponent of “0” gives 1

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



Does Anybody Need Really Big Numbers?

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



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 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.