Cosmology & Astronomy

Dr John S. Reid FRAS; F. Inst. P.
Department of Physics

Hubble Deep Field HST · WFPC2
PRC96-01a · ST ScI OPO · January 15, 1996 · R. Williams (ST ScI), NASA

What is cosmology?

- Understanding the Universe as a whole
- Is it just speculation?
  - no!
- Cosmology is now a science with impressive predictions and explanations

Temple of Heaven

- Physics, mathematics and logic work
  - cosmology must be consistent with them

Scientific Principles

- logic and self consistency
- the principle of adequate simplicity
  - Einstein said: '*everything should be made as simple as possible, but not simpler*'

- the principle of testability

Classical cosmology

Claudius Ptolemy
~150 AD

- The Earth was at the centre of the Universe
- The 7 planets revolved around the Earth in orbits that could be described with circular components
- Each planet was contained within its own crystalline sphere
- On the 8th crystalline sphere or firmament lay the stars
- Beyond the stars was the sphere of the prime mover
- Earthly bodies were made of the four elements, Earth, Fire, Water and Air but the planets and stars were made of Quintessence
- In the realm of the planets and stars, nothing ever changes

Cosmology evolved

Copernicus →
(1473 – 1543)

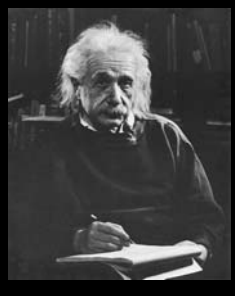
Brahe ↑
(1546 – 1601)

← Galileo
(1564 – 1642)

Wm Herschel →
(1738 – 1822)

Modern cosmology dawns

- Modern cosmology is built on Einstein's "General Relativity"
  - General Relativity devised in the second decade of 20th century
  - gravity controls the universe at large



Albert Einstein in 1947

How does cosmology work?

Isaac Newton
1643 - 1727

- Apply the laws of physics to the Universe as a whole
  - across all of space and through all time
- Newton: gravity extended to the solar system
  - throughout the Universe

Physical constants

- The physical constants have stayed constant
- The anthropic principle
  - the universe *as we know it* would not exist if the physical constants were different

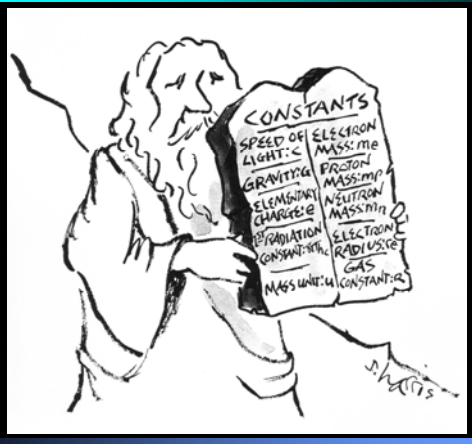
speed of light c

strength of gravity G

Boltzmann's constant k

Planck's constant h

electronic charge e

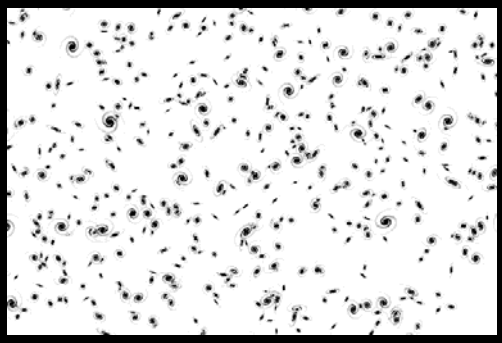


The cosmological principle

- On a large scale, the Universe is isotropic
  - isotropy means the same in all directions
    - not on a galactic scale
    - on a scale of 100 Mpc
      - 1 parsec (pc) = 3.26 light years
- The Universe is homogeneous (on a large scale)

Hubble deep field South; courtesy NASA

Uniform and isotropic simulation



- Courtesy:http://www.astro.ucla.edu/~wright/deepgal.gif