

A deep-field astronomical image from the Hubble Space Telescope showing a vast number of galaxies in various shapes and colors (yellow, orange, blue, white) against a black background. The galaxies are scattered across the frame, with some appearing as bright, distinct objects and others as faint, distant specks.

Cosmology & Astronomy

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Hubble Deep Field

HST • WFPC2

PRC96-01a • ST ScI OPO • January 15, 1996 • R. Williams (ST ScI), NASA

What is cosmology?

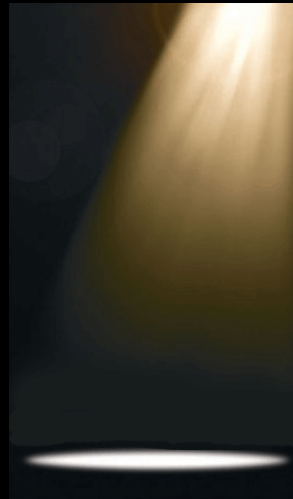
- Understanding the Universe as a whole
- Is it just speculation?
 - no!
- Cosmology is now a science with impressive predictions and explanations
- Physics, mathematics and logic work
 - cosmology must be consistent with them



Temple of Heaven

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

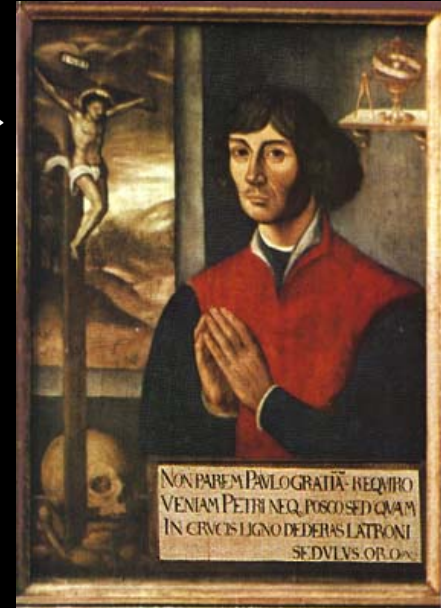
Claudius Ptolemy
~150 AD



- 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)

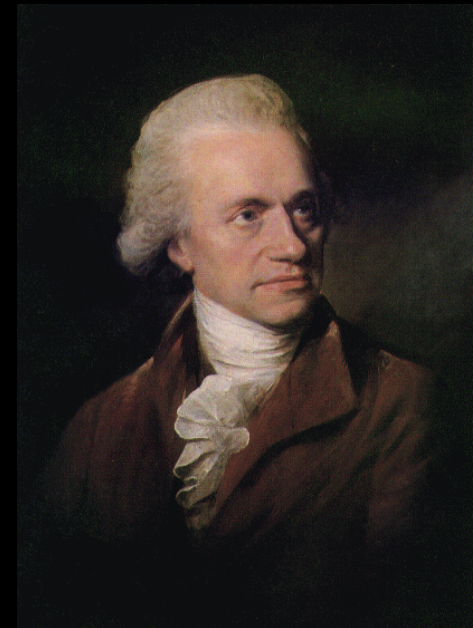


Brahe ↑
(1546 – 1601)



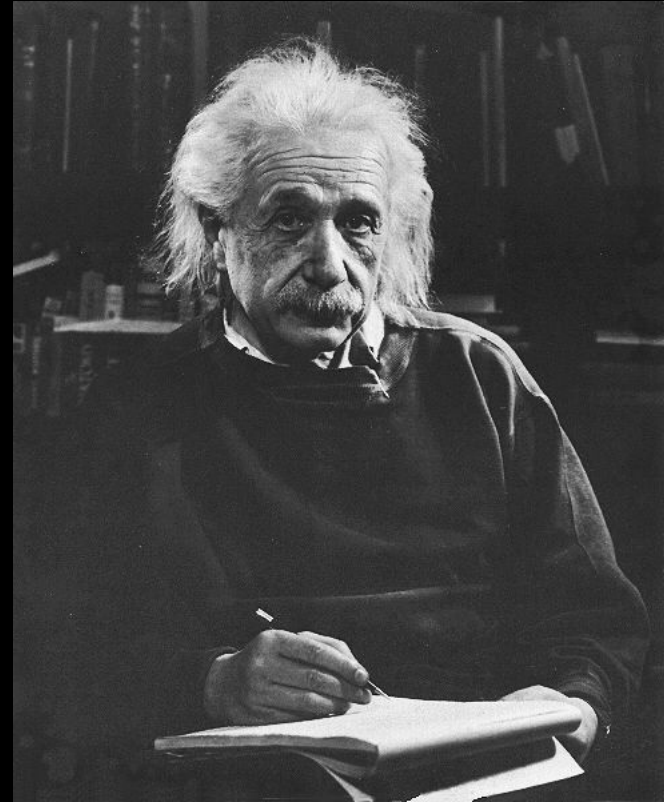
← Galileo
(1564 – 1642)

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

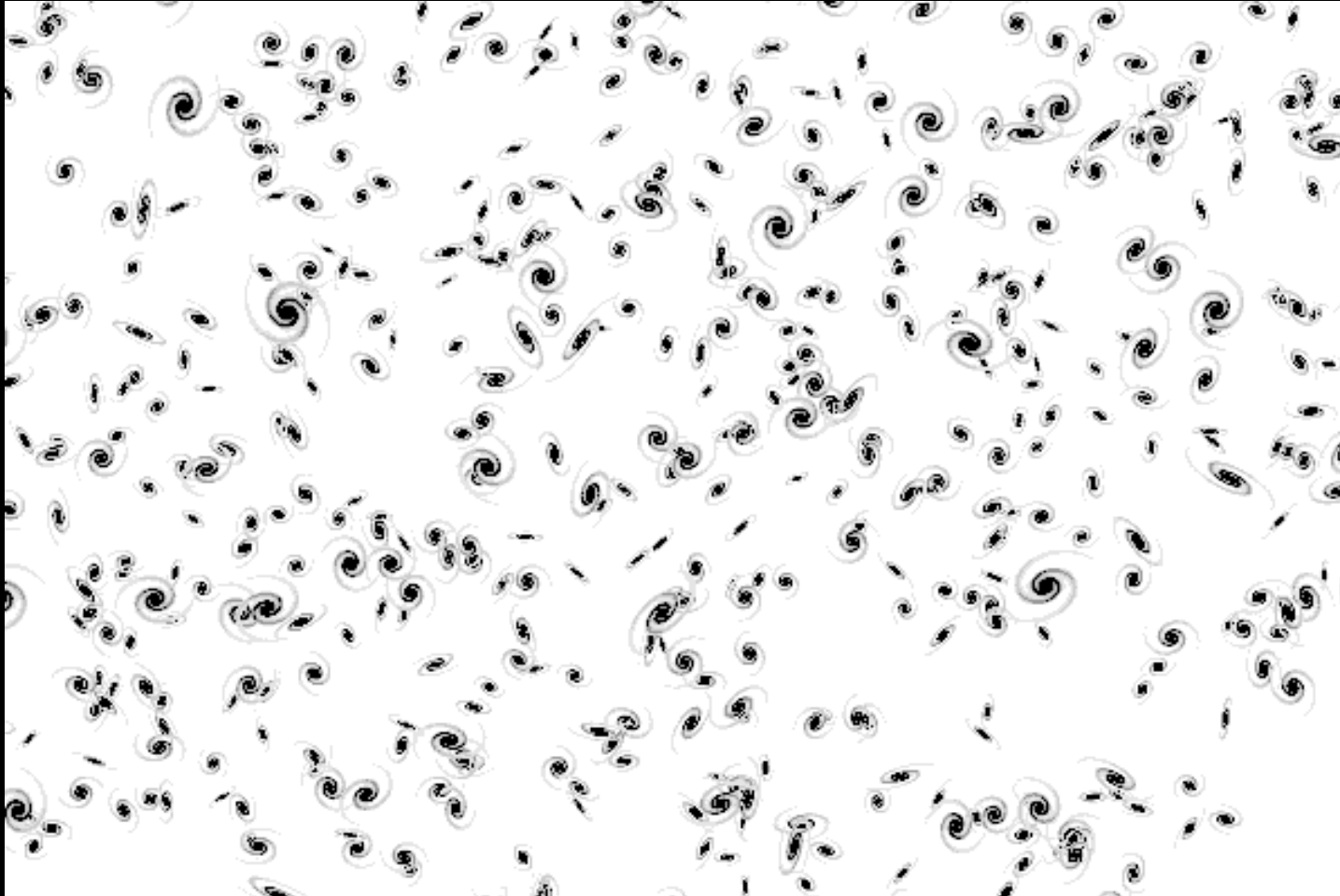


The cosmological principle

- 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>

COSMOLOGY MARCHES ON

