

Physics 102 - March 31, 2014

Fundamental Particle

Quarks

u, d, c, s, t, b

$u, c, t \quad +2/3$

$d, s, b \quad -1/3$

(qqq)

Baryons

p, n

$(q\bar{q})$

Mesons

π, ρ, ω, \dots

K, kaons

Fundamental forces

gravitation

Strong

Weak

Electromagnetism

STANDARD MODEL
Quantum Field Theory

Fundamental Particle

Fundamental forces

Leptons

e, μ, τ

ν_e, ν_μ, ν_τ ← neutrinos

gravitation

Strong

Weak

Electromagnetism

Gauge Bosons

γ , W^\pm , Z^0 , g , G
EM, weak, gluon, graviton

Higgs

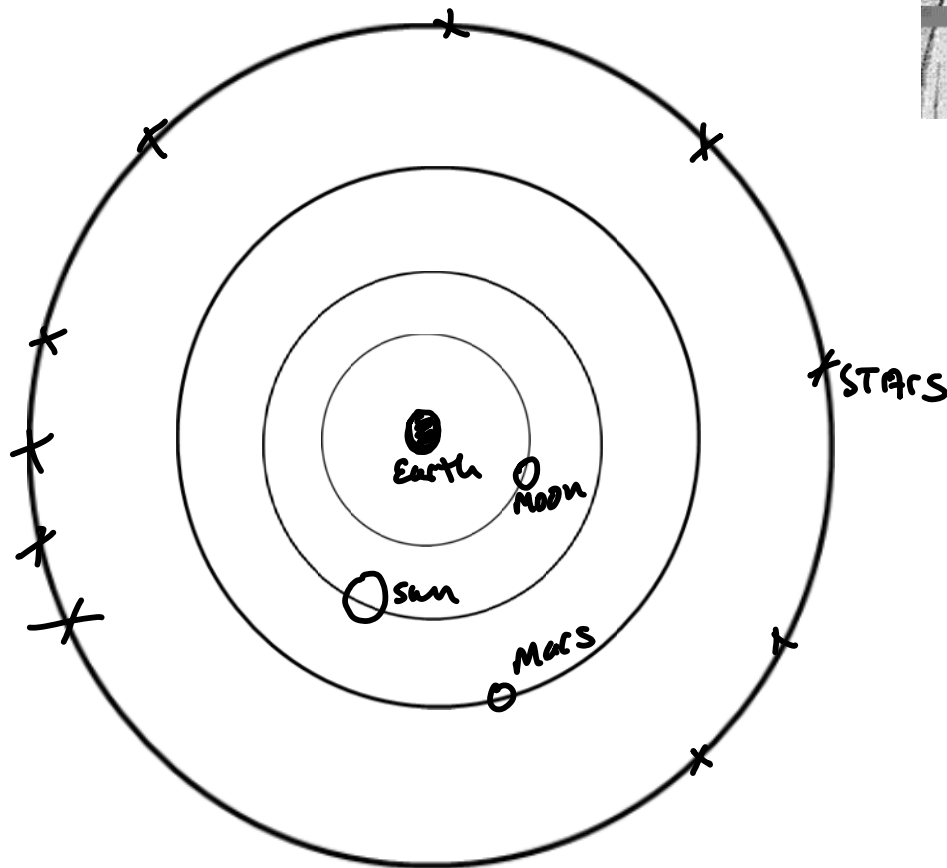
STANDARD MODEL
Quantum Field Theory

Move from inner space to outer space

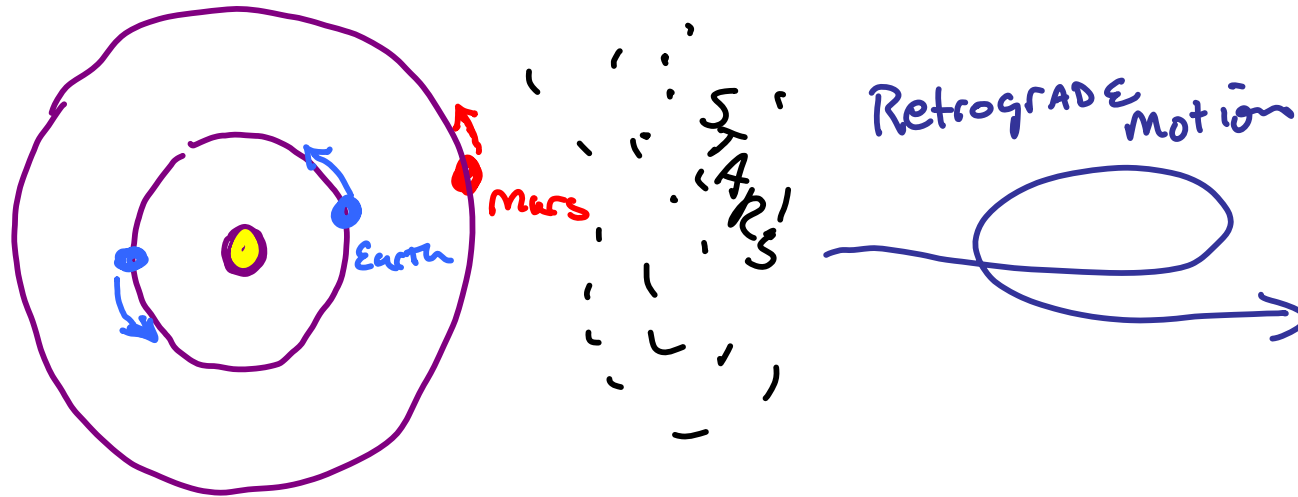
Note Title

3/21/2007

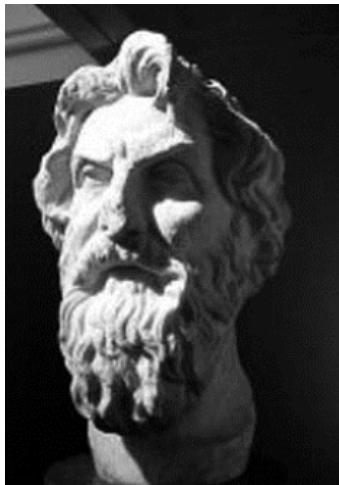
Pythagorean theory
Early Greek view of the universe



Pythagoras
of
Samos
~ 500BC

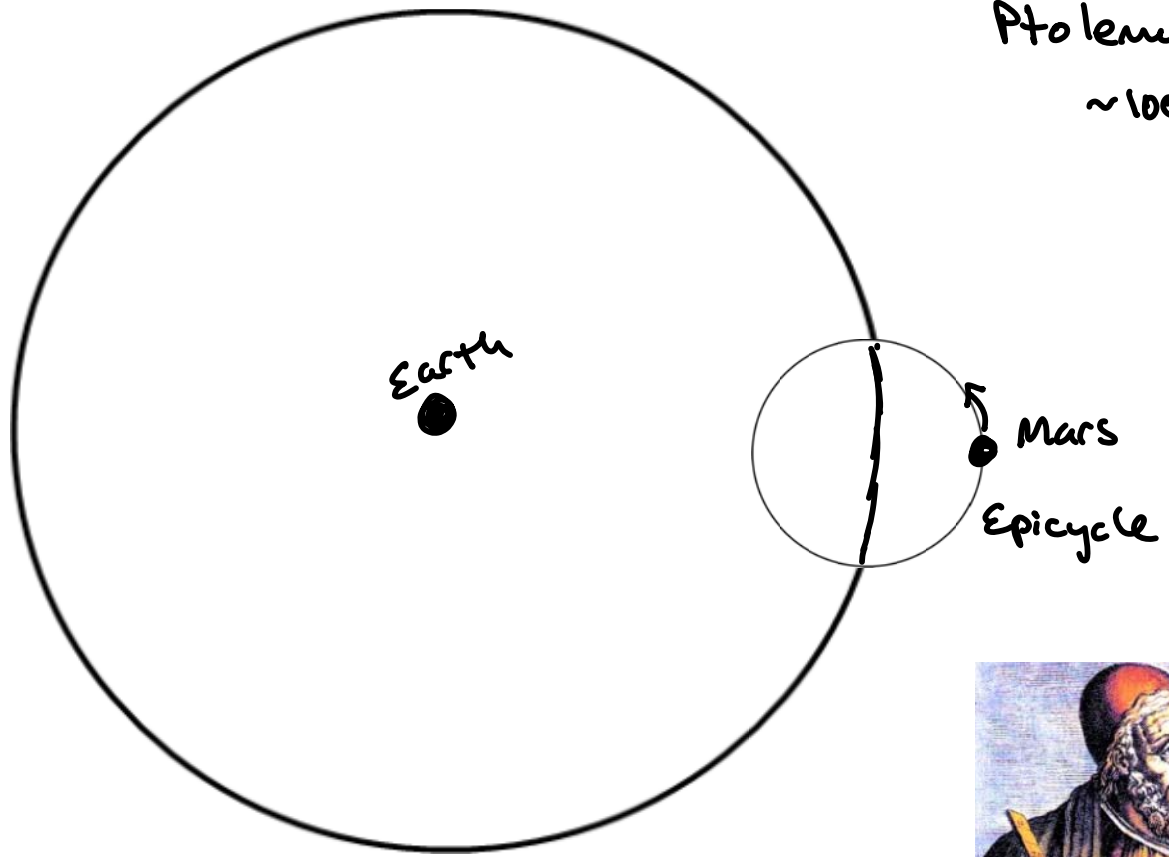


Plato ~ 400 BC ~ Multiple spheres



Aristarchus ~310 - 230 BC
(Greek)

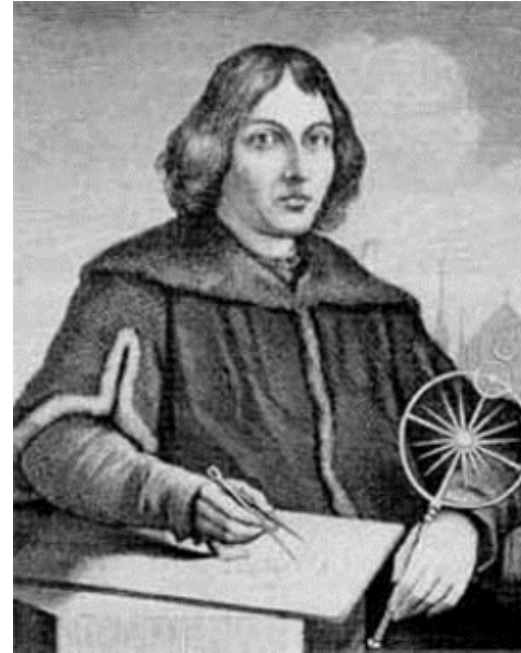
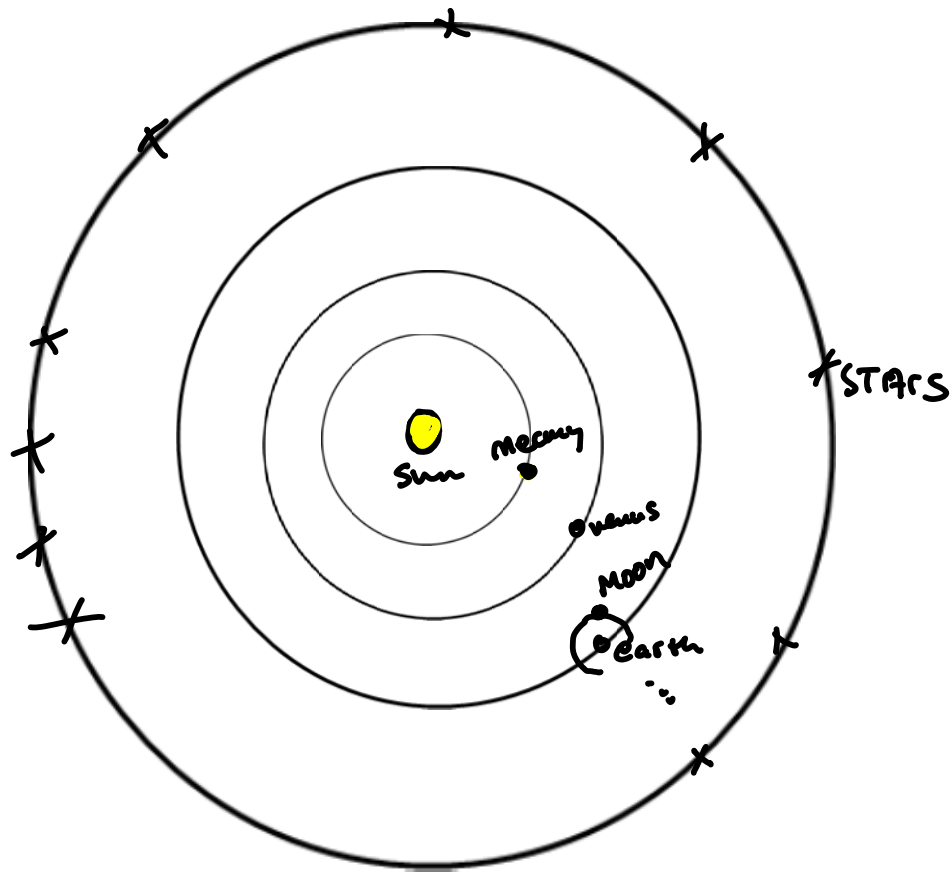
Proposed sun-centered universe
→ rejected



Ptolemy
~100 AD



Sun Centered universe

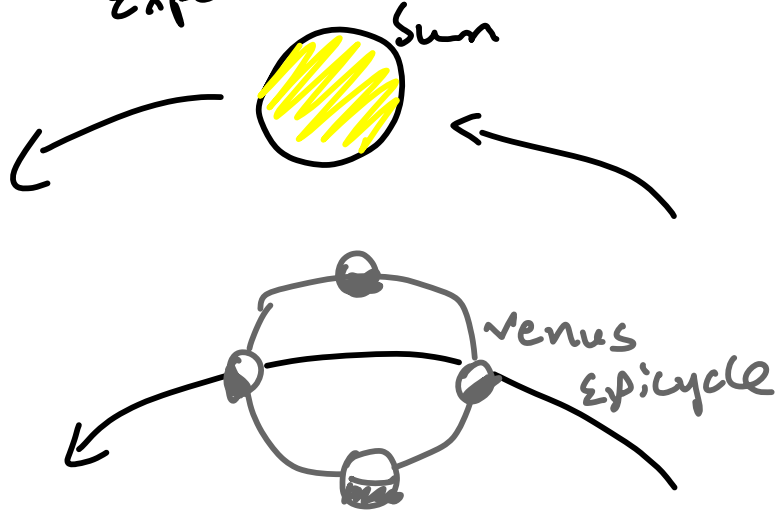


Nicolaus Copernicus
1473-1543
(Poland)

On the Revolutions of the
Heavenly Spheres

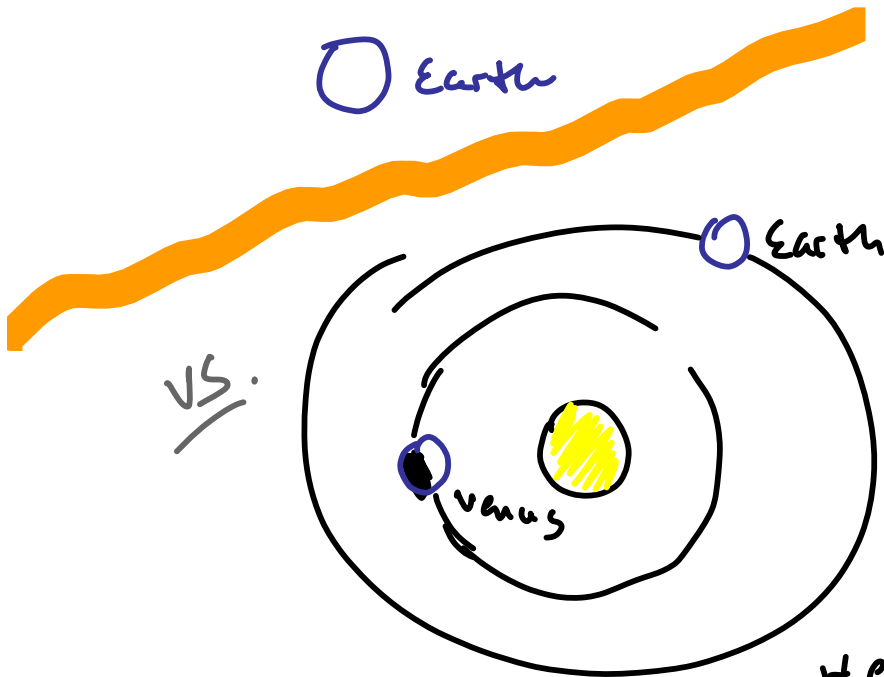
Please read "The Copernican Myths"
in Reserve reading on Blackboard

Ptolemy
Expectation



Galileo Galilei
(1564 - 1642)

Earth

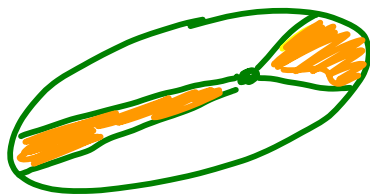


Observed phases
of Venus

Heliocentric expectation



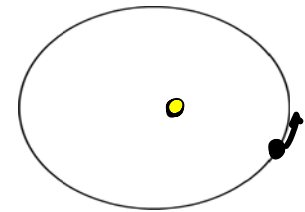
Tycho Brahe
1546-1601
(Dane)
careful observations
of positions
of sun, moon, planets



Brahe's data did NOT fit perfectly
with Copernicus' theory



Johannes Kepler
1571-1630
(German)



⇒ Elliptical orbits

fits the data!

Determined 3 laws
that mathematically
describe orbits seen -
relate periods, areas, axes



Sir Isaac Newton
1643-1727
(England)

universal law of gravitation

$$F = G \frac{M_1 M_2}{r^2}$$

+

Laws of Motion

⇒ derived Kepler's
3 laws of planetary motion

Copernican Principle:

Earth is not in a central, favored position in the universe.

Humans do not occupy a privileged position in the universe

Mediocrity Principle:

There is nothing special about humans/Earth

If you observe a phenomenon (or an exceptional event), it should be assumed the event occurs other times/places under the correct circumstances

Anthropic Principle

Brandon Carter - Australian astrophysicist

1973 "Although our situation is not necessarily central, it is inevitably privileged to some extent."

Weak anthropic Principle (Carter): Our location (space and time) in the universe is necessarily privileged to the extent of being compatible with our existence as observers.

Strong anthropic Principle: ^(Carter) The universe must be such as to admit the creation of observers within it at some stage

John Barrow, Frank Tipler (1986)

Weak anthropic Principle (Barrow + Tipler):

The observed values of all physical and cosmological quantities are NOT equally probable but they must take on values restricted by the requirement that there exist sites where carbon-based life can evolve and by the requirements that the universe be old enough for it to have already done so.

Strong anthropic Principle (Barrow + Tipler):

The Universe must have those properties which allow life to develop within it at some stage in its history.

Cosmology

Scientific Study of the large scale structure of the universe — Attempt to understand to origin, evolution and fate of the universe

http://wmap.gsfc.nasa.gov/m_uni.html

good online reference
for this class

Not quite the same thing

Cosmetology

The business of being a beautician — The treatment of skins, hair and nails

<http://careerplanning.about.com/cs/occupations/p/cosmetology.htm>

While we're at it ...

Astronomy



Astrology

Light travels at a finite speed

On to the very big ...



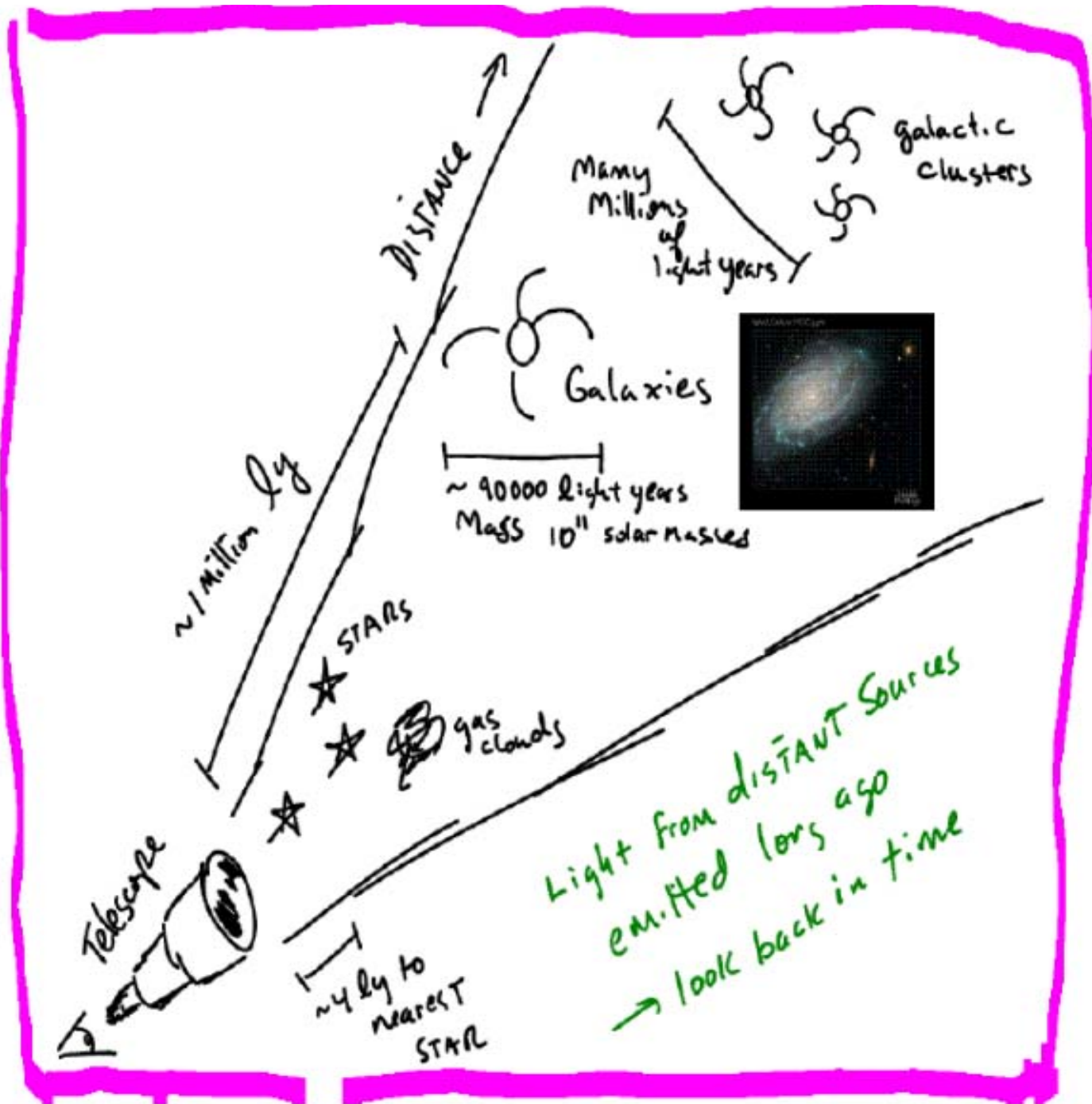
Telescopes are
time machines

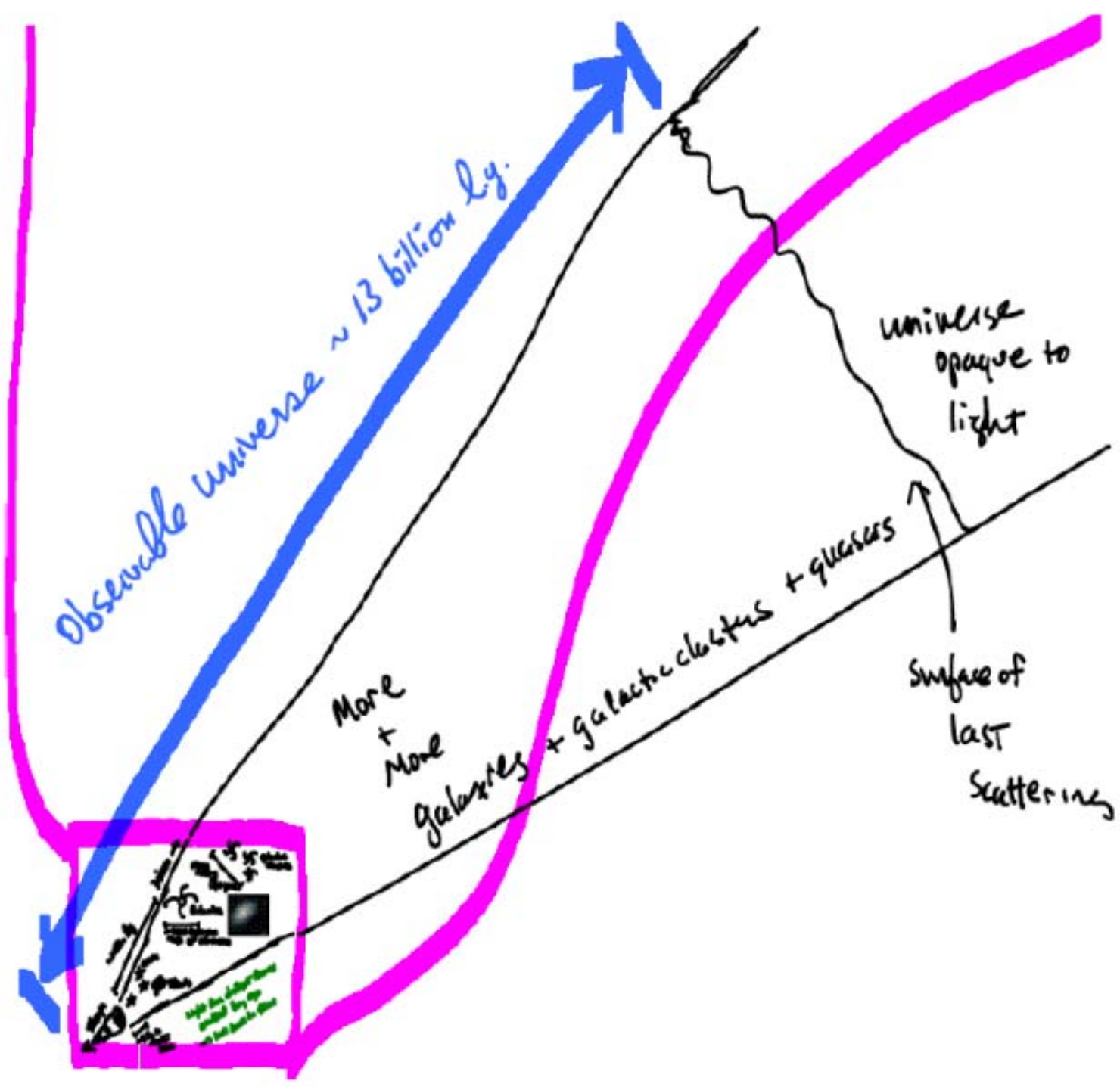
1 Mpc = 1 Megaparsec = 3×10^{22} m

1 light year = 9×10^{15} m

Light travels from NYC to San Francisco in 1/100 second
.... and it travels 1 Mpc in 3 million years

Farther Away, the object ... longer ago light emitted.





Observable universe ~ 13 billion ly.

More + More galaxies + galactic clusters + quasars

universe opaque to light

Surface of last scattering



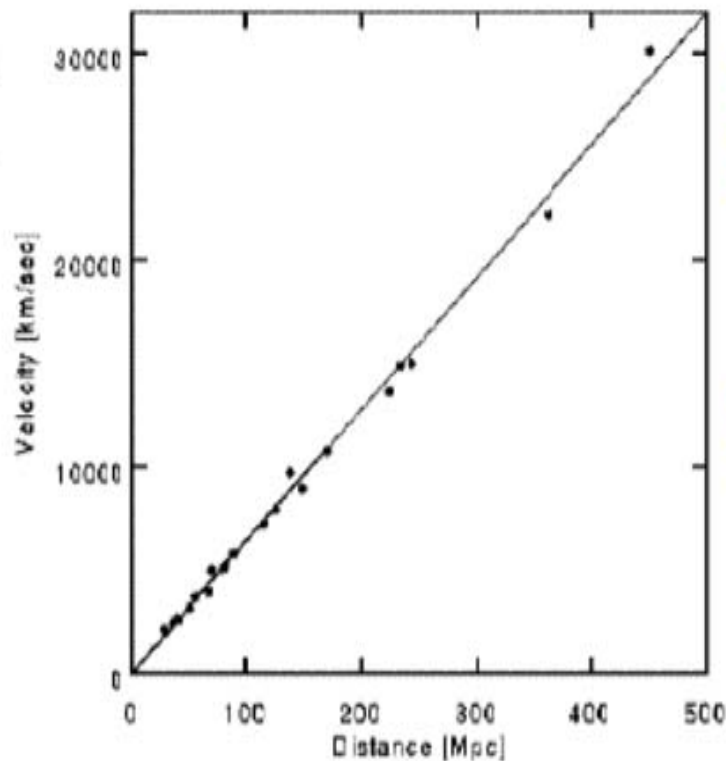
We live in an expanding universe



Edwin Hubble
(1929)

Determined by
redshift of Atomic
Spectral lines

Recession Velocity



Slipher
early 20's

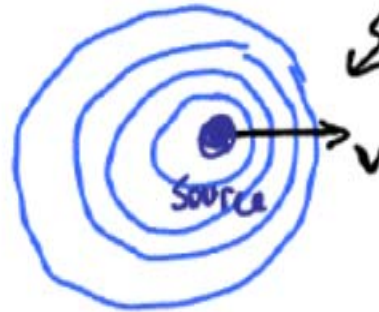
Also
Milton
Humason

Distance to galaxy

Determined by brightness
(Supernova in distant galaxy)

"Redshifted" light

frequency appears lower to objects in direction away from direction of motion



frequency appears higher to observers in direction of motion

"Blueshifted" light

larger v — larger the red and blue shifts.

Atomic Spectrum

