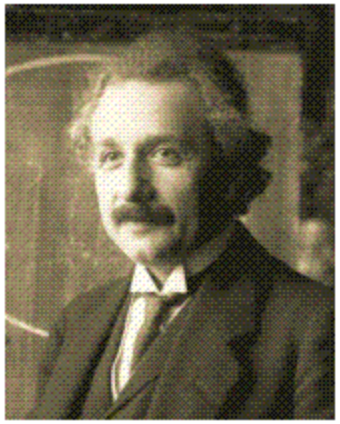
Physics 100 - April 6, 2009

- No recitations this week
- Exam 2 on April 22
  - Hoyt - regular class time
  - More info soon
- Presentations — 7 Groups
  - April 15
  - " 20
  - " 27
  - " 29 (last day of class)

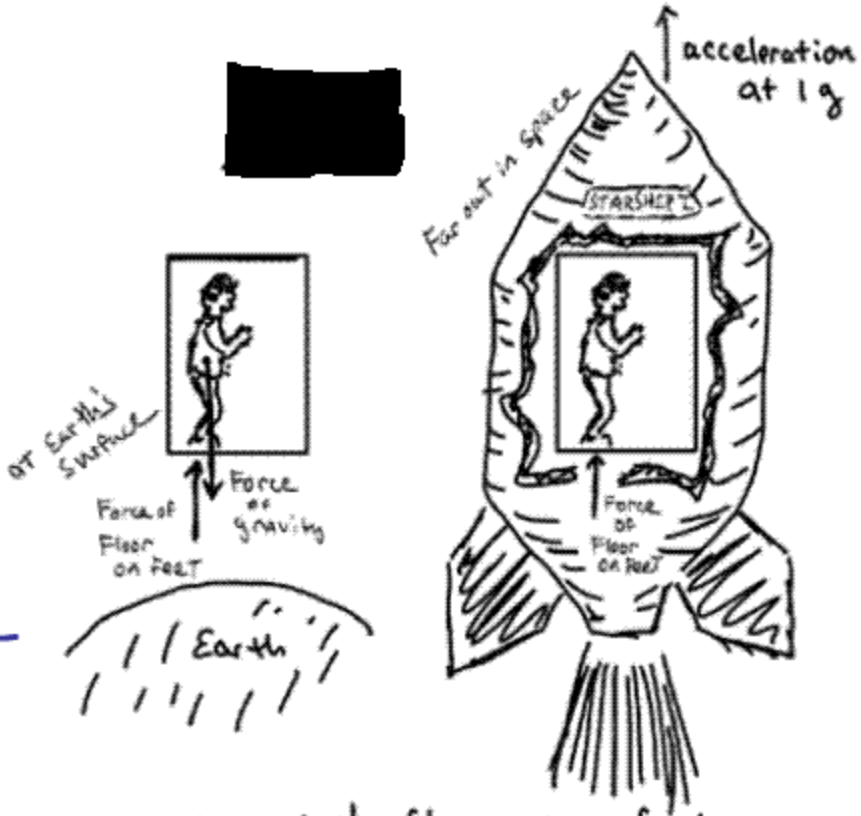
Each group spokesperson needs to give me an ordered list of preferred presentation times

Last Time –

Gravitation – The general theory of relativity



[redacted]



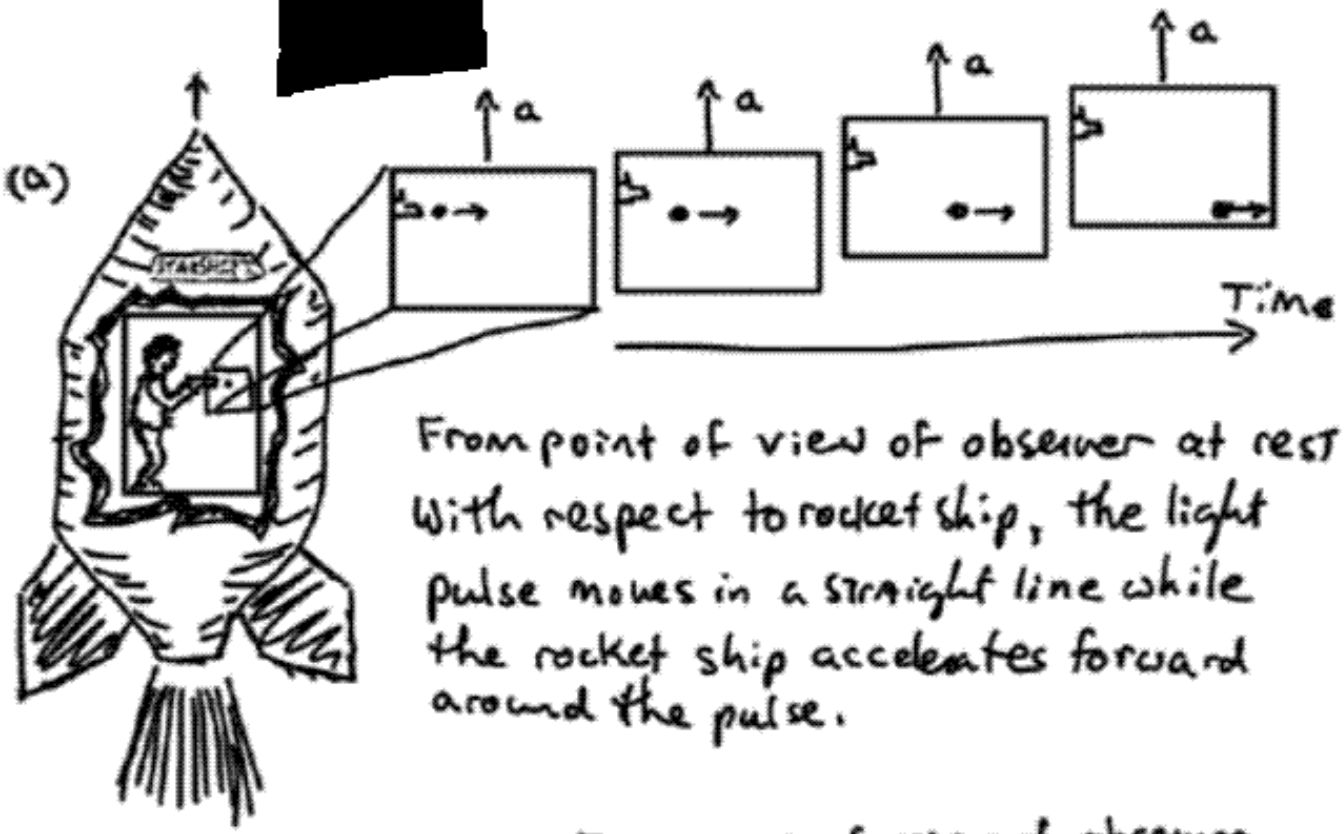
Equivalence principle

Accelerated reference frame
|||
gravitational field

The force of the floor on your feet is the same in both cases. This is what you perceive as your weight.

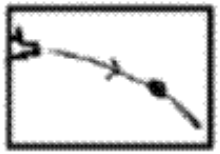
[redacted]

(a)

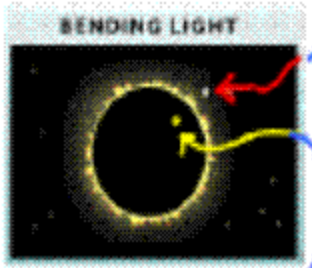


From point of view of observer at rest with respect to rocket ship, the light pulse moves in a straight line while the rocket ship accelerates forward around the pulse.

(b)



From point of view of observer on the rocket ship, the light pulse seems to travel in a path that curves downward.

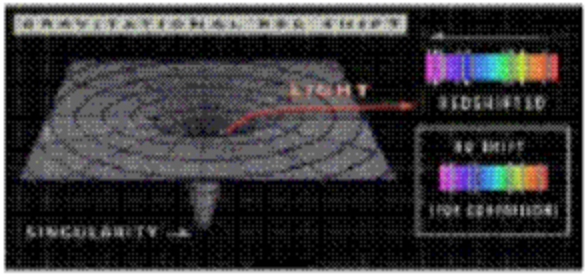


Apparent position

Actual Position

- Bending of light by gravitational field ✓

- Gravitational Redshift of light ✓



- Perihelion advance of Mercury ✓

- Gravitational Waves ?

Amplitude ~ 10^{-16} m

LIGO

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 skin, hair and nails

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

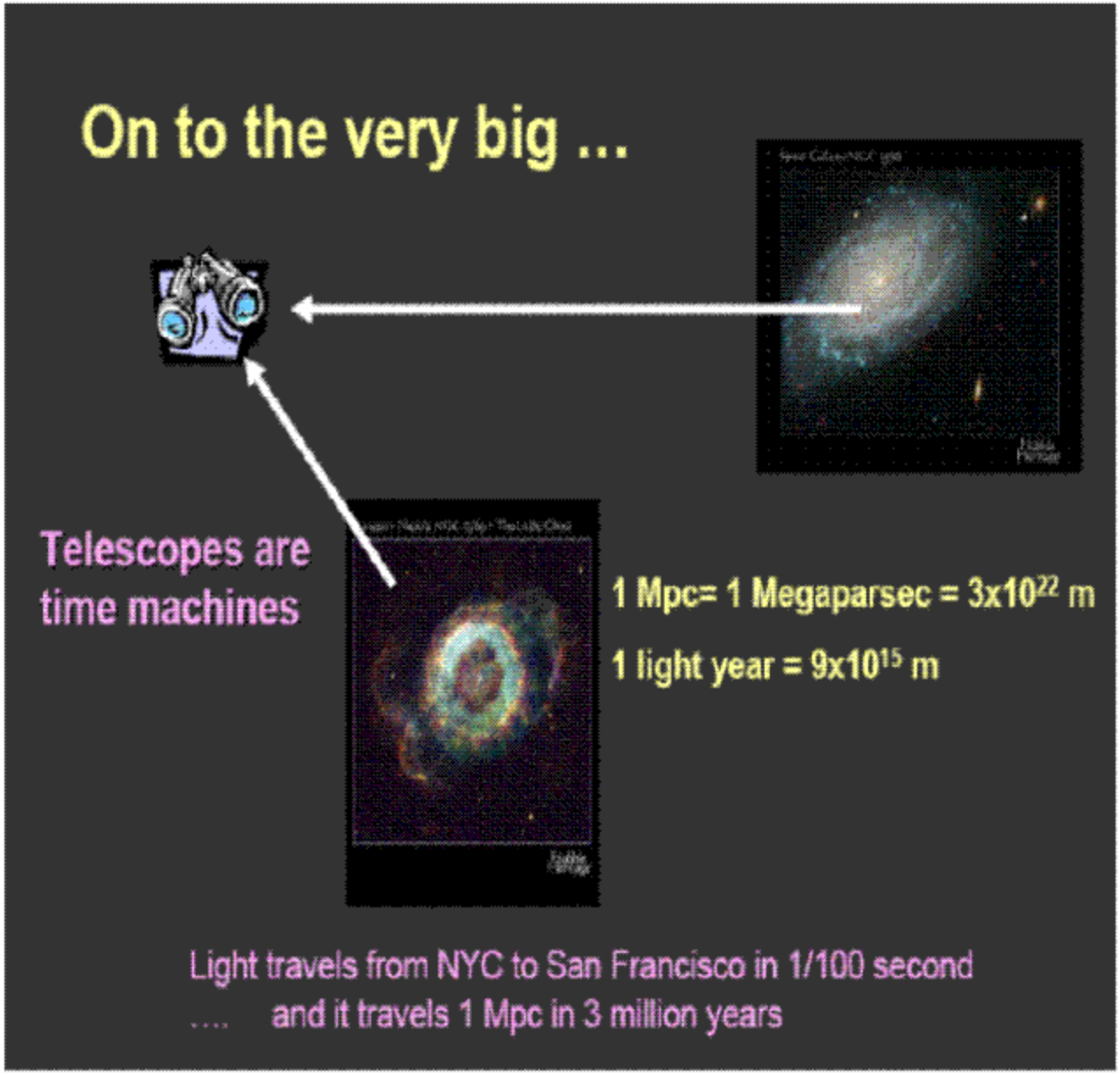
while weie at it ...

Astronomy

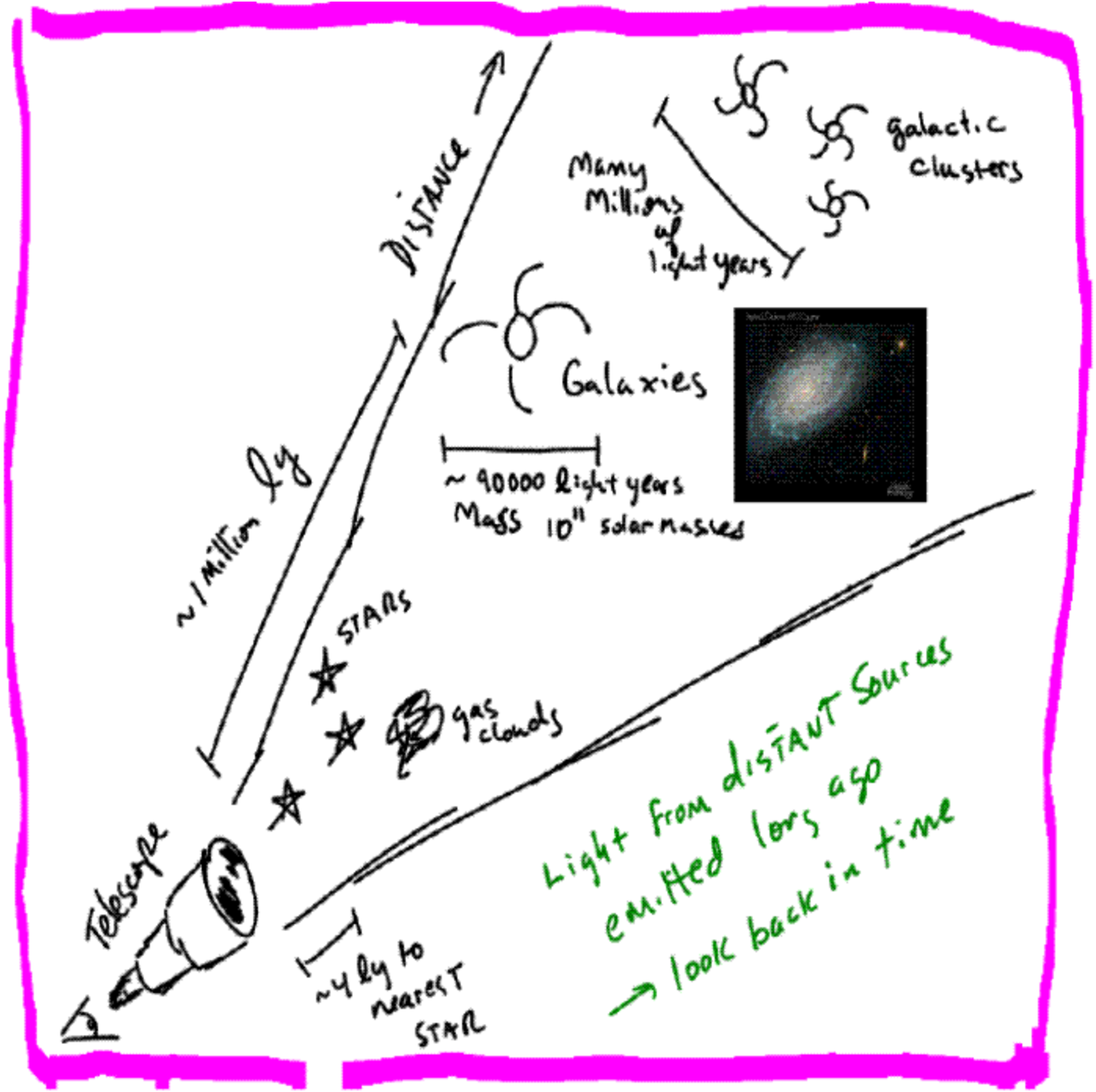
$\neq$

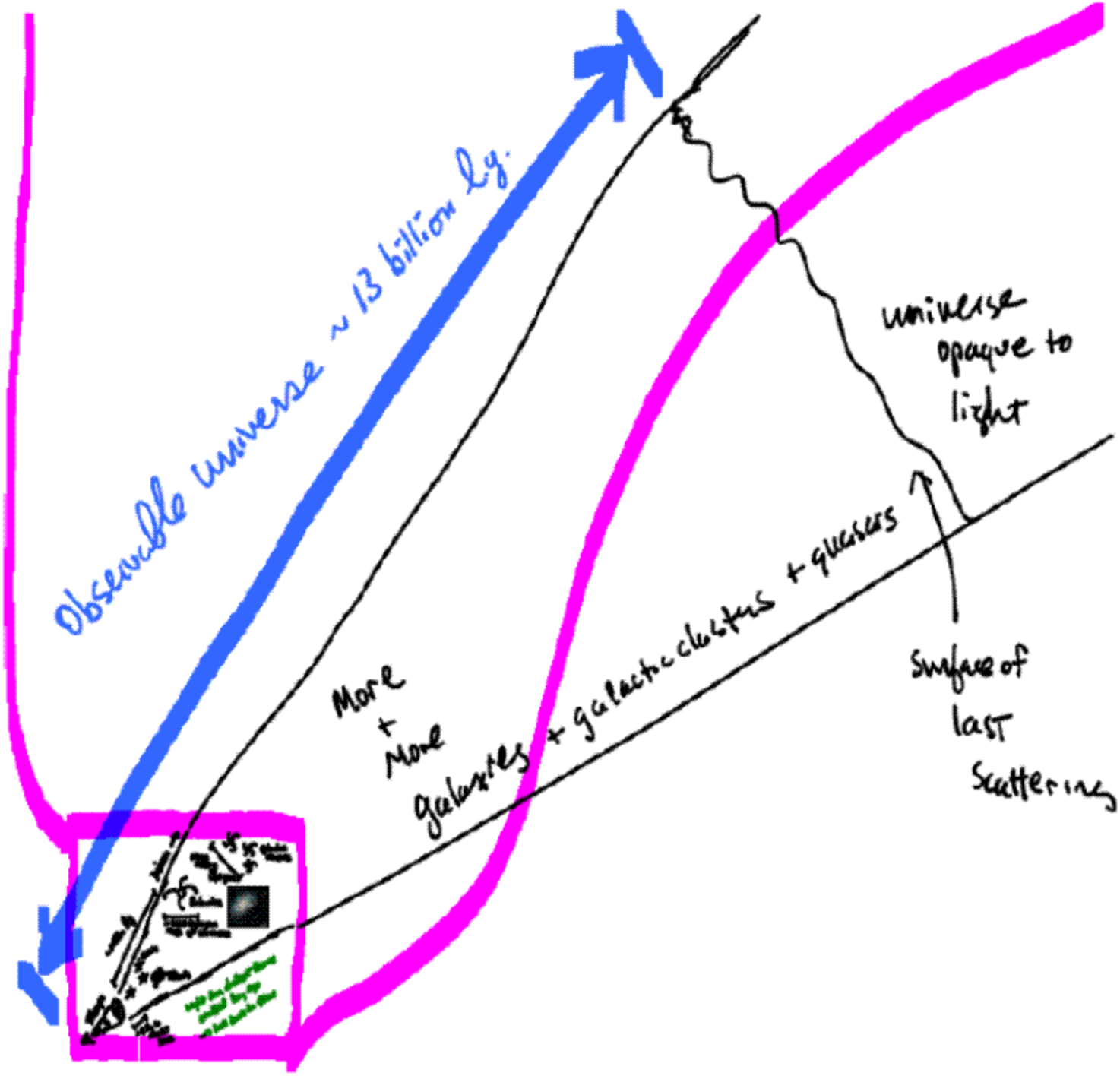
Astrology

light travels at a finite speed



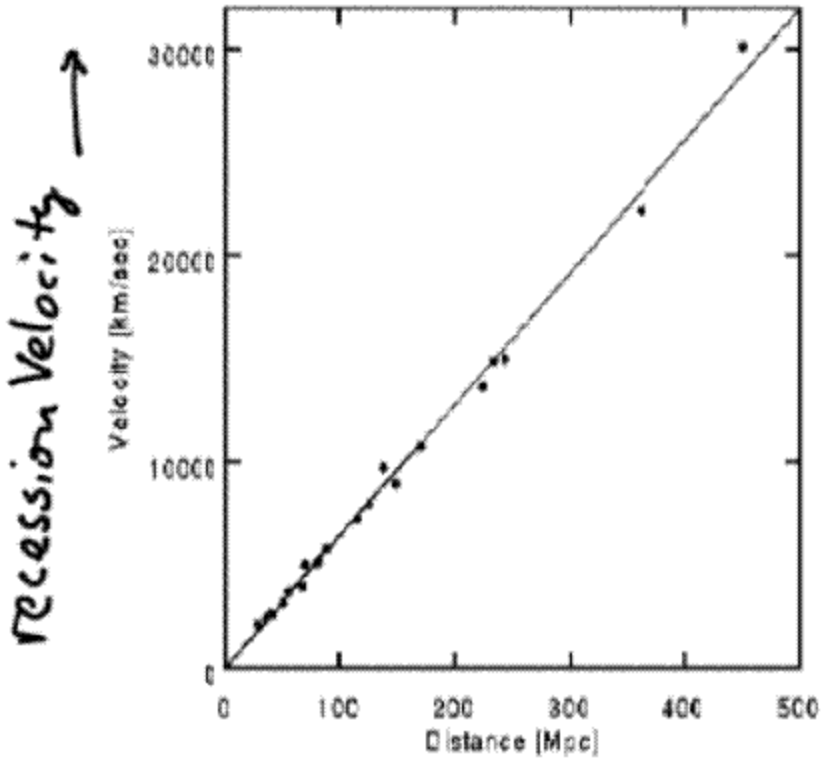
Farther away the object ... longer ago light emitted.


DISTANCE
Many Millions of light years
galactic clusters
Galaxies
~ 90000 light years
Mass 10^{11} solar masses
~1 million ly
STARS
gas clouds
Telescope
~4 ly to nearest STAR
Light from distant sources emitted long ago
→ look back in time


observable universe ~ 13 billion l.y.
universe opaque to light
More + More galaxies + galaxy clusters + quasars
Surface of last Scattering

We live in an expanding universe

Edwin Hubble
(1929)



Slipher early 20's

Also Milton Humason

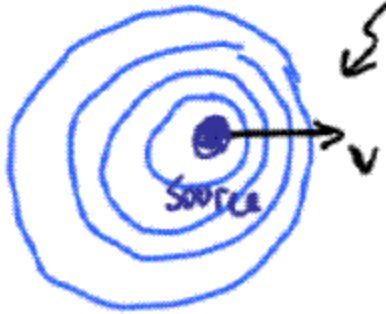
Distance to galaxy

Determined by redshift of atomic spectral lines

Determined by brightness (supernova in distant galaxy)

"Redshifted" light

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



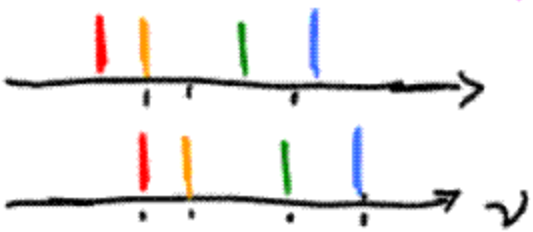
frequency appears higher to observers in direction of motion

observer

"Blueshifted" light

larger v — larger the red and blue shifts.

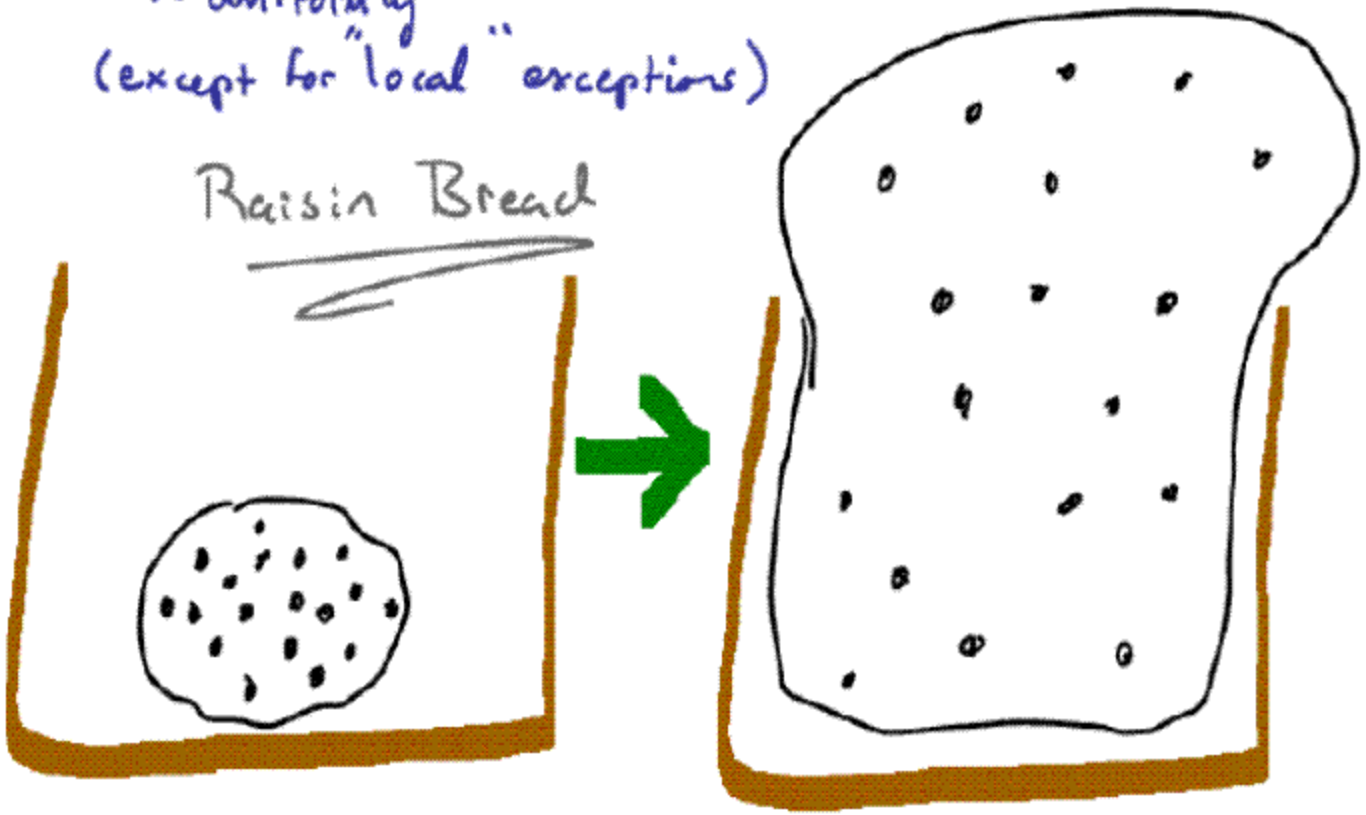
ATOMIC spectrum



spectrum line positions shifted in color/frequency for source moving away from observer

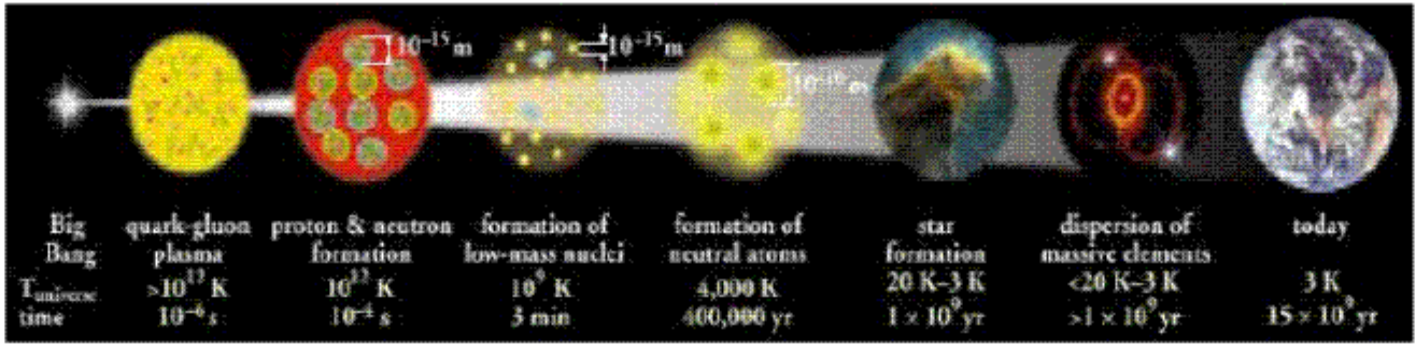
(color also changes — NOT shown)

Galaxies Receding in all directions
~ uniformly
(except for "local" exceptions)



No need to think our galaxy is at center of universe.

Expansion of space makes effect same to all observers throughout universe.



↑

HOT Big BANG predicts this

light should Travel to us from time ~ 400K yr to now ... massively redshifted

$t = 4000\ K \longrightarrow t = 4\ K$

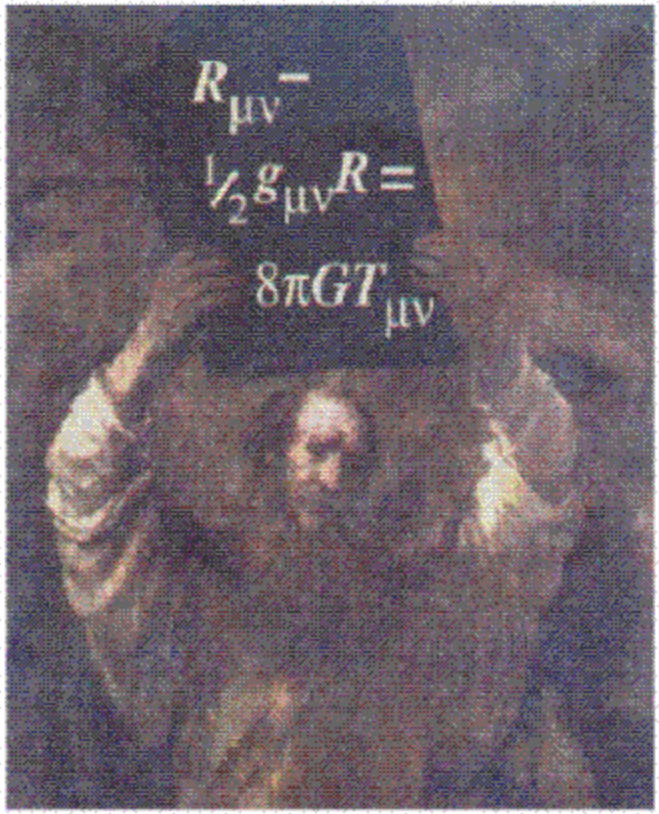
"Perfect Blackbody"

Should come to us from all directions

Cosmic Microwave Background

"CMB"

Why Believe? ...

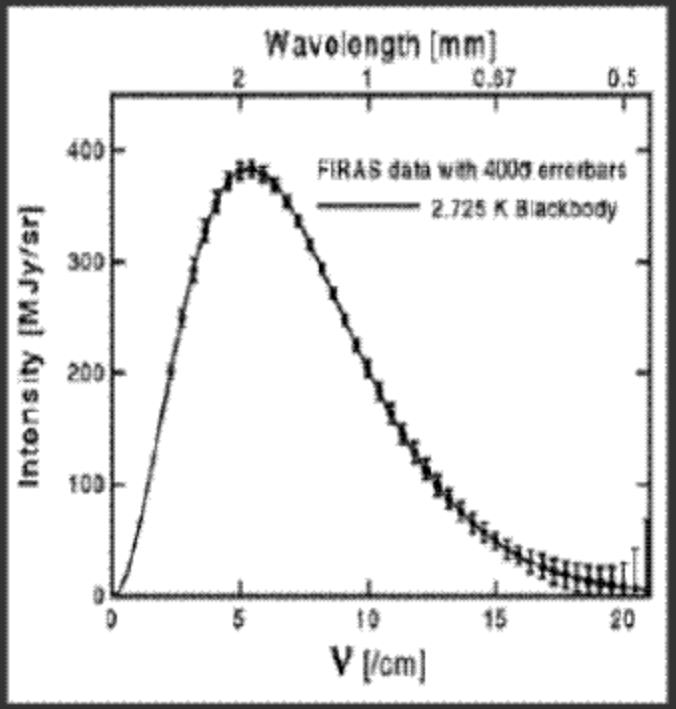


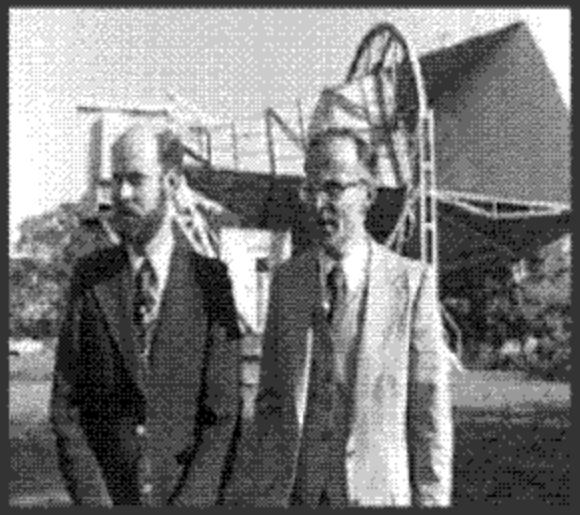
– R. Kolb

Evidence for Big BANG

Cosmic Microwave Background

Penzias and Wilson - 1964





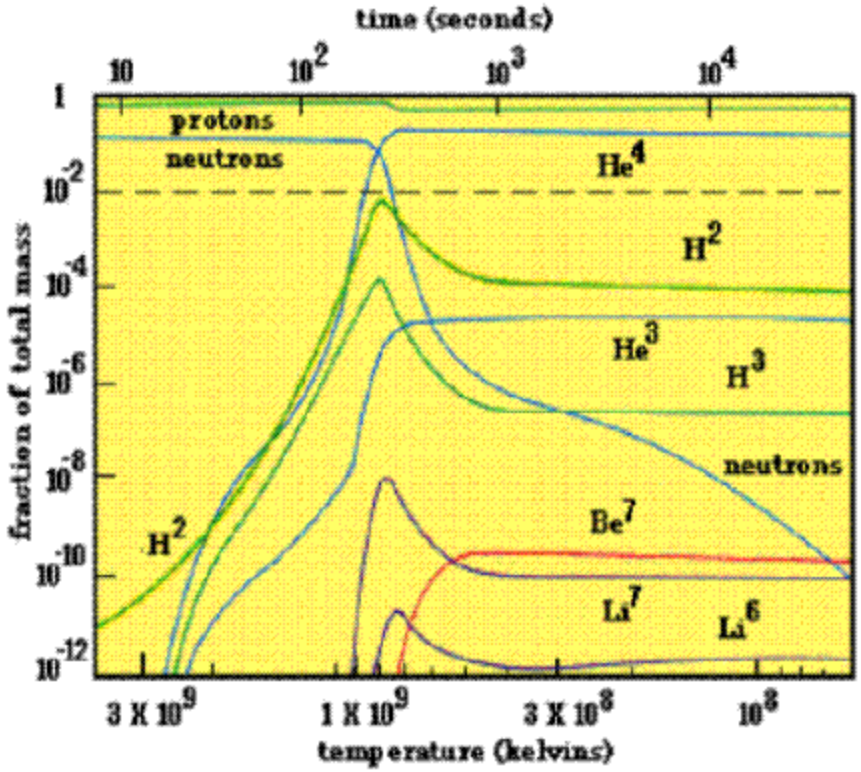
Uniform and isotropic

– in as far as they could measure

1978 Nobel Prize

Big Bang Nucleosynthesis

$t \cong 100$ seconds



http://www.astro.ucla.edu/~wright/BBNS.html

We see ~expected distribution of light nuclei in universe.