

Physics 100 - April 4, 2007

Exam 2 time → April 11

Note Change!

Presentation Schedule

- 16 17, Solar System formation
- 18 2, nucl. bombs - 6, GPS - 18, Football
- 23 24A, Feynman - 21, nucl. Terrorism
- 25 26, music
- 30 24, Galileo - 25, comets MASS ext.

for Apr. 11 exam —

waves, electromagnetic waves, diffraction, refraction, interference, dispersion, Planck, blackbody radiation, photoelectric effect, de Broglie and his matter wave hypothesis, rise of quantum mechanics, the electron-volt, how imaging depends on wavelength, Bohr, Bohr model of atom, circular motion, mathematical condition for circular motion, atomic spectra (what is meant by spectrum? cause of spectra, potential use), Heisenberg, Schroedinger, Schroedinger's equation (basically what it is and why important, not how to solve it or write it down), basic idea of what comes out of Schroedinger's equation when solved for case of hydrogen atom, atomic orbitals, Rutherford, Rutherford scattering, intrinsic spin, fermions, bosons, Stern-Gerlach experiment, periodic table of the elements, atomic bonds, covalent and ionic bonds, Heisenberg's uncertainty principle, Copenhagen interpretation of quantum mechanics, many worlds interpretation of quantum mechanics, Max Born, quantum entanglement, Roentgen, x-rays, lasers, proton, neutron, nuclear physics, relevant energy scale for atomic and nuclear processes, gamma decay, beta decay, alpha decay, band of stability, half life, decay constant, binding energy/nucleon curve, fission, fusion, fission bombs, chain reaction, stellar evolution, black holes, neutron stars, white dwarfs, supernovae, synthesis of elements

we discussed upcoming exam and reviewed
a few things

Review of Particle Physics →

Fundamental Particles

Fundamental Forces

Strength

Quarks
u, d, c, s, t, b
fractional electric chg

(qqq) *strong*
p, n
Baryons

$(q\bar{q})$
Mesons
 π, K

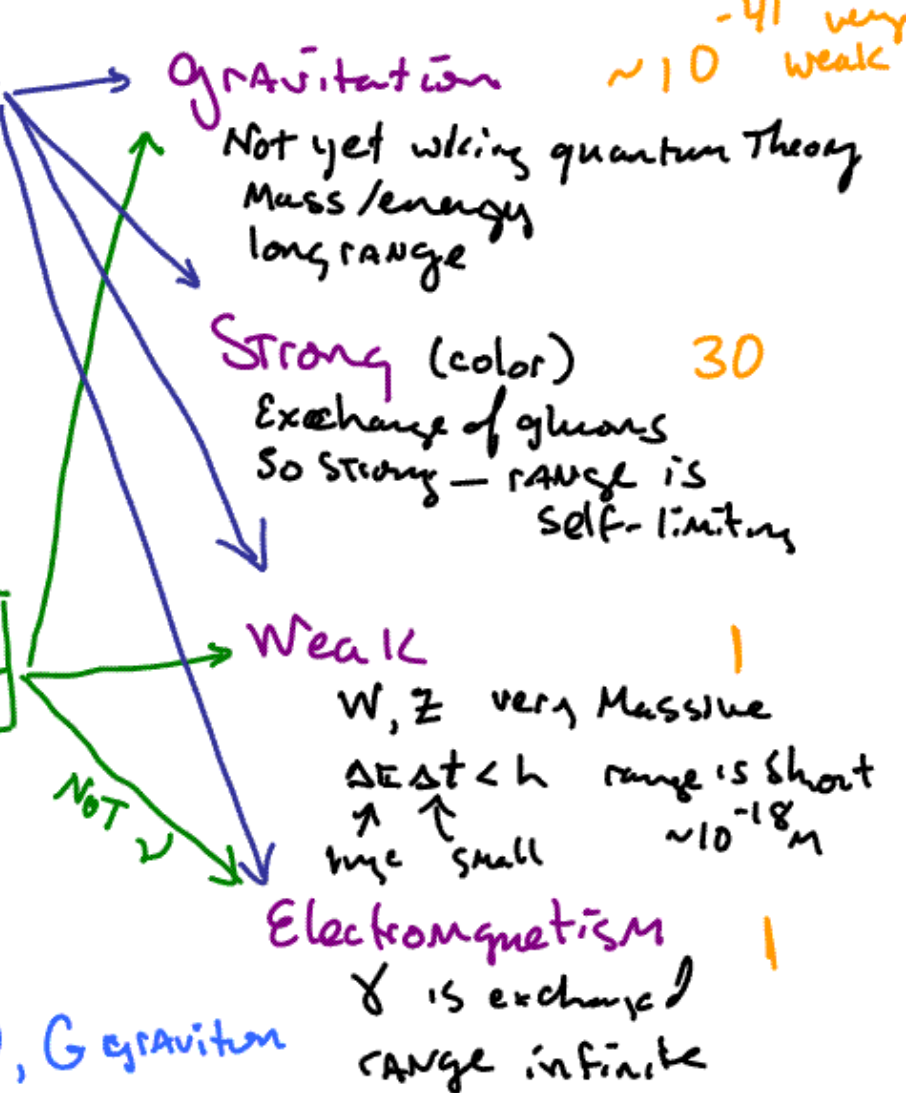
Leptons
e, μ, τ (charged)
 ν_e, ν_μ, ν_τ (neutral) (neutrinos)

Gauge Bosons
mediate forces
 γ photon, $W^{+/-}, Z^0, g$ (gluon), G graviton

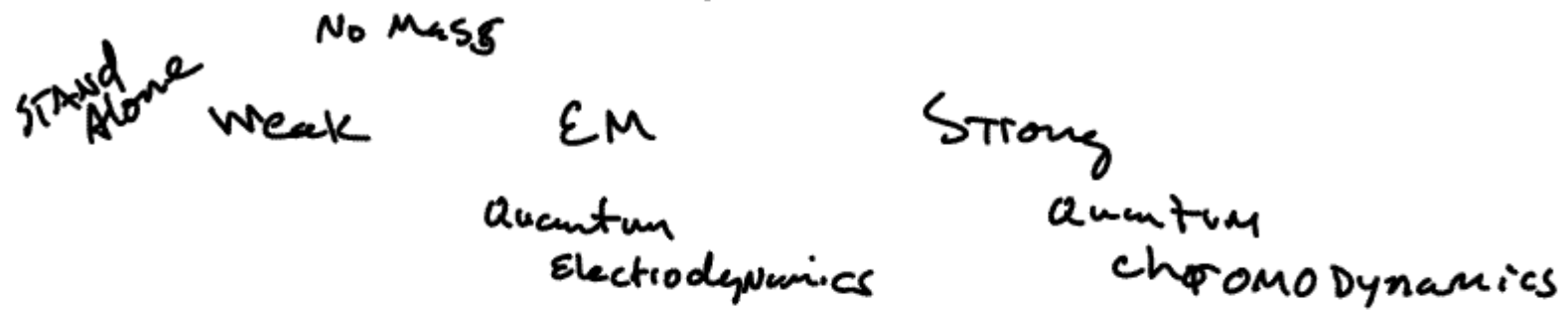
Higgs (undiscovered)

Feel

Feel



Quantum Field Theory



Weak + EM + Higgs

↓

Electroweak force

Mass of Particles ok

W, Z



↓

STANDARD Model

Experimentally Successful

Something does what Higgs does

Active Area of research

Neutrinos

neutral, small mass, 3 types



formed in nuclear reactions (β decay)

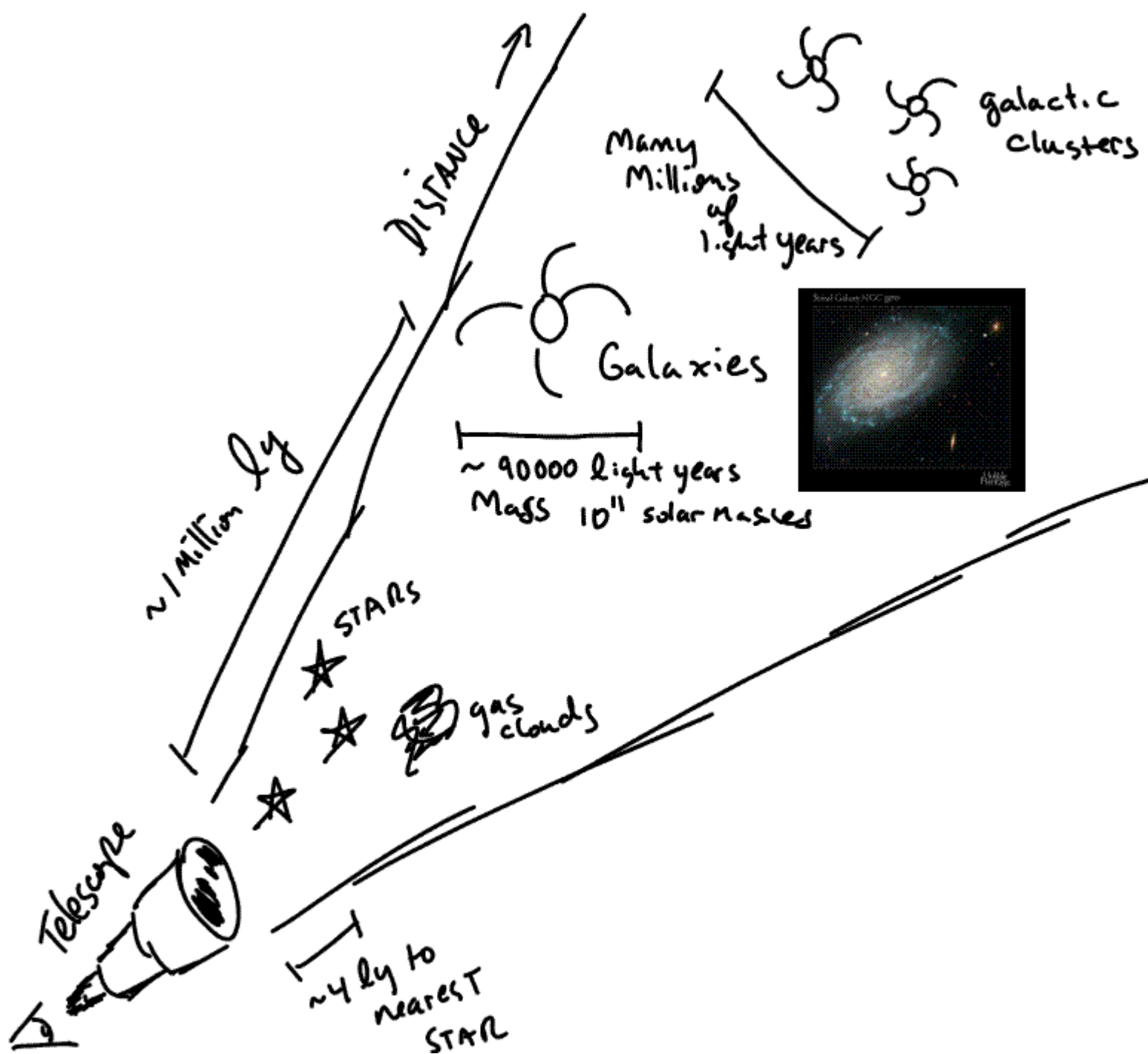
Produced in core of STARS

(early STAGES of universe, Supernovae)

$\nu_e \longrightarrow \nu_\mu \longrightarrow \nu_e$ can oscillate

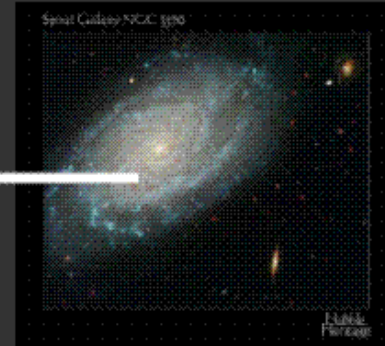
Possible explanation looking for

Matter - Antimatter ASymmetry
in universe.

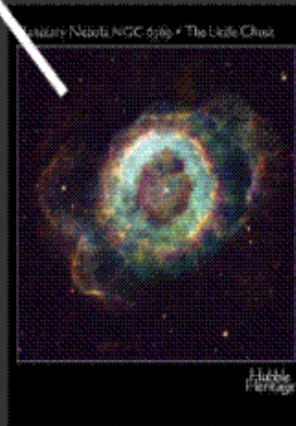


Light travels at a finite speed

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.



**Edwin Hubble (1889-1953)
discovers a surprise in 1929**

**Galaxies that are further away
appear redder**

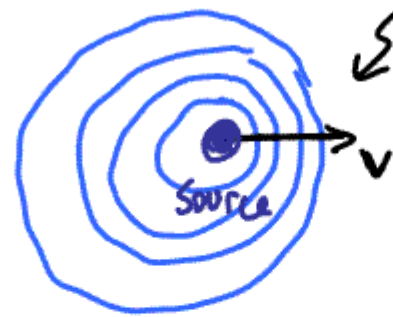
Apparent Doppler shift

check out doppler shift Applet :

http://galileoandeinstein.physics.virginia.edu/more_stuff/flashlets/doppler.htm

"Redshifted"
light

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



frequency appears higher
to observers in direction
of motion



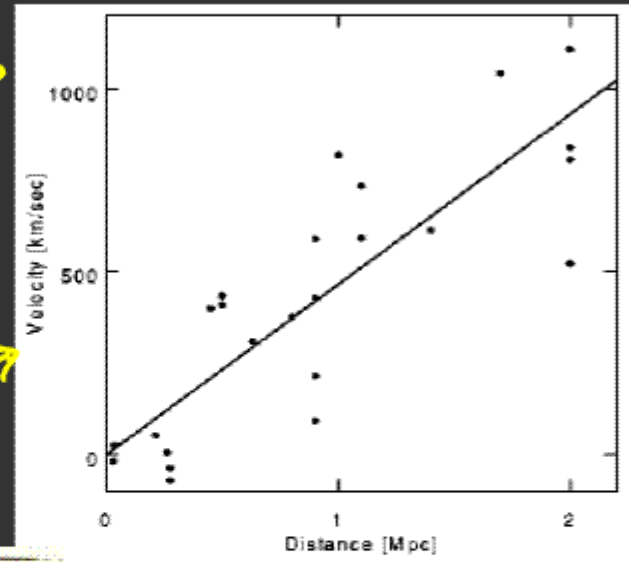
"Blueshifted"
light

larger v — larger the red and blueshifts.

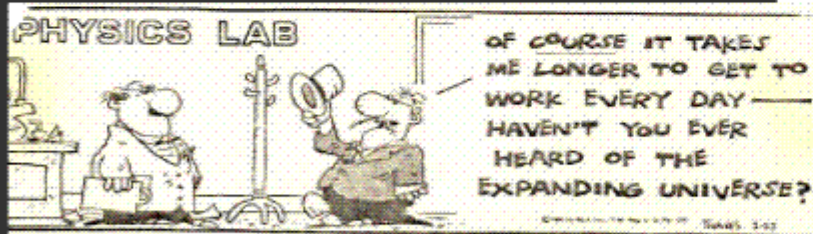


How fast galaxy
moves
away
from
us

Early
Measurement



↑
Distance to galaxy

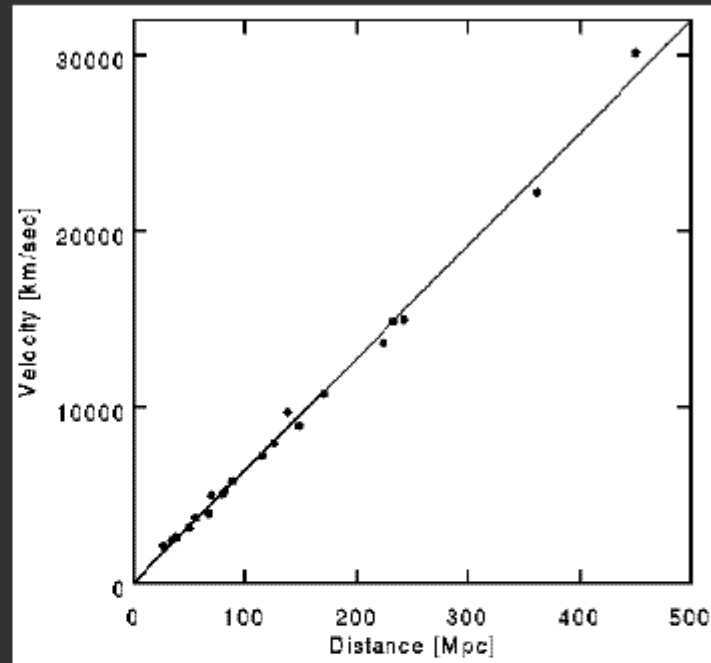


Hubble notes that the galaxies all recede from us
... more distant galaxies recede from us faster

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

**Welcome to the
“expanding universe”!!**

**extrapolate back in
time find the age of the
universe → 13 billion
years.**



Type Ia SNe from Riess, Press and Kirshner (1996)

more modern data ... looking at galaxies much farther away

Space in the universe is expanding!

Think of Raisin bread or dots on balloon.