Astronomy: Taking Pictures of the Night Sky

Thursday 1/21/2021 – 3/3/2021 6:15 – 7:00 pm

Zoom: https://us02web.zoom.us/j/85949382384?pwd=R08xKzZuRXAxNkk3dXErSk1BSmpSQT09

David M. Caditz Ph.D.

What you will need:

1. iPhone
2. NightCap camera app. (https://nightcapcamera.com/nightcap-camera/)
    a) Please familiarize yourself with the online tutorials
3. Tripod or equivalent camera mount: (e.g., https://www.amazon.com/s?k=iphone+tripod)
4. Shutter release
    a) Some tripods come with remote shutter release.
    b) You can also use the iPhone headphone volume up/down button.

Optional equipment:

1. Photo editing app (e.g., https://apps.apple.com/us/app/snapseed/id439438619)
2. Binoculars. Telescope or telephoto lens
3. iPhone adapter (e.g., https://www.amazon.com/s?k=iphone+telescope+adapter)
    a. This is to mount the iPhone to the binoculars or telescope

Week 1: Photographing the Moon

- Dark location
- Atmosphere
- Phases and shadows
- Focus, ISO, Shutter speed

- Scenic vs Close- up

Apps to consider:

- Planets (http://www.qcontinuum.org/planets)
- Moon Phase and Lunar Calendar (https://apps.apple.com/us/app/moon-phases-and-lunar-calendar/id1126370589)
- Exif Metadata (https://apps.apple.com/us/app/exif-metadata/id1455197364)

Moon Data:

https://nssdc.gsfc.nasa.gov/planetary/factsheet/moonfact.html
https://community.dur.ac.uk/john.lucey/users/lunar_sid_syn.html

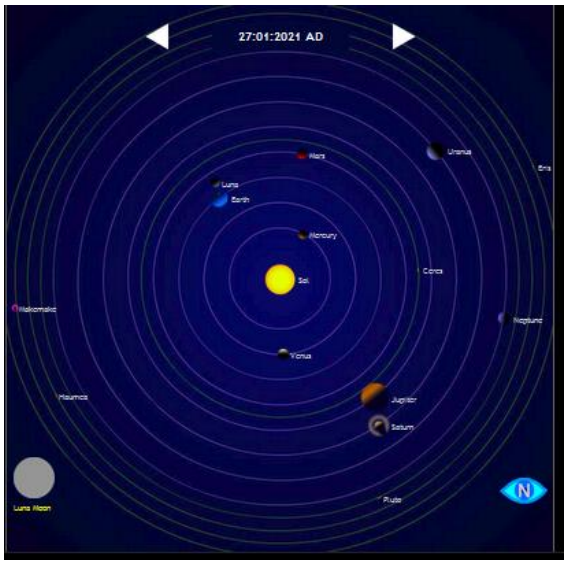
- Mass = 0.012 Earth
- Radius = .27 Earth
- Orbital Radius: 3.8 x 10^5 KM = 60 X Earth radius
- Orbital Period:
  - Sidereal 27.32 days (relative to stars)
  - Synodic 29.53 days (relative to Earth)
- Crater Theophilus:
  - 100Km diameter. 4000m deep, central mountain 1400m high
  - Grand Canyon 1800m deep

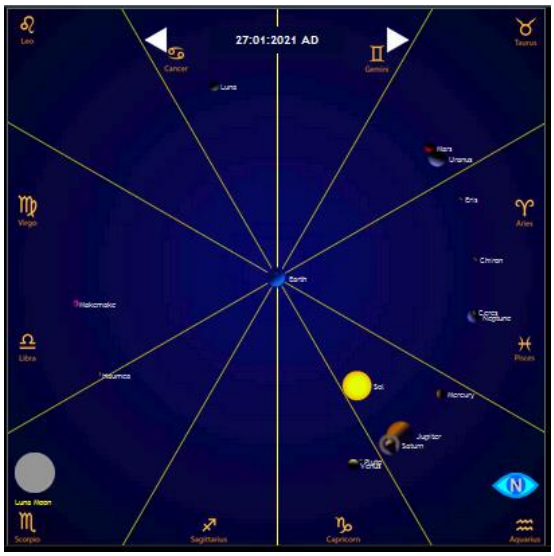
Theories of Moon Formation:

- Capture (But Earth and Moon are very similar in chemical composition)
- Fission (Spinning earth split. Hard to make happen)
- Co-formation (You might expect moon to have similar iron core as Earth)
- Giant Impact (explains why moon has small iron core)

Week 2: The Planets

- Visualizing the Solar System
  - Earth-centric vs Sidereal
    - https://www.theplanetstoday.com/index.html
    - https://eyes.nasa.gov/apps/orrery/#/home
    -





- Planet Comparison
  - https://ssd.jpl.nasa.gov/?planet_phys_par
  - https://callumprentice.github.io/apps/planet_compare/#

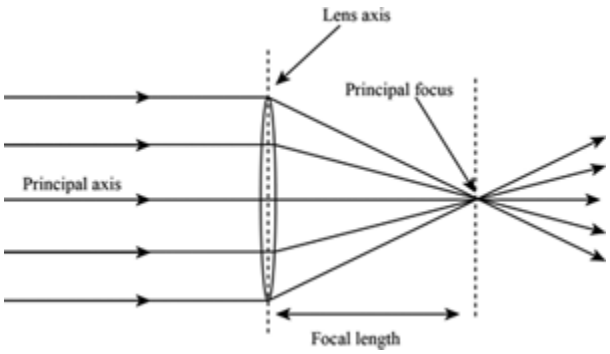
- Example Photos:
  - https://www.ericteske.com/2012/04/iphone-astrophotography-of-venus.html

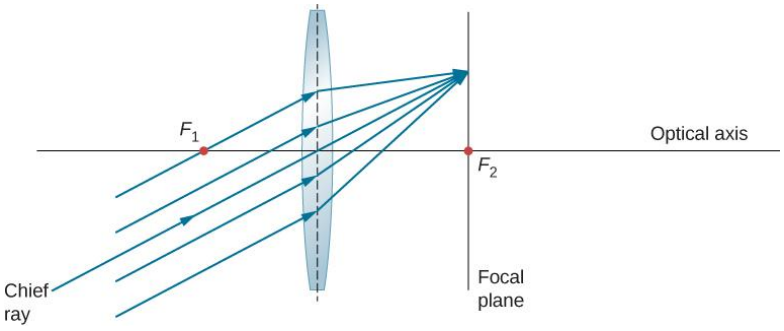
Week 3: Eyes, Optics, CCDs, Formation of the Solar System

Human eye dark adaptation:

- Pupils open, change from cones to rods.
- 20 mins to adjust to darkness.
- Astronomers use dim red flashlight to not interfere with dark adaptation.
- Averted vision.

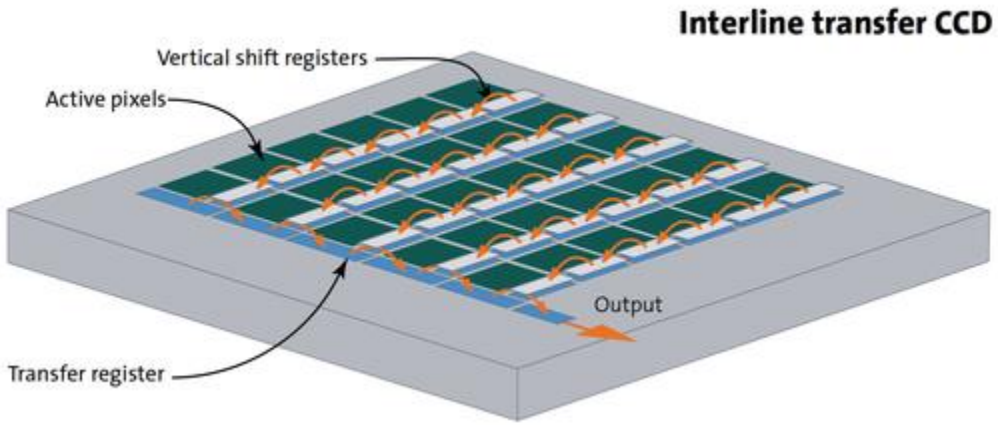
Optics lens and focal plane:



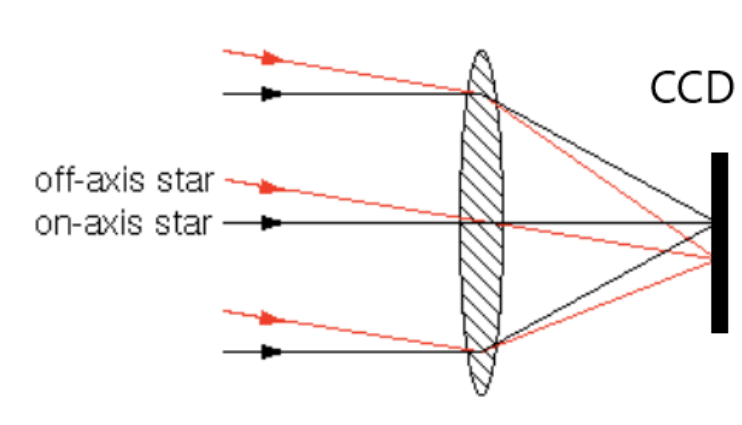


Light entering a lens is bent to the focal plane

CCD: “grid of buckets”



iPhone X: 4000 x 3000 grid = 12,000,000 pixels



Solar System Composition and Theories of Formation

Nebular Hypothesis (https://en.wikipedia.org/wiki/Nebular_hypothesis)

Stars form from gravitational collapse of Giant Molecular Cloud (mostly hydrogen)

Frost Line: **water, ammonia, methane, carbon dioxide, carbon monoxide**

Week 4:

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Note: Mars Landing 11:15 am PST Thursday February 18!

https://mars.nasa.gov/mars2020/timeline/landing/watch-online/

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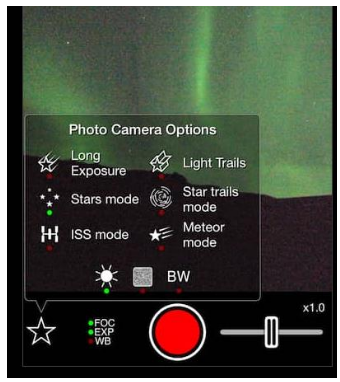
1. Stars Mode



Nightcap Stars Mode

1. Set up camera on tripod in dark location
2. Open NightCap
3. Point toward desired constellation
4. Select Stars Mode
5. Tap to dismiss info screen
6. Press shutter to start photo – it will automatically stop in a few seconds

Orion Constellation

7. The Messier Catalog

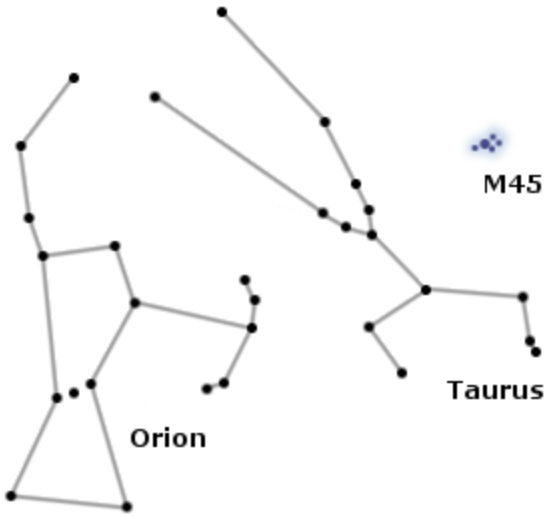
In 1758 Charles Messier, searching for comets.

110 objects in the Northern hemisphere sky. M1 – M110

https://www.nasa.gov/content/goddard/hubble-s-messier-catalog

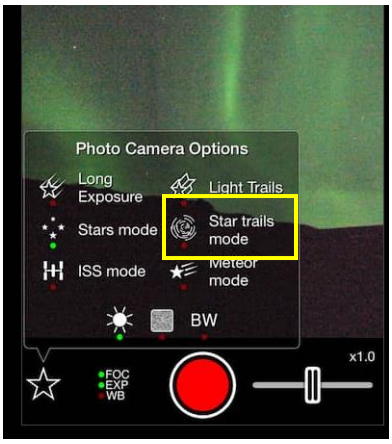
M31 Andromeda Galaxy

M45 **The Pleiades Star Cluster**


M45
Taurus
Orion

Week 5:

1. Star Trails



Nightcap Star Trails Mode

a. Find North direction.
b. Choose a nice foreground. (No bright lights!)
c. Set up camera on tripod.
d. Wait for dark sky.
e. Nightcap: select star trails mode (tap to dismiss info screen.)
f. Press shutter button to start. (it is nice to use a remote shutter release)
g. Wait about 10-30 minutes
h. Press shutter button again to stop

2. Astronomy Distances

Speed of light: 670,616,629 mph

186,282 miles per second

299,792 kilometers per second

It takes 8 minutes 19 seconds for light to travel from Sun to Earth.

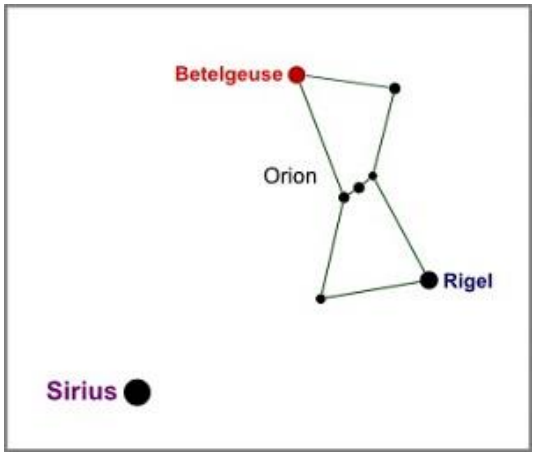
Light Year: How far does light travel in 1 Year?

300,000 kilometers/sec x **60** sec/min x **60** min/hour x **24** hour/day x **365** day/year

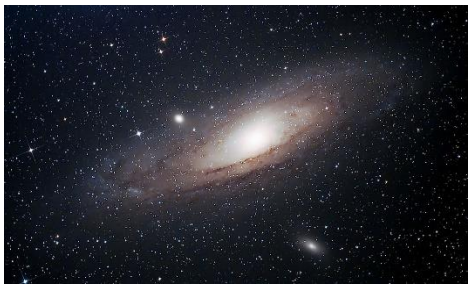
= 9,400,000,000,000 kilometers

Nearest stars to Earth (not including Sun):

	Star system	Distance in light-years
1	Alpha Centauri	4.24-4.37
2	Barnard's Star	5.96
3	Wolf 359	7.78
4	Lalande 21185	8.29
5	Sirius	8.58
6	Luyten 726-8	8.73
7	Ross 154	9.68
8	Ross 248	10.32
9	Epsilon Eridani	10.52
10	Lacaille 9352	10.74
11	Ross 128	10.92



Nearest Galaxies:



Andromeda Galaxy: 2.5 million LY

3. Hubble Telescope Archive

   https://hubblesite.org/resource-gallery/images

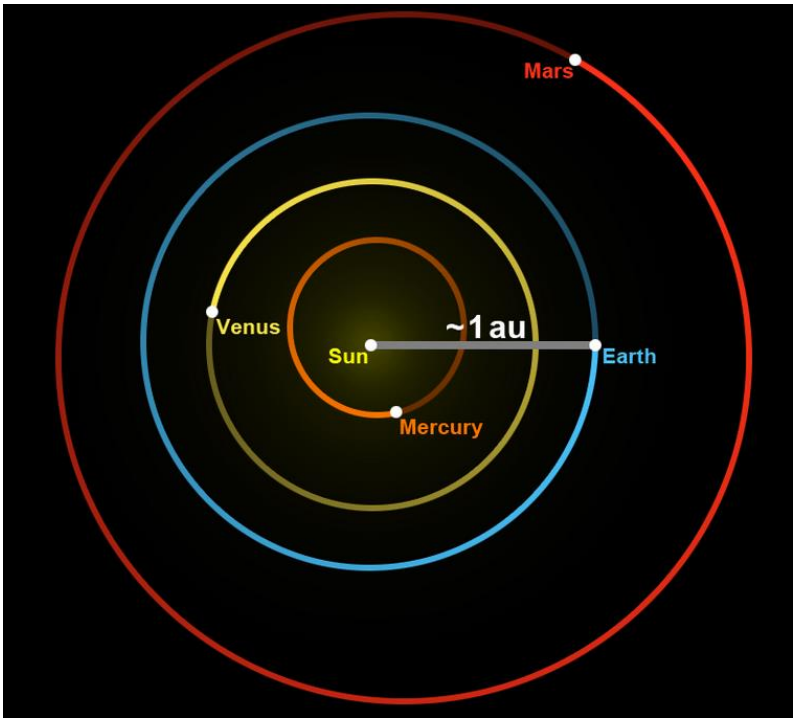
Week 6:

1. Your Photos?

2. The Cosmic Distance Ladder

   How do we know how far away objects are?

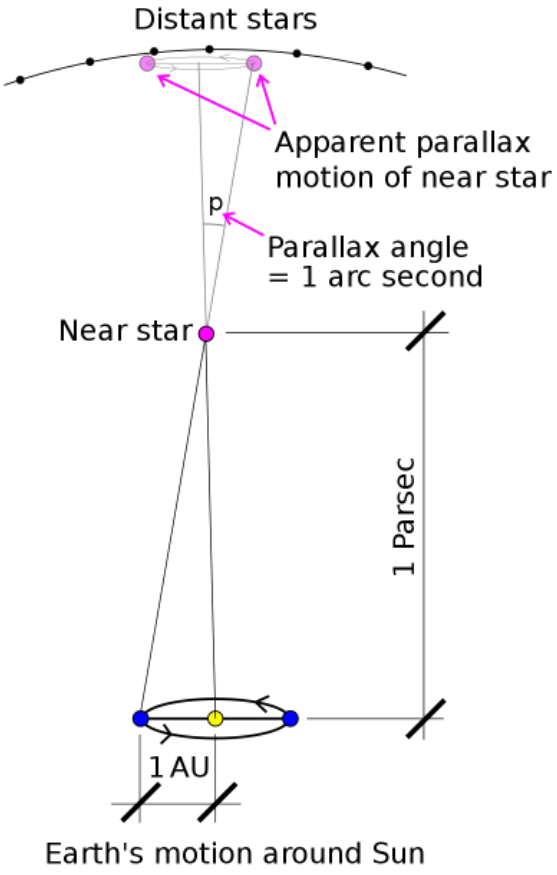
   1. Orbital Dynamics (planets)
      a) Astronomical Unit: (1AU = 150,000,000 km)



Planet	Period (years)	Radius (AU)
Mercury	0.24	0.39
Venus	0.6	0.72
Earth	1.00	1
Mars	1.88	1.52
Jupiter	11.86	5.20
Saturn	29.46	9.54
Uranus	84.01	19.19
Neptune	164.82	30.06

$$G M /(4 \pi^2) P^2 = R^3$$

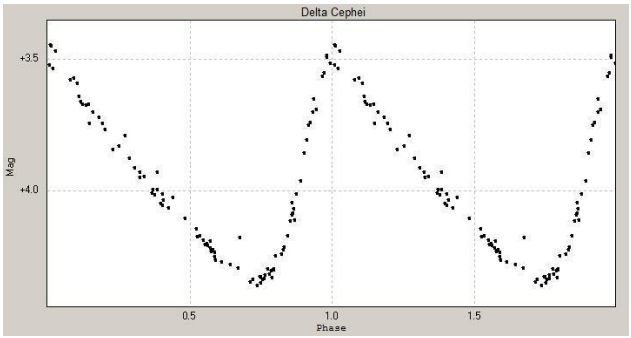
2. Parallax (stars up to a few thousand light years)
    a) Parsec: (= 3.26 LY)

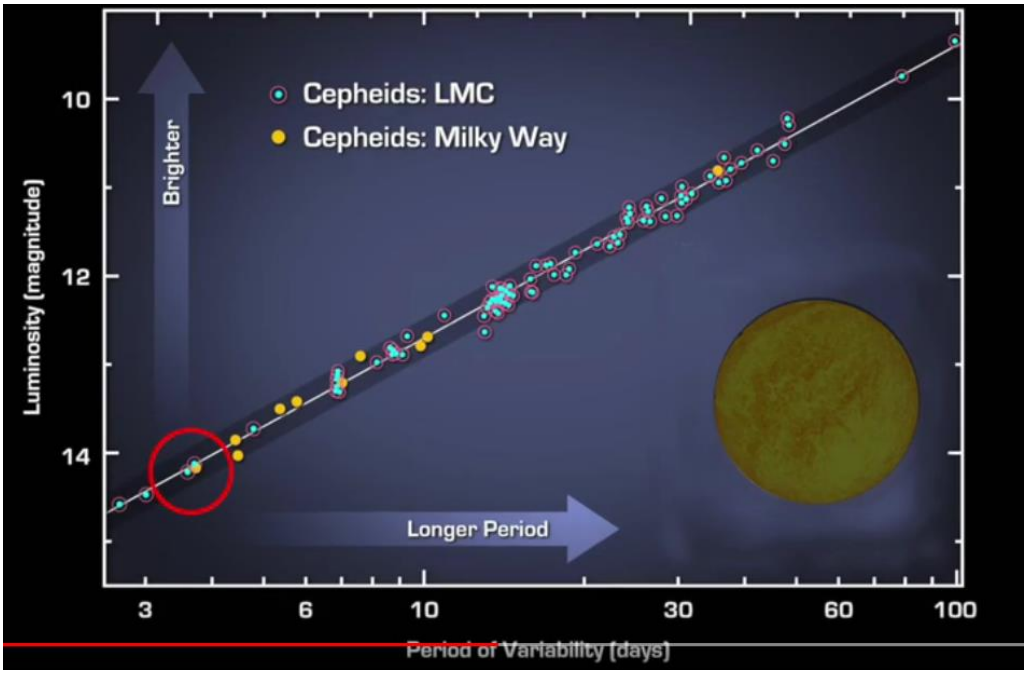


3) Standard Candles

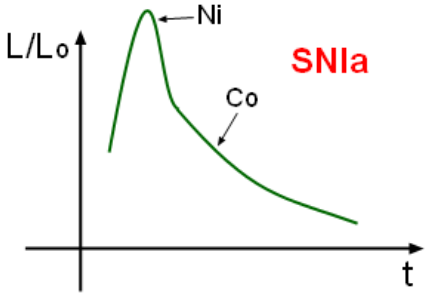
a) Cepheid Variables (Nearby Galaxies - 50 million LY)

https://astronomy.com/news/2018/01/mapping-the-cosmos-with-cepheid-stars

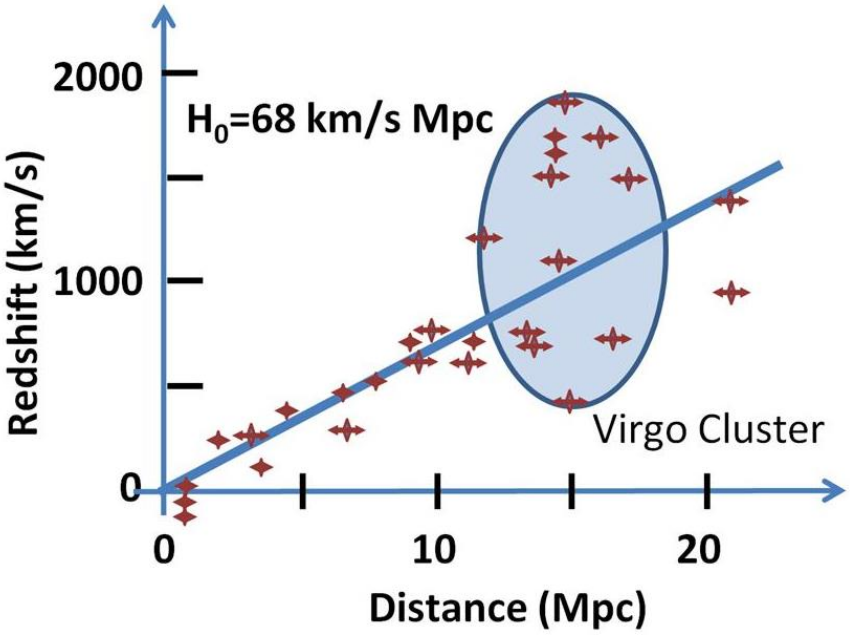


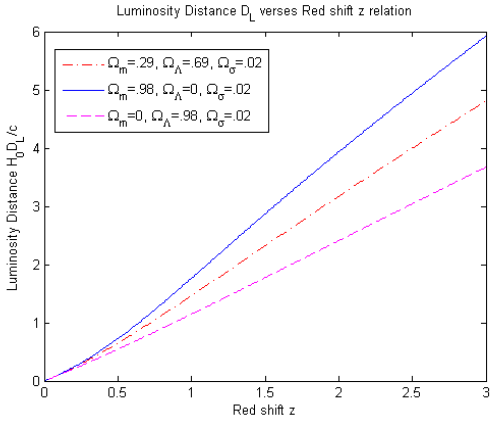


b) Type 1a Supernovae (up to ~10 billion LY)



4) Redshift (13 billion LY – age of universe)


2000
1000
0
H_0=68 km/s Mpc
Redshift (km/s)
Virgo Cluster
0
10
20
Distance (Mpc)


Luminosity Distance D_L verses Red shift z relation
Ω_m=.29, Ω_Λ=.69, Ω_σ=.02
Ω_m=.98, Ω_Λ=0, Ω_σ=.02
Ω_m=0, Ω_Λ=.98, Ω_σ=.02
Luminosity Distance H_0D_L/c
Red shift z
0
1
2
3
4
5
6
0.5
1.5
2.5