Astronomy 111

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Course Info

- ***read* course outline**: ***http://wordpress.viu.ca/arkosg***

Notes, Labs, Quizzes

- (***incomplete) notes*** posted ***online***
- ***labs*** *start next week (****bi-weekly****)*
- on the ***website***; *fill-in* format; ***NO*** lates
- ***NO*** deferred quizzes (***best 5 of 6***)
- there is ***NO*** "***make-up***" ***work***, ***extra work***, *etc*.

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Observing Project

- ***includes*** outdoor observations, independent work
- ***detailed*** *guidelines & due date* on ***website***
- ***NO lates***

Doing well

- ***come to class*** & ***participate***
- *don't leave* ***observing project*** *to the last minute*
- ***study, see me when you have Q's***

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CLICKER: *Which faculty do you belong to?*
(a) Sci & Tech
(b) Arts & Humanities
(c) Social Sci
(d) other

CLICKER: *How did you hear about this course?*
(a) VIU calendar
(b) recommended (by advisor, friend, etc.)
(c) course website or poster on campus
(d) other

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ASTR 111

Introductory Astronomy: The Solar System

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Course Overview

- Introduction
- History
- The Sky
- Seasons
- Eclipses
- Earth & Moon
- The Solar System

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- Earth is a ***planet*** which ***orbits the Sun***

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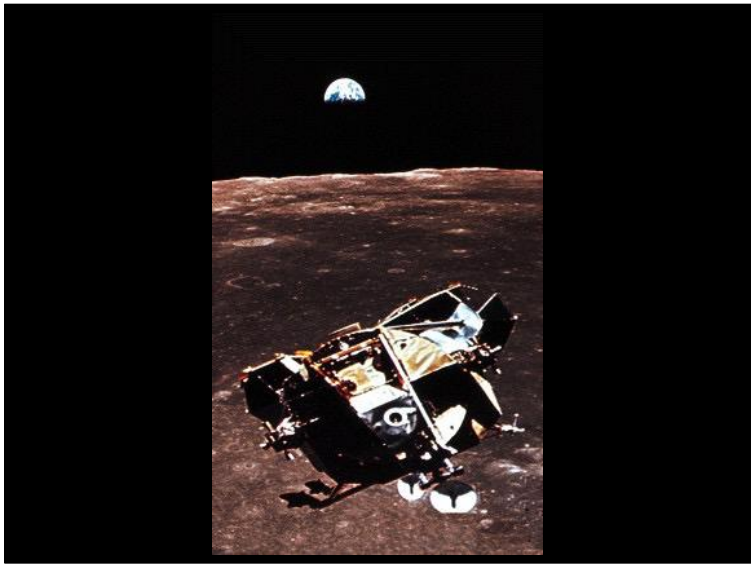

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CLICKER: *If Earth was the size of a basketball & the Moon a tennis ball, they would be roughly… ?*

(a) 1 foot apart
(b) 5 feet apart
(c) 25 feet apart
(d) 100 feet apart

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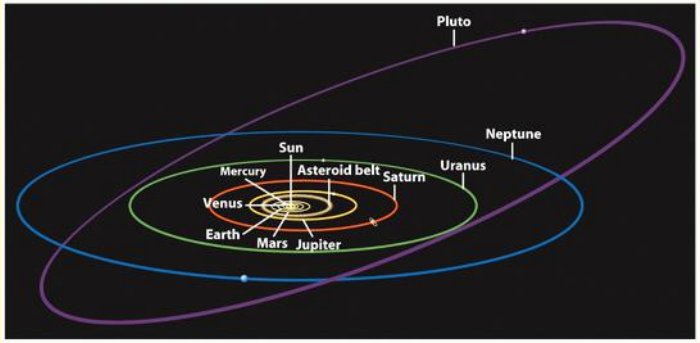
Our Solar System

- consists of the *Sun & **all** objects orbiting it*



Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune

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How to remember the order...

MVEMJSUN

"**M**y **V**ery **E**xcellent **M**other **J**ust **S**erved **U**s **N**achos"

"**M**ore **V**elocity **E**nsign **M**ight **J**ust **S**ave **U**s **N**ow"

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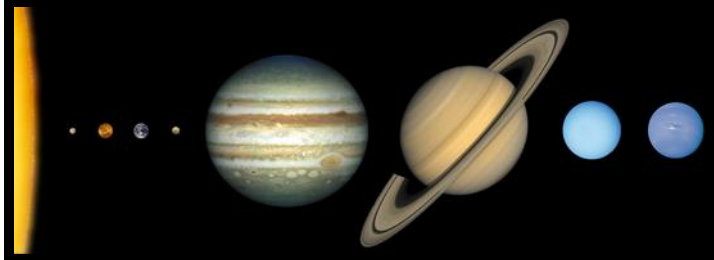
Relative Sizes



Q: *What trends do you notice about the planets?*

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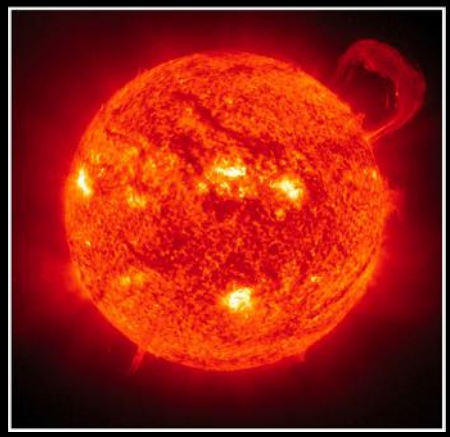

• our Sun is a ***star*** similar to ***those we see at night***

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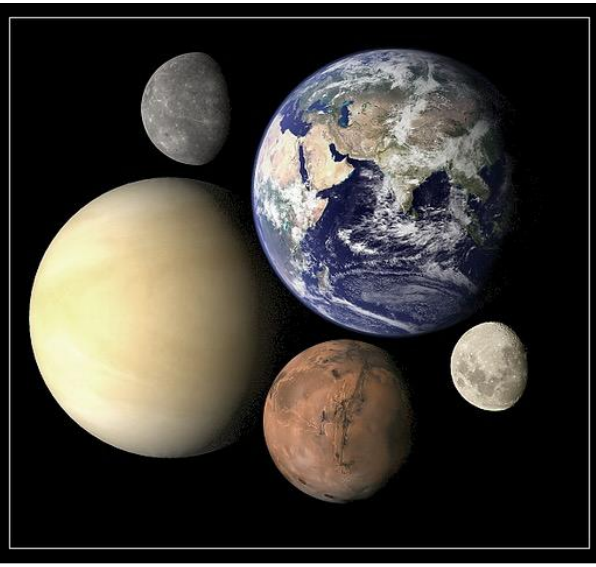

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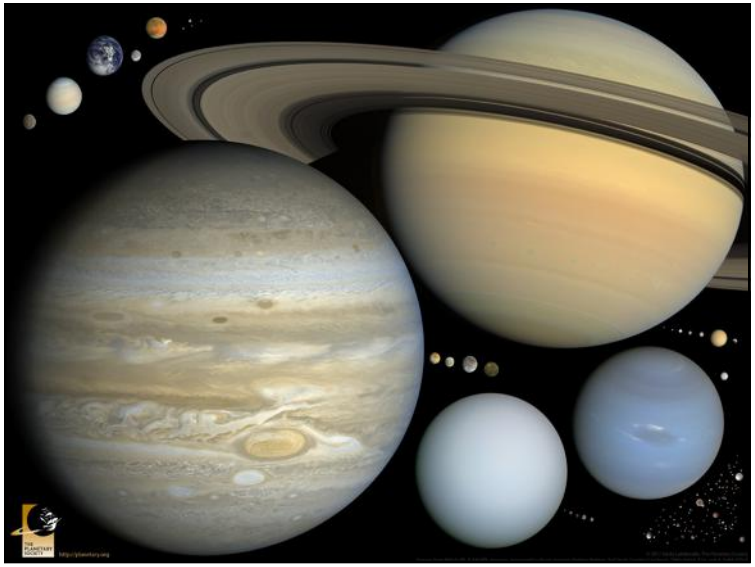

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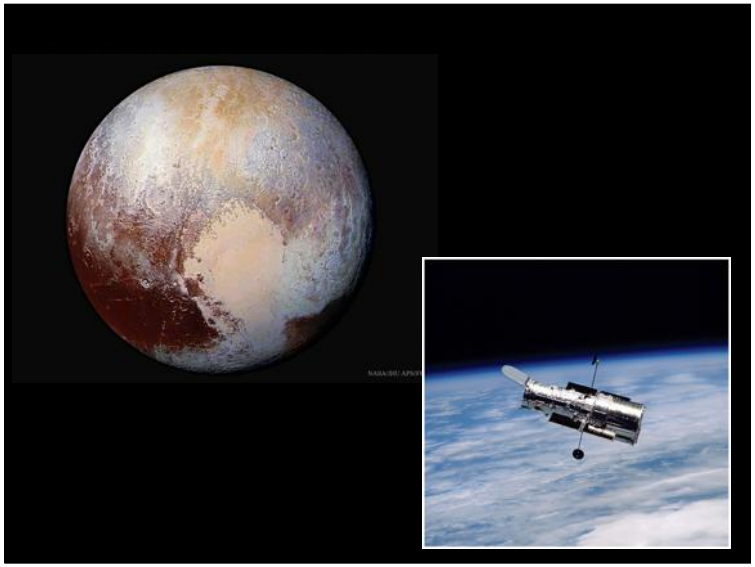

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- ***solar system & stars we see**** are in ***Milky Way***

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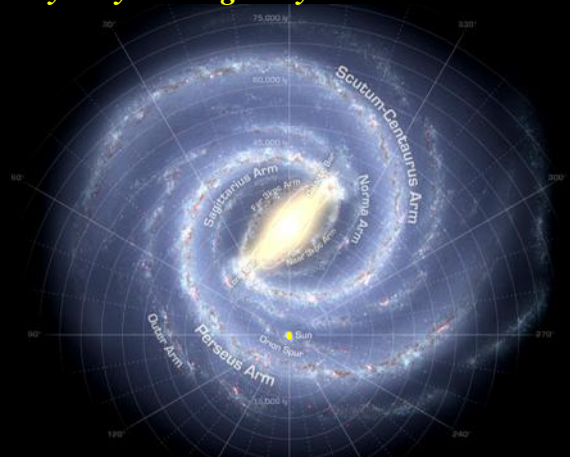
- ***Milky Way*** is our ***galaxy*** - 100+ billion stars



- count all the stars in our galaxy: ~ ***3000 years***

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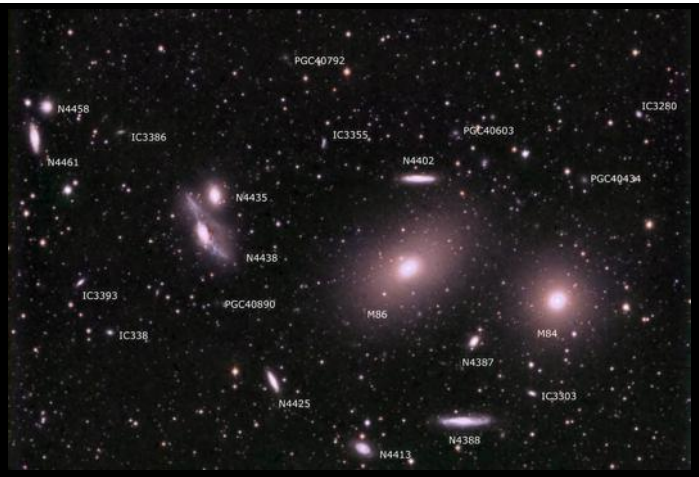

- ***Milky Way*** is one of many ***galaxies***
- ***galaxies*** exist in ***groups*** called ***clusters***

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• ***100 billion*** galaxies in the (observable) **universe**

• **number of stars in the universe**… ***exceeds all the grains of sand on all the beaches on the Earth***

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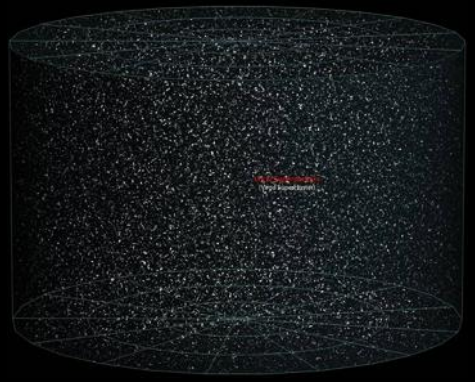
Our Cosmic Address

Observable Universe



• *Earth, the Solar System, the Milky Way, the Local Group, Virgo Supercluster, the Universe*

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The Universe

• …is ***expanding*** (it was *smaller* in the past!)

CLICKER: *How old is the universe?*

(a) thousands of years
(b) millions of years
(c) billions of years
(d) trillions of years

• …is ~***13.7 billion years*** *old*

• originated in the ***Big Bang*** *("primordial fireball")*

• *Sun & solar system* formed ***much*** later

• ~ ***4.6 billion years ago***

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A Sense of Time…

Represent **Big Bang** to **present** on **12 month calendar:**

• ***Big Bang*** took place ***Jan 1st***

• ***Milky Way*** formed in ***February***

• ***Earth*** formed around ***mid-August***

CLICKER: *When did abundant,* ***complex*** *life appear?*

(a) late August
(b) early October
(c) mid December
(d) late December

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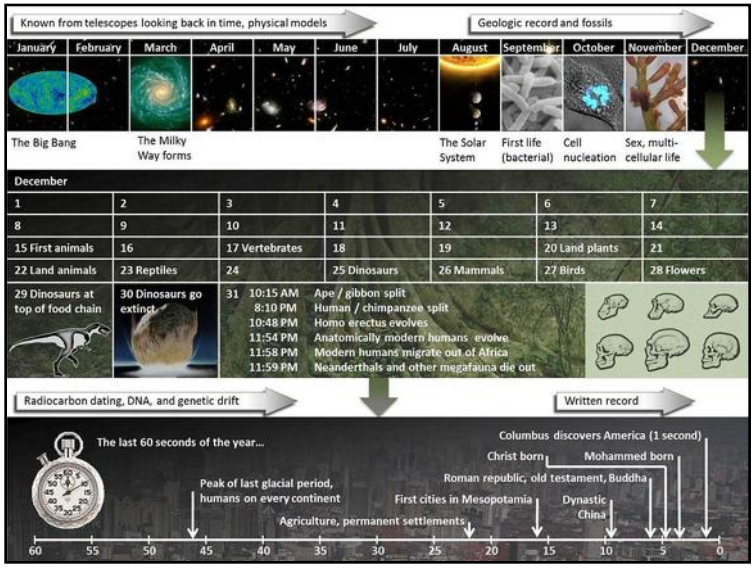

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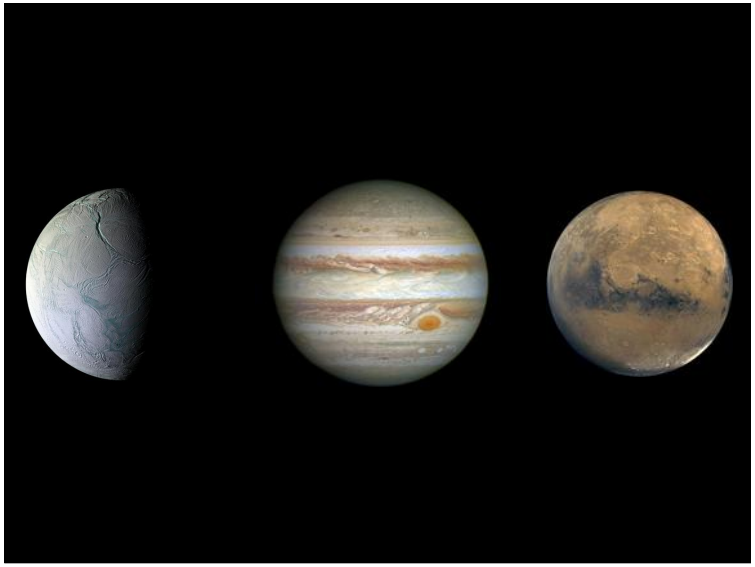

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Science

- ***science*** is based on the ***scientific method***

(1) ***predict*** (*hypothesis* or *model*) ⇒ a ***Law*** or ***Theory***
(2) ***observe*** (or *experiment*)
(3) ***accept***, ***modify*** or ***reject***

"In questions of science, the authority of a thousand is not worth the humble reasoning of a single individual."
-- Galileo

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CLICKER: *What is it* ***specifically*** *that disqualifies astrology from being considered a "science"?*

(a) deals with phenomena beyond the Earth
(b) astrology has never been tested
(c) UBC does not offer a degree in astrology
(d) does not adhere to the scientific method

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Pseudo-Science

"Listen to the evidence; it never lies." *- Gil Grissom, CSI*

- *pseudo-science* lacks *evidence* or is *untestable* and ***does not*** adhere to ***scientific method***

(eg) astrology

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Scientific Notation

- also called *exponential notation*
- useful for *very large* (& *very small*) numbers
- written as a number times a *power of ten* (10)

$2.5 \times 10^4 = 25{,}000$

- *exponent* tells you how many *tens* to multiply by:

$2.5 \times 10^4 = 2.5 \times (10 \times 10 \times 10 \times 10)$
$= 2.5 \times (10000)$
$= 25{,}000$

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- *exponent* tells how many *places* to move *decimal*:

$1.0 \times 10^2 = 100.0$ ⇒ *decimal moves 2 places to right*

$3.0 \times 10^{-1} = 0.3$ ⇒ *decimal moves 1 place to left*

(eg) Write the following in scientific notation:

- distance to the Sun: 148,800,000 km
- exponential notation: 1.488×10^8 km
- size of an atom: 0.0000000001 m
- exponential notation: 1.0×10^{-10} m

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• can also use metric *prefixes*:

giga (G) - one billion
mega (M) - one million
kilo (k) - one thousand
micro (μ) - one millionth
nano (n) - one billionth

(eg) a *thousand* meters is a… ?

(eg) a *billionth* of a second is a… ?

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Astronomical Unit (*AU*)

• distances in astronomy can be *very* large

• so a *large* unit is *convenient* to measure distances!

• ***astronomical unit*** (***AU***) is "***the average distance between the centers of the Earth and Sun***"

1 AU = 1.5 x 10^8 km

(eg) *Jupiter is ~ 5.2 AU from the Sun*

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Light Year (*ly*)

• *distance* light travels (*in a vacuum*) in *one year*
• it is a *distance*, ***not*** a time!

1 ly = 9.46 x 10^{12} km

(eg) To drive a light year at 100 km/h would take:

$$time = \frac{length}{speed} = \frac{9.46 \times 10^{12}\,\text{km}}{100\,\text{km/h}} = 9.46 \times 10^{10}\,\text{hours}$$

• this is nearly ***11 million years***!

(eg) ***Proxima Centauri*** *(closest star beyond Sun)* is 40x10^{12} km **or** 265,000 AU **or** 4.2 ly *away*

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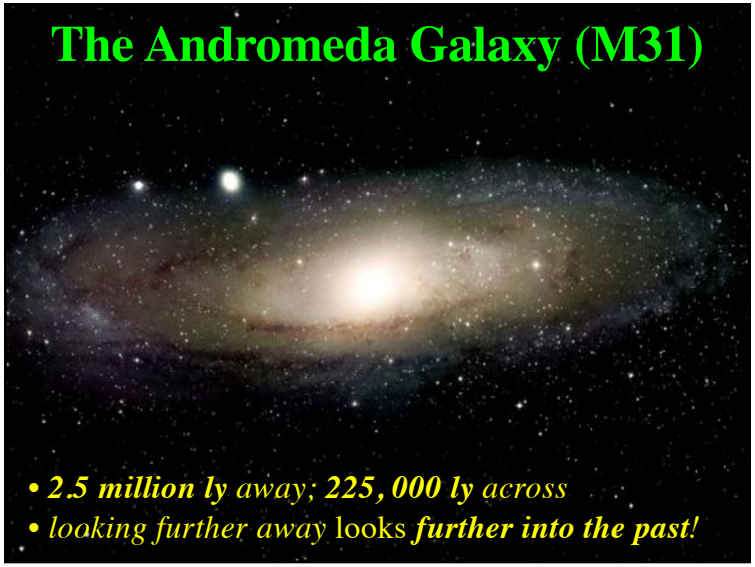
The Andromeda Galaxy (M31)



• ***2.5 million ly*** *away;* ***225, 000 ly*** *across*
• *looking further away* looks ***further into the past!***

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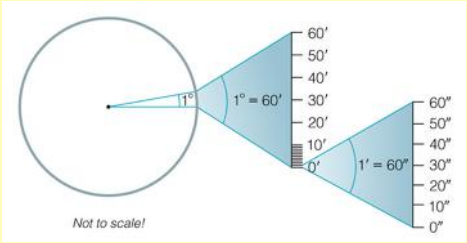
Angular Measurement

- *angular measurement* is in ***degrees***
- 360 degrees (°) in a circle
- a degree is divided into 60 ***arcminutes*** (*arcmin* or ')
- a minute is divided into 60 ***arcseconds*** (*arcsec* or '')



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CLICKER: *The separation between the pointer stars in the Big Dipper is 5° . What is this separation in arcminutes?*

(a) 60
(b) 300
(c) 3600
(d) 18, 000

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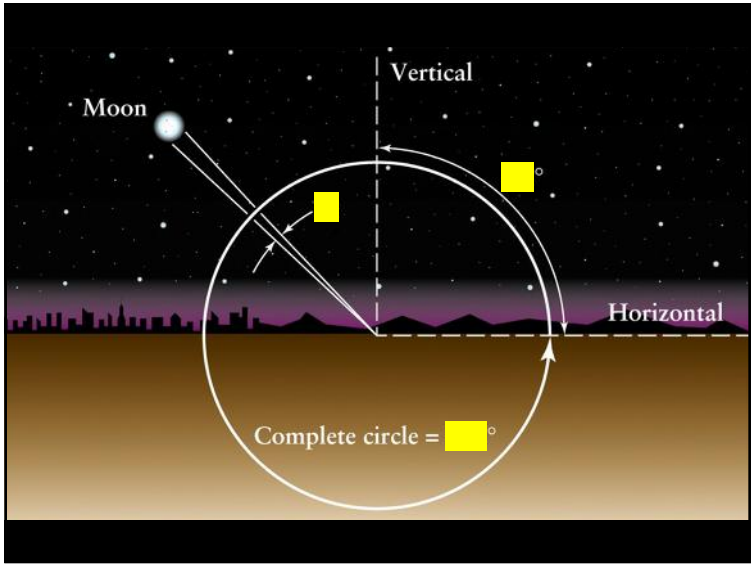

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Angular Separation of Objects

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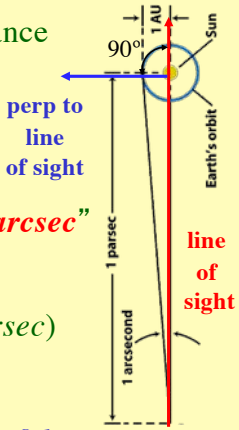
Parsec (*pc*)

- another astronomical unit of distance

1 pc = 3.09 x 10^{13} km = 3.26 ly

- ***"the distance at which 1 AU perpendicular to the observer's line of sight makes an angle of 1 arcsec"***



- for even ***larger*** distances use **kpc** (*kiloparsec*) or **Mpc** (*megaparsec*)

(eg) *1 kpc = 1000 pc = 1x10^3 pc*

(eg) *Earth to center of Milky Way ~ 9 kpc*

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CLICKER: *Which of the following distances are* ***best*** *measured using astronomical units (AU)?*

(a) distances on the Earth
(b) distances within our solar system
(c) distances between stars in our galaxy
(d) distances between galaxies

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