PHYS 1403 Stars and Galaxies

Questions for Todays Class

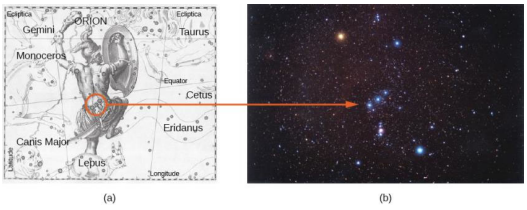
1. What are Constellations?
2. How do we name stars?
3. How do we measure brightness of stars?
4. What are the distance units used in Astronomy?
5. What do we Mean by the Scale of the Universe?

What are Constellations?

Topics
1. Old Definitions
2. Modern Definitions

Old Definitions

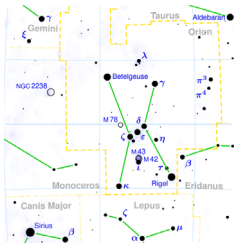
Certain group of Stars appeared as great heroes and mythological figures



Modern Definitions

Today constellations are referred to as regions in the sky defined by boundaries much like counties on a map of a Texas state.

Yellow dash line defines the boundary of the constellation Orion



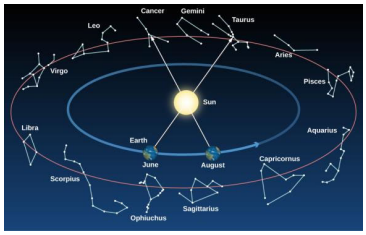
https://en.wikipedia.org/wiki/File:Orion_constellation_map.png

http://ontheworldmap.com/usa/state/texas/texas-county-map.html

Constellations

- There are 88 Constellations
- 12 of these hold special significance because the Sun passes through them in the course of a year. They are called Zodiacal constellations and are also used by Astrologers.

Constellations of the Zodiac



Position of the Sun in a zodiacal constellations as the Earth revolves in a year

How do we name stars?

Topics

1. Greek Letters
2. Naming convention
3. Examples

Order of Greek Letters

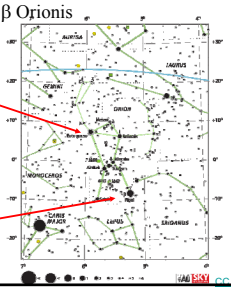
A α	alpha	N ν	nu
B β	beta	Ξ ξ	ksi
Γ γ	gamma	O o	omicron
Δ δ	delta	Π π	pi
E ε	epsilon	P ρ	rho
Z ζ	zeta	Σ σς	sigma
H η	eta	T τ	tau
Θ θ	theta	Y υ	upsilon
I ι	iota	Φ φ	phi
K κ	kappa	X χ	chi
Λ λ	lambda	Ψ ψ	psi
Mμ	mu	Ω ω	omega

Greek alphabet chart © by deTraci Regula; licensed to About.com

Star Names in a Constellation

Stars are named by a Greek letter (α, β, γ) according to their relative brightness within a given constellation + the possessive form of the name of the constellation:

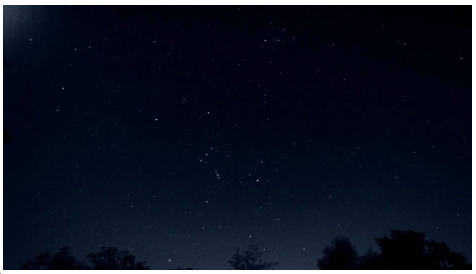
Betelgeuse = α Orionis
Rigel = β Orionis



https://en.wikipedia.org/wiki/Orion_(constellation)#/media/File:Orion_IAU.svg CC BY 3.0

Night Sky View

It is clear that not all stars are the same brightness.
How do you measure the brightness of a Star?



www.startribune.com

How do we measure brightness of stars?

Topics

1. Night Sky view
2. History
3. Modern Definition
4. Comparing Brightness
5. Quantifying Brightness – Magnitude Equation
6. Examples
7. The Magnitude Scale used Today
8. Constellation Stars and Magnitudes

History

- Greek astronomer Hipparchus (160-127 BC) invented a number system to measure brightness of stars based on their appearance of brightness.
  - Brightest stars: ~1st magnitude
  - Faintest stars (unaided eye): 6th magnitude

This scale is subjective and does not have a quantitative basis

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Modern Definition

- In1856 Norman Pogson proposed that the eye's perception of light is logarithmic so five (6-1=5) magnitude difference corresponds to $\sqrt[5]{100} \approx 2.512$, consequently 1st magnitude star is 2.5 times brighter than 2nd magnitude star and the 3rd magnitude star is 2.5 x 2.5 = 6.25 times brighter than 1st magnitude star.

Larger the magnitude number, fainter the brightness of star

Larger the magnitude, smaller the size on the chart

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Comparing Brightness

This table is one way to remember the relationship between brightness and magnitude.

Magnitude Difference	Corresponding Flux Ratio
0.00	1.00
1.00	2.51
2.00	6.31
3.00	15.8
4.00	39.8
5.00	100

This table is limited if the magnitude difference has decimal numbers

Quantifying Brightness –Magnitude Equation

This is how Astronomers work it out. The proper way to do it.

Apparent Magnitude (*m*): Brightness of the star irrespective of its distance from us

m = apparent magnitude
b = brightness
1 = Star A
2 = Star B

$$m_1 - m_2 = 2.5 \log\left(\frac{b_2}{b_1}\right)$$

Examples

- Two stars differ by 3 magnitude. What is the brightness ratio?

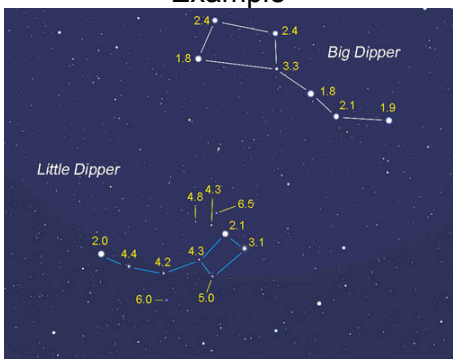
$$\frac{b_2}{b_1} = (100^{0.2})^{m_1 - m_2} = 100^{0.2(3)} = 16$$

- Sirius is 24.2 time more bright than Polaris. What is the magnitude difference?

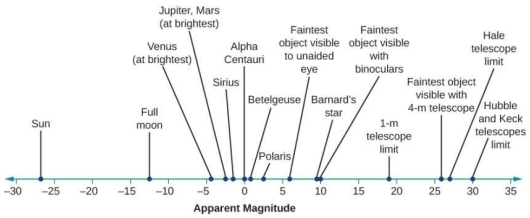
$$m_1 - m_2 = 2.5 \log\left(\frac{b_2}{b_1}\right) = 2.5 \log(24.2) = 2.5 \times 1.38 = 3.5$$

Exercise: Practice with these two examples to learn how to do it in your calculator

Example



Extended Magnitude Scale



What are the distance units used in Astronomy?

Topics

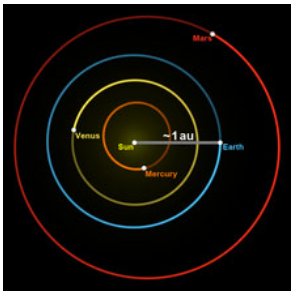
1. Astronomical Unit (au or AU)
2. Light Year (ly or LY)

Astronomical Unit

One Astronomical Unit is the distance between the Earth and the Sun.

1 Astronomical Unit (AU) = Distance Sun – Earth = 150 million km

Our solar system is 80 AU in diameter



The Light Year

Astronomical Unit is inadequate to use for large distances
So
We need a new unit of distance

1 light year (ly) = Distance traveled by light in 1 year

= 63,000 AU = 10^{13} km

= 10,000,000,000,000 km

(= 1 + 13 zeros)

= 10 trillion km

Speed of light = c = 3 x 10^8 m/s

Nearest star to the Sun:

Proxima Centauri, at a distance of 4.2 light years

Light Year is also a look back time: The farther we look the older the Universe we see

What do we Mean by Scale of the Universe?

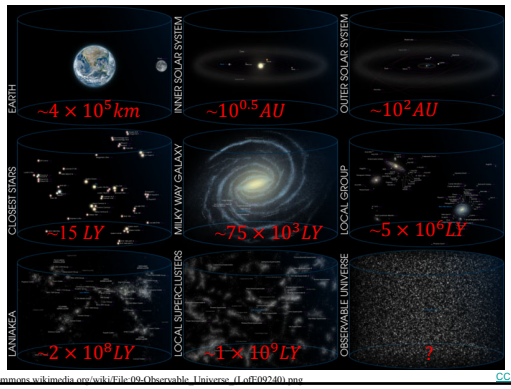
Topics

1. Powers of 10^x
2. Universe on the Large Scale
3. Universe on the Small Scale

Powers of 10

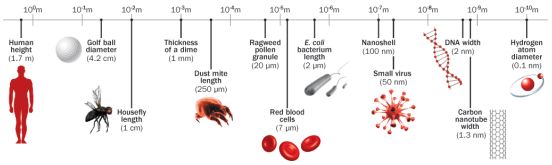
- Distances can be approximated in powers of 10 to show the large scale of the Universe. Positive exponent of 10 show large numbers.
- Powers of 10 can also be used to show the microscopic scale in the Universe. Negative exponent of 10 show very small numbers.

Universe on the Large Scale



https://commons.wikimedia.org/wiki/File:09-Observable_Universe_(LotE092240).png CC BY 2.0

The Universe of the Very Small Scale



http://www.sciencenews.org/pictures/120410/nanotubes_sizes_zoom.gif

Acknowledgment

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