Comments

- “Space is big. Really big. You just won't believe how vastly hugely mind-bogglingly big it is. I mean, you may think it's a long way down the road to the chemist, that's just peanuts to space.”
  — *Hitchhiker's Guide To The Galaxy* by Douglas Adams

Units

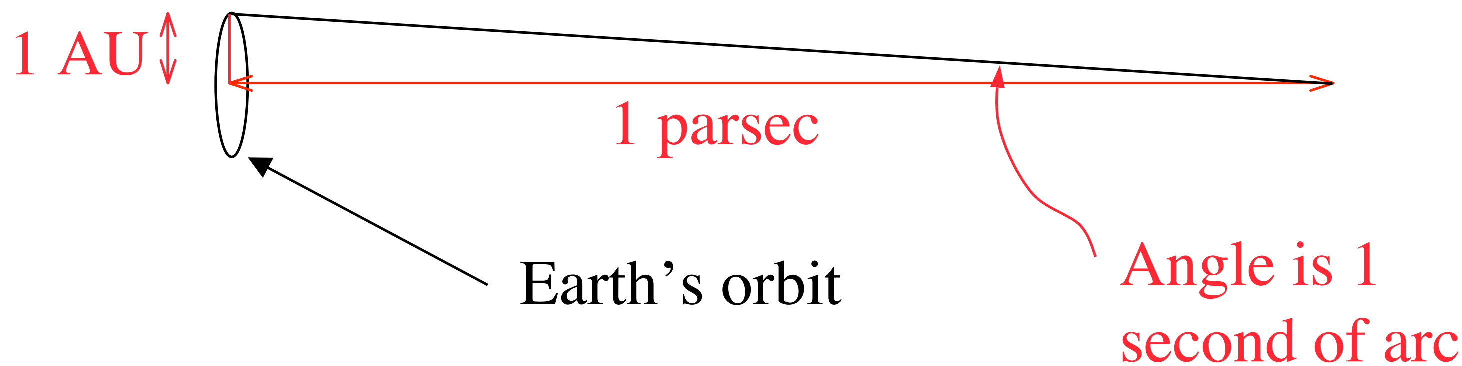
- Because everything in astronomy is on a grand scale, and because it has often been difficult to make measurements in traditional units (e.g., SI units), astronomers have developed their own peculiar set of units to describe astronomical phenomena.
- Anyone interested in doing research connected to astronomy needs to be familiar with these units, which appear all over the literature.

Distance

- There are two major units of astronomical distance
  - Astronomical Unit (AU), essentially the mean distance from the Earth to the Sun.
  - Used to describe distances in the solar system
  - 1 Astronomical unit (AU)$\approx 1.5\times 10^8$ km
  - The conventional nine planets are from 0.4 to 40 AU from the Sun; solar system extends to thousands of AU

Distance

- There are two major units of astronomical distance
  - The parsec is used to measure distances in the galaxy and between galaxies
  - 1 parsec=2.06265 × 10^5 AU ≈ 3 ×10^{13} km



  - When an astronomer says "parallax," she means "distance." It is the angle at the right, when the star is a given number of parsecs from the Sun

Distance

- There are two major units of astronomical distance
  - Nearest star to sun is over 1 parsec away
  - Density of stars near sun is about 0.1 star per cubic parsec
  - Sun is about 10^4 parsecs from center of galaxy
  - Nearest galaxy (Large Magellanic Cloud, or LMC) is about 5×10^4 parsecs away
  - Nearest large galaxy is about 8×10^5 parsecs away, nearly 1 *megaparsec*.
  - The observable universe is measured in tens of *gigaparsecs*.

Masses

- Masses of astronomical objects are generally measured in terms of the Sun's mass
  - Historical reasons: Mass of sun can't be measured directly and one got better predictive accuracy of orbits in terms of that unit than if one tried converting to SI units
  - 1 solar mass (1 $M_\odot$) $\approx 2\times10^{30}$ kg
  - Largest planet in solar system (Jupiter) has mass less than $10^{-3}\ M_\odot$
  - Stars have masses from less than 0.1 $M_\odot$ to almost 100 $M_\odot$
  - Large galaxies have masses of order 10^{11}-$10^{12}\ M_\odot$

Luminosities

- Luminosities (energy output of a star or galaxy per second) is usually measured in terms of the Sun's luminosity
  - 1 solar luminosity ($L_\odot$)$\approx 4\times10^{27}$ joules/second
  - Stellar luminosities range from about $10^{-4}L_\odot$ at the low end to $10^{6}L_\odot$ at the high end.

Magnitudes

- To confuse the issue, astronomers commonly use a logarithmic scale to describe the luminosities of stars. The scale is defined so that a difference of 5 in the magnitude corresponds to a *factor* of 100 in the luminosities
- To further confuse the issue, numerically smaller magnitudes correspond to *more* luminous objects
- The system goes back to ancient times, when the brightest stars visible to the naked eye were designated "first magnitude" and the faintest "sixth magnitude". A difference of one magnitude is readily recognized by the naked eye, whereas a smaller difference is more difficult to discern.

Magnitudes

- Astronomers also distinguish *apparent magnitude m*, that which we observe from Earth (what the ancients defined) and *absolute magnitude M*, defined as the apparent magnitude a star would have if it were at a standard distance of 10 parsecs.
- The absolute magnitude of the Sun is about +4.8
- The apparent magnitude of the Sun is about -26.7
- There is a *defined* relationship between apparent magnitude, absolute magnitude, and distance, given by

$$M = m + 5 - 5\log_{10} d$$

  where d is the distance to the star in parsecs.
- The quantity *m-M* is the *distance modulus* of an object, and is directly related to the object's distance (and is often used instead of a distance expressed in parsecs, particularly with galaxies)