Units in astrophysics

(Read Chapters 1, 2, and 3 of "Fundamentals of Astrophysics" by Stan Owocki)

Angles: There are 360 degrees in a circle.
There are 60 arcminutes in one degree (60' = 1º).
There are 60 arcseconds in one arcminute (60"= 1'). ("The Babylonian's Revenge")

The Moon covers about half a degree, or about 30 arcminutes.
The resolution limit (the smallest detail) the unaided human eye can see is about 1'.
The resolution limit of the Campus Observatory's telescope is about 2-3".
This is set by turbulence in Earth's atmosphere, called *seeing*.

The best ground-based telescopes (on Earth's surface) get 0.25" resolution 25% of the time, although computer-controlled adaptive optics can do better.

The resolution limit of *Hubble Space Telescope* is 0.07". This is because it is above Earth's atmosphere, so the seeing is perfect. It's still limited by diffraction, because light has wave properties (see Chapter 2).

One arcsecond is a *tiny* angle. It's only 1/3600th of one degree. If I were 2 miles from you and I held up a dime, you would see it cover one arcsecond (1").

Astronomers now routinely measure angles of less than 1".
The state-of-the-art is now milliarcseconds, or 1/1000th of 1".
This is the angle covered by a dime 2000 miles from you (in Chicago, from Fresno).

CGS units (centimeters-grams-seconds) (cm-g-s) (which really shouldn't be a big deal)**:**

The original definition of the gram (during the French Revolution, when the metric system was created) was that one gram of water at room temperature and at atmospheric pressure has a volume of 1 cm^3.

Density:	1 g cm^{-3} for liquid H_2O 7 g cm^{-3} for solid Fe 14 g cm^{-3} for solid Pb 22.6 g cm^{-3} for solid osmium (element 76) 10^6 g cm^{-3} = 1 metric Tonne/cm^3 for white dwarf material 10^{14} g cm^{-3} = 10^8 T/cm^3 for neutron star material
Force:	1 dyne = 1 g cm s^{-2} = 10^{-5} Newtons
Energy:	1 erg = 1 g cm^2 s^{-2} = 10^{-7} Joules 1 erg ≈ the kinetic energy of a mosquito landing on you, pronounced "ergs" (not "urges").
Power (also called luminosity):	1 erg s^{-1} = 10^{-7} Watts
Magnetic field:	1 gauss = 10^{-4} Tesla Earth's B field ~ 0.5 G (Gauss) The Sun's global B field ~ 1 G In a big sunspot, B ~ 2000-6000 G Highest B fields known (in magnetars) ~ 10^{15} G = 10^{11} T Highest B field generated in a lab on Earth = 1200 T = 1.2 × 10^7 G

Owocki's book uses both CGS units and physics-standard MKS (meters-kg-s) (SI) units.
The Astrophysical Journal no longer changes MKS units into cgs units in papers they publish.
Are things changing?

Hybrid, or "canonical" units (scaled for what's to be measured):
1 solar mass = 1 $\mathfrak{M}_\odot$ = 2 × 10^{33} g = 2 × 10^{30} kg
1 Jupiter mass = 2 × 10^{27} kg = (1/1047.57) $\mathfrak{M}_\odot$ ≈ 10^{-3} solar masses
1 Earth mass = 6 × 10^{24} kg = 1/317.8 Jupiter masses

1 solar luminosity = 1 $L_\odot$ = 3.8 × 10^{33} erg s^{-1} = 3.8 × 10^{26} W ≈ 4 × 10^{33} erg s^{-1}
It's easy to memorize 2 × 10^{33} g and 4 × 10^{33} erg s^{-1}, which may be why astronomers still use cgs units.

1 solar radius = 1 $R_\odot$ = 7 × 10^{10} cm = 7 × 10^8 m = 7 × 10^5 km
Speeds are often given in km/s.

1 Astronomical Unit = 1 A.U. = the average distance between Earth and Sun
= 93 million miles = 1.5 × 10^8 km = 150 million km = 1.5 × 10^{13} cm
1 light-year = the distance light travels in one year = 6 trillion miles = 9.46 × 10^{12} km
1 parsec = 3.26 light-years = 3.086 × 10^{13} km = 3.086 × 10^{18} cm = 3.086 × 10^{16} m

1 parsec is defined to be the distance corresponding to an annual trigonometric parallax of 1".

Astronomers prefer to use **parsecs** over light-years, since parallax is something astronomers measure.