Equation summary: linear motion

- \( v = \frac{d}{t} \)
  - \( v \) = speed (or velocity)
  - \( d \) = distance
  - \( t \) = time

- \( a = \frac{v}{t} \)
  - \( a \) = acceleration

- \( F = ma \)
  - \( F \) = Force
  - \( m \) = mass
Eqn summary: circular motion

- $C = 2\pi r$
  - $C$ = circumference
  - $r$ = radius

- $v = \frac{2\pi r}{P}$
  - $v$ = speed around circle
  - $P$ = period

- $j = mvr$
  - $j$ = angular momentum
  - $m$ = mass

- $F_c = \frac{mv^2}{r}$
  - $F_c$ = Centrifugal Force
Gravity

- $F_g = G \frac{Mm}{d^2}$
  - $F_g =$ force of gravity
  - $G =$ gravitation constant
  - $M =$ mass (e.g. of planet or star)
  - $m =$ mass of object
  - $d =$ distance from mass $m$ to $M$

- $g = \frac{GM}{R^2}$
  - $g =$ acceleration of gravity
  - $M =$ mass (e.g. of planet or star)
  - $R =$ radius (e.g. of planet)
  - $M =$ mass (e.g. of planet or star)

- $W = F_g = mg$
  - $W =$ weight on planet
  - $g =$ acceleration of gravity
  - $m =$ mass of object

- $v^2 = \frac{GM}{r}$
  - $v =$ Orbital speed at radius $r$ around mass $M$
  - $M =$ mass (e.g. of planet or star)
  - $r =$ distance from mass $M$ to $m$
General form of Kepler’s 3rd law

\[
\frac{M_1 + M_2}{M_{\text{sun}}} = \frac{(a / AU)^3}{(P / \text{yr})^2}
\]

- \(M_1 + M_2\) = sum of masses of orbiting bodies (in \(M_{\text{sun}}\))
- \(a\) = semi-major axis of ellipse
  (for circ. orbits, \(a=\text{radius}\))
- \(P\) = Period (in years)
Waves & light

Waves

- $\lambda f = c$
  - $\lambda =$ wavelength
  - $f =$ frequency
  - $c =$ speed of light wave

- $E = hf = \frac{hc}{\lambda}$
  - $E =$ Energy
  - $h =$ Planck’s constant

Photon of light

- $F/F_{\text{sun}} = (T/T_{\text{sun}})^4$
  - $F =$ Flux (energy/area/time)

- $L/L_{\text{sun}} = (R/R_{\text{sun}})^2 (T/T_{\text{sun}})^4$
  - $L =$ Luminosity (energy/time)
  - $R =$ radius (in m)

- $\lambda_{\text{max}} = 500 \text{ nm} (T_{\text{sun}}/T)$
  - $\lambda_{\text{max}} =$ wavelength of maximum flux (in nm)
  - $T =$ temperature (in K)
  - $T_{\text{sun}} =$ 6000 K
Doppler shift

\[ \frac{\lambda_{obs} - \lambda}{\lambda} = \frac{V}{c} \]

- \( \lambda_{obs} \) = observed wavelength
- \( \lambda \) = Lab or “rest” wavelength
- \( V \) = speed of emitter toward or away from the observer
- \( c \) = speed of light = 300,000 km/s
angular size, resolution & Telecopes

- \( a = (s/d) \frac{360^\circ}{2\pi} \) 
  \( s = \) physical size/separation 
  \( d = \) distance

- \( a = 1.2 \frac{\lambda}{D} \) radians 
  \( = 0.25'' \left( \frac{\lambda}{\mu m} \right) \left( \frac{D}{m} \right) \) 
  \( \lambda = \) wavelength of light

- \( A = \frac{(\pi/4)D^2}{\pi} \) 
  \( A = \) Area of mirror 
  \( D = \) Diameter of mirror