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Ch.3 The Continuous Spectrum of Light p.57

§3.2 The Magnitude Scale p.60

The vast majority of our astronomical info comes from em rad.

Apparent Magnitude

Greek astronomer Hipparchus (190-120 BC) compiled positions of 850 stars + invented magnitude scale.

Brightest star he could see = 1st magnitude, dimmest m=6.

Modern def.: log scale, $\Delta m = 5 \Rightarrow 100\times$ brightness $\Rightarrow$

$\Delta m = 1 \Rightarrow 100^{\frac{1}{5}} = 2.512\times$ brightness, $\Delta m = 2 \Rightarrow (2.512)^2 = 6.310$, etc

$m_{sun} = -26.83$, m(faintest detectable) = 30

Flux, Luminosity, + the Inverse Square Law

"brightness" = radiant flux F = radiant energy per time per area

For an isotropically emitting object of luminosity L, the flux at distance r is $F = L/4\pi r^2$ (see ?)

Ex. 3.2.1 p.61 $L_\odot = 3.839\times10^{26}$ W, Earth $r = 1\,AU = 1.496\times10^{11}$ m

$F = \frac{L}{4\pi r^2} = 1365\ W m^{-2}$ = solar irradiance = solar constant

Absolute Magnitude

M = magnitude a star would have if it were 10pc away.

Since $\Delta m = 5$ corresponds to $\times100$ brightness, $F_2/F_1 = 100^{(m_1 - m_2)/5}$

The Distance Modulus

For star at distance d, $100^{(m-M)/5} = \frac{F_{10}}{F} = \left(\frac{d}{10pc}\right)^2$, or

$d = 10pc \cdot 10^{(m-M)/5} = 10^{(m-M+5)/5}$ pc (note: 1pc = 3.26 ly)

distance modulus = $m - M = 5\log_{10}(d) - 5 = 5\log_{10}(d/10pc)$

Ex. 3.2.2 p62 $m_{sun} = -26.83$, $d_{sun} = 1\,AU = 4.848\times10^{-6}$ pc $\Rightarrow$

$M_{sun} = m_{sun} - 5\log_{10}(d_{sun}) + 5 = +4.74 \Rightarrow$ kind of dim

For 2 *'s at d = 10pc, $F/F_\odot = \frac{L}{L_\odot} = 100^{(M_{sun} - M)/5} \Rightarrow M = M_{sun} - 2.5\log(L/L_\odot)$

If we know the type of *, then M known $\Rightarrow$ m $\Rightarrow$ d.

This ignores extinction $\Rightarrow$ dimming due to scattering + absorption by matter.

End of §3.2