APPARENT AND ABSOLUTE MAGNITUDES: RELATION TO FLUX

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Reference: Carroll, Bradley W. & Ostlie, Dale A. (2007), *An Introduction to Modern Astrophysics*, 2nd Edition; Pearson Education - Chapter 3, Problem 3.6.

The apparent and absolute magnitudes of a star are given in terms of the flux received from the star by

$$\frac{F_{10}}{F} = 100^{(m-M)/5} \tag{1}$$

where F is the actual flux from the star and F_{10} is the flux that would be received if the star were at a distance of 10 pc.

The flux is related to the luminosity and distance of the star by the inverse square law

$$F = \frac{L}{4\pi d^2} \tag{2}$$

If we want to compare the absolute magnitudes of two stars, then $d =$ 10 pc for both stars and we get (using base-10 logs):

$$\frac{F_1}{F_2} = 100^{(M_2-M_1)/5} = \frac{L_1}{L_2} \tag{3}$$

$$M_2 = M_1 - 2.5\log\frac{L_2}{L_1} \tag{4}$$

where both fluxes are for the star at $d = 10$ pc. If star 1 is the Sun, then

$$M = M_{Sun} - 2.5\log\frac{L}{L_{Sun}} \tag{5}$$

To relate the apparent magnitude m to the flux, we start with 1 but applying m to star 2 and M to star 1:

$$\frac{m_2 - M_1}{5}\log 100 = -\log\frac{F_2}{F_{10,1}} \quad (6)$$

$$m_2 = M_1 - 2.5\log\frac{F_2}{F_{10,1}} \quad (7)$$

where $F_{10,1}$ is the flux received from star 1 at a distance of 10 pc. If star 1 is the Sun, then the apparent magnitude of star 2 is

$$m_2 = M_{Sun} - 2.5\log\frac{F_2}{F_{10,Sun}} \quad (8)$$

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