

## 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

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

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

$$(2) \quad F = \frac{L}{4\pi d^2}$$

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):

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

$$(4) \quad M_2 = M_1 - 2.5 \log \frac{L_2}{L_1}$$

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

$$(5) \quad M = M_{Sun} - 2.5 \log \frac{L}{L_{Sun}}$$

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

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

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

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

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

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