# BOLOMETRIC MAGNITUDES AND COLOUR INDICES

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The *bolometric magnitude* of a star is the magnitude integrated over the entire electromagnetic spectrum. Since no single measuring instrument is capable of detecting all wavelengths, the bolometric magnitude must be calculated from several measurements on different types of telescope.

A standard set of magnitude values often used is the UBV system (for ultraviolet, blue and visual). A star's apparent magnitude is measured using narrow-pass filters at three wavelengths:

- $M_U, U$: the absolute and apparent ultraviolet magnitude, covers $365 \pm 34$ nm;
- $M_B, B$: the absolute and apparent blue magnitude, covers $440 \pm 49$ nm;
- $M_V, V$: the absolute and apparent visual magnitude, covers $550 \pm 44.5$ nm.

From these three magnitudes, we can calculate two *colour indices*, defined as

$$U - B \text{ index} = U - B = M_U - M_B \tag{1}$$

$$B - V \text{ index} = B - V = M_B - M_V \tag{2}$$

Since we're dealing with differences in magnitude, we can use either the apparent or absolute magnitude to calculate the indices. Because the magnitude scale increases for fainter stars, the larger the colour index, the brighter the star in the second-named wavelength. For example, a large $U - B$ index means the star is brighter in the blue region than in the ultraviolet.

The *bolometric correction* $BC$ is the difference between a star's bolometric magnitude $M_{bol}$ and its visual magnitude.

$$BC \equiv m_{bol} - V = M_{bol} - M_V \tag{3}$$

**Example.** For Sirius, $V = -1.44$ and $BC = -0.09$ so

$$m_{bol} = -1.53 \tag{4}$$

Using the distance to Sirius $d=2.639$ pc, we can get its absolute bolometric magnitude

$$M_{bol} = m_{bol} + 5 - 5\log d \tag{5}$$
$$= +1.36 \tag{6}$$

For the Sun, $M_{bol} = +4.74$, so Sirius is considerably intrinsically brighter than the Sun. The ratio of luminosities is

$$\frac{L_{Sirius}}{L_{Sun}} = 100^{(M_{Sun}-M_{Sirius})/5} = 22.49 \tag{7}$$

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