The Magnitude System

The energy arriving from any astronomical body can, in principle, be measured absolutely. The brightness of any point source can be determined in terms of the number of watts which can be collected by a telescope of a given aperture. For extended objects a similar method can be used. These types of measurement can be applied to any part of the electromagnetic spectrum.

However, in the optical part of the spectrum, absolute brightness measurements are rarely made directly; they are usually obtained by comparison with a set of stars which are chosen to act as standards. The first comparisons were, of course, made directly by eye. In the classification introduced by Hipparchus, the visible stars were divided into six groups. The brightest apparent) were labelled as being of first magnitude and the faintest which could be detected be eye were labelled as sixth magnitude. Stars with brightnesses between these limits were labelled as second, third, fourth or fifth magnitude, depending on how bright the star appeared.

The advent of the telescope allowed stars to be recorded with magnitudes greater than sixth; catalogues of the eighteenth century record stars of seventh, eighth and ninth magnitude. At the other end of the scale it was found that some stars were brighter than the first magnitude classification and so the scale was extended to include zero and even negative magnitude stars. The range of apparent brightnesses amongst the stars revealed that it necessary to subdivide the unit of magnitude Thus, stars visible to the naked eye could have magnitudes of −0·14, +2·83 or + 5·86 (say), while stars which can only be detected with the use of a telescope could have magnitudes of +6·76, +8·54 or even as faint as +23.

Several astronomers of the late eighteenth and early nineteenth centuries performed experiments to see how the magnitude scale was related to the amount of energy received. It appeared that a given difference in magnitude, at any point in the magnitude scale, corresponded to a ratio of the brightnesses which was virtually constant. The value of the ratio was accepted to correspond to a magnitude difference of five, as suggested by Pogson in 1856, and was set at 100. Thus, the ratio of two stellar brightnesses, B_1 and B_2, can be related to their magnitudes, m_1 and m_2, by the equation

$$\frac{B_1}{B_2} = 2{\cdot}512^{-(m_1 - m_2)}, \qquad \text{(equation ①)}$$

since $100^{\frac{1}{5}}$ is equal to 2·512. This is known as Pogson's equation. The negative sign before the bracketed term reflects the fact that magnitude values increase as the brightness falls.