The Stars

Armed with a knowledge of the climatic record of the Earth for the past 4000 million years and the current power output of the Sun, the mechanisms of its internal energy generation processes have been deduced. These nuclear furnaces have provided the light and heat which have supported life on Earth for this considerable period of time. A comforting thought, but what of the future? How long will the Sun radiate its life-preserving energy, will ice ages reappear or, even worse, will the Sun gradually cool until the entire Earth is cocooned in a mantle of ice; will all life expire?

To answer these chilling questions astronomers must have more information. They need to study not only the Sun but many stars and from their observations hope to detect patterns which will indicate trends in the life cycles of stars. Knowing these, astronomers can compose pictures of how stars are born, flourish in youth, then grow old and die. We will learn that not all stars expire by a slow fading decay. A few are truly spectacular; their lives are consumed in a brief fiery span, and their brilliant hues of blue and white are shining beacons in the Galaxy. When their fuel is exhausted they explode with cataclysmic violence, the light from which is brighter than that from 1 000 million Suns.

How may astronomers study other stars? They are so distant that even the largest optical telescopes can not reveal their shapes. They still appear as twinkling points of light, but even the naked eye can see that these twinkling points are not identical; they differ in brightness. This is a combination of different intrinsic brightnesses and the varying distances of stars from the Earth. Another difference apparent to the naked eye is the colours of stars. The stars Aldebaran (α Tauri) and Betelgeuse (α Orionis) have orange/red hues and these may be contrasted with the blue and white of Rigel (β Orionis) and Sirius (α Canis Majoris). Intermediate are the yellow stars such as Capella (α Aurigae) and our Sun. Experience tells us that when objects are heated, they first glow dull red, then bright red and then white, so perhaps the colours signify stars of differing temperature. Further investigation leads us into the realm of **astrophysics**, whereby astronomical observations together with knowledge of the laws of physics enable the secrets of stars to be understood.

The manner by which astronomers classify the brightness of stars as judged by the naked eye was discussed in Chapter 1. Let us now expand this discussion in a quantitative form. Firstly, we wish to classify the apparent brightness of stars, known as their **apparent magnitudes**, m. It is convenient and also necessary for rigorous classification and study to relate magnitude determinations to a standard. This removes differences between the observers' eyes and equipment. Also, because the human eye, photographic plates and photoelectric devices have responses which vary differently with wavelength, magnitudes determined by those techniques are referred to as visual, photographic and photoelectric and you will often find them expressed as m_{vis}, m_{pg}, m_{pe}. To obtain more information concerning the spectral distribution of the light from astronomical sources, certain specific wavelengths of study have been selected by the use of colour filters. The most common of these are called U, B and V, which respectively transmit only ultraviolet, blue and visible light. Apparent magnitudes measured with these filters are designated by m_U, m_B, m_V or more usually just U, B and V. The UBV system of the 1950s, still in use today, has filters with the following characteristics:

apparent magnitude	wavelength of peak transmission
name (colour)	**(nm)**
U (ultraviolet)	360
B (blue)	420
V (visible)	540

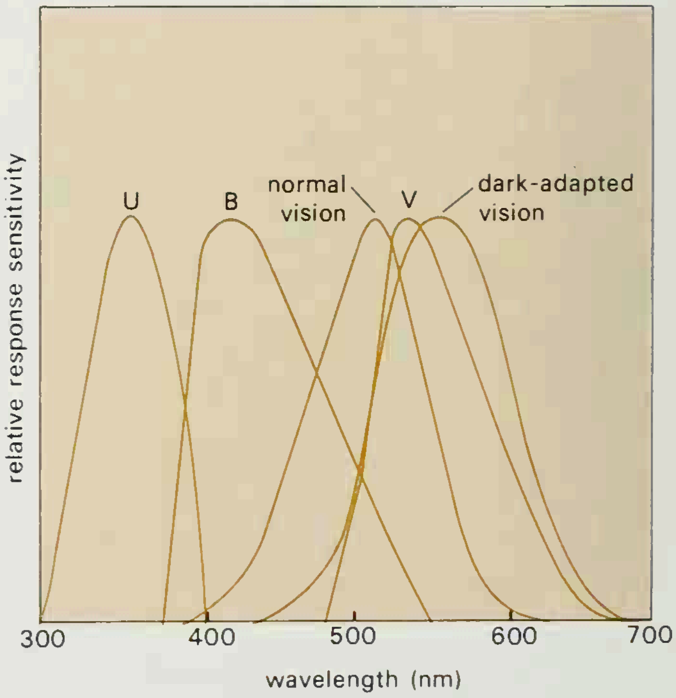

Fig. 3·1
Response curves for the filters used in the UBV system of astronomical photometry. These curves show how the transmission of the filters varies with wavelength. The spectral response of the normal and dark-adapted human eye are also shown for comparison.