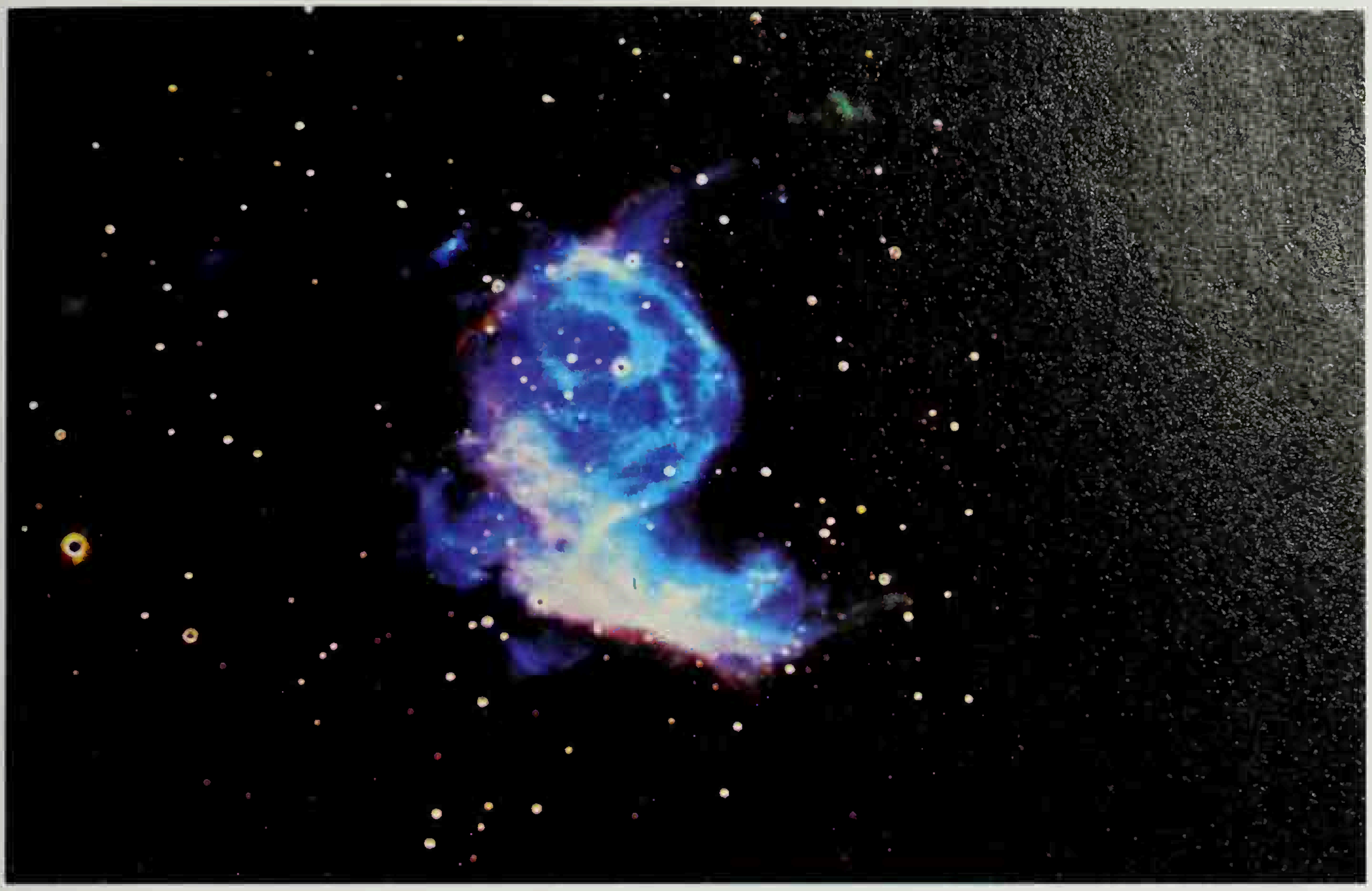

This nebulosity, NGC 2359, surrounds a very hot Wolf-Rayet star to which it owes its luminosity.

known as population classes. Class I is for stars which are metal rich whilst class II is for those that are metal deficient. Metal-rich stars are believed to be very young on an astrophysical timescale, while metal-deficient stars are the very oldest in space.

Peculiar stars

As with any large assemblage of data, peculiarities are bound to occur and this is certainly the case with stars. Although we have up to now been referring to absorption line spectra, some stars reveal emission lines. These emission lines may be superimposed on what is otherwise a normal absorption line spectrum such as the **Shell stars** and **P Cygni** classes. It is believed that these hot stars have very extended atmospheres, sometimes showing expansion. Alternatively, the emission lines, usually of ionized helium, carbon, nitrogen and oxygen are broad and very few absorption lines are seen. These are known as **Wolf-Rayet stars** and with average effective temperatures estimated at between 40 000 K and 50 000 K are the hottest stars known. Other strange features observed in stellar spectra have been found to be caused by strong and often variable magnetic fields. Such stars are those known as **Peculiar A stars**.

Rotation

One further piece of information may be gleaned from very careful study of the lines in a stellar spectrum. This is the rate of rotation of the star, which can be measured using the Doppler effect. A spectral line appears broadened as one side of the star approaches the observer and radiation is shifted to a lower wavelength, while the opposite side of the star recedes and radiation is seen at a longer wavelength. Because we see radiation from the whole disc of the star, the line appears equally red and blue shifted compared with radiation emitted by the centre of the stellar disc. A sharp line may then be grossly broadened under conditions of rapid rotation and although the measurements are tricky and difficult to analyse it is believed that some stars rotate with extreme rapidity. There appears to be a general trend for hotter stars to be the most rapidly rotating. The Sun, however, rotates at a mere 2 km per s, while some O and B stars have rotation velocities as high as 250 km per s. It is thought that the extended clouds of gas surrounding the Shell stars resulted from being thrown off due to extreme rates of rotation, perhaps up to 500 km per s.

Lifetimes and energy sources

How do the observable stellar factors of temperature, luminosity, mass and radius relate to the internal structure of a star? Can we answer the fundamental questions of when stars were born, how long they will live and how they will die? We can, but in doing so we must explore the province of physics applied to astronomical situations.

Stars continuously radiate energy and the mass-luminosity law tells us that for main sequence stars the rate at which they lose energy (their luminosity) increases as the mass increases. Does this imply that stars of different masses have varying lifetimes? From our inspection of the H-R diagram, we know that stars are not scattered at random but populate well-defined zones. We thus believe that certain relations exist between luminosity and surface temperature of stars. Could the H-R diagram represent a form of evolution scheme for stars? How can we begin to determine the ages of stars?

Let us consider the Sun. Inspection of fossil remains on the Earth reveal that it has radiated