Variable Stars

One of the most worthwhile fields of observation is perhaps that of variable stars, and here amateur observations are not only important, but frequently essential. So many variable stars are now known that with limited time and restricted access to telescopes, most professional work must be confined to specific aspects of variability, and it is often only amateurs who can follow stars' changes over a long period of time. Even so, the vast majority of individual variables go unstudied.

Some of the brightest stars are variable and can be followed by the naked eye, although most of them have fairly small amplitudes which can be difficult to determine accurately. With even a small pair of binoculars, however, many thousands of stars are available for study, and the numbers rise so greatly with increased apertures that no observer can hope to cover more than a small fraction of the known objects.

There are so many different classes and sub-classes of stellar variability that they cannot all be described here. However, the most popular types are probably the long-period variables (periods over 100 days and reasonably regular light-curves) the semi-regulars (more erratic behaviour but still with some periodicity), and the eruptive stars, particularly the dwarf novae (sudden outbursts with 'periods' of between a few tens of days to years, depending upon the individual stars) as well as other related types. True novae and supernovae are, of course, observed whenever they happen to be visible. Of the other classes the most important are probably the eclipsing binaries, where the orbital plane of the two individuals is so aligned in space that, as seen from Earth, each star periodically eclipses the other. The analysis of observations of any of these objects not only provides information about the particular star involved, but also adds to what is known about the nature and causes of variability in general, of the various phases of stellar evolution (page 61), and of the changes occurring within certain types of binary systems.

Although for historical reasons the system of nomenclature used for variable stars is a little complicated, the majority are known by single or double letters, e.g. R Scuti or WW Aurigae, or by a number preceded by the letter V, e.g. V1500 Cygni, which is the official name for Nova Cygni 1975 (page 65). The positions and characteristics of many of the brighter variable stars are listed in celestial handbooks and shown on many charts and atlases. Detailed charts of individual fields can be obtained from the organisations that specialize in variable star observation, together with magnitude sequences of comparison stars. As the magnitude of a variable is usually obtained by comparing its brightness with two comparison stars, one slightly brighter and the other slightly fainter than the variable, it is important that these 'official' magnitude sequences are used, as magnitudes derived from other (or mixed) sources may not be consistent with one another. The number of observations which are made of a particular object will depend upon the actual class of object, or at least should do so if bias is to be avoided. Slow variables such as the long period stars should only be observed about once every ten days, whereas eruptive objects can be estimated perhaps every hour when they are caught on the rise to maximum. Although a form of light-curve may be constructed from observations by an individual observer, there are inevitable personal errors. For this reason it is usual for observations to be reported to one of the amateur groups – just as with many other types of observation – which then prepare mean light-curves using many other estimates, and also carry out further analyses. They may then pass the observations to professional workers for further detailed examination.

The professionals, in their turn, may request specific coverage of particular objects, perhaps to coincide with periods of observation by other specialized telescopes or satellites operating in any of the many regions of the electromagnetic spectrum.

Many amateurs are now acquiring photoelectric equipment, and this can have many uses in the study of variable stars, not least in the determination of accurate sequences of magnitudes for objects to be studied by other means. In addition such equipment may be used to detect both low-amplitude and short-term variations which are difficult, if not impossible, to follow by other methods. All sorts of classes come within this category, including RR Lyrae stars (pages 67 and 172), so that in the end there are very few types of variables that are not studied by amateurs in some way or other. In the field of eclipsing binaries photoelectric work, especially when combined with professional spectroscopic determinations, can provide an amazing amount of information about the stars, their absolute sizes, masses, orbits, limb darkening and so on.

Quite apart from the derivation of light-curves, the actual discovery of certain types of variable is very important, and many amateurs carry out visual or photographic patrols aimed at the detection of novae and supernovae. Supernova work will be discussed elsewhere (pages 212–3); but for the discovery of novae, similar visual observation methods are used as for the detection of comets (page 150) – i.e. the use of large binoculars or rich-field telescopes and the memorizing of star patterns

Fig. 8·2
Opposite: *A detailed chart and magnitude sequence for the variable star R Scuti, which may conveniently be observed during the evening in late summer to early autumn. (See star chart, p. 41, for the general location of the area.) Magnitude estimates made at intervals of a week or so should show the star's variation.*

Right: *Novae generally occur close to the galactic equator, and in an organized nova patrol the search areas are arranged accordingly.*

A light curve of R Scuti, based on BAA observations for 1975 and 1976.