18.1: Introduction to Spectroscopic Binary Stars

The orbital elements of a binary star system are described in Chapter 17, and are *a*, *e* , *i*, Ω, ω and *T*. However, on thinking about the meaning of the element W, the position angle of the ascending node, the reader will probably agree that we cannot tell the position angle of either node from radial velocity measurements of an unresolved binary star. We have no difficulty, however, in determining which component is receding from the observer and which is approaching, and therefore we can determine which node is ascending and which is descending, and the sign of the inclination. Thus we can determine some things for a spectroscopic binary that we cannot determine for a visual binary, and *vice versâ*. If a binary star is both spectroscopic and visual (by which I mean that we can see the two components separately, and we can detect the periodic changes in radial velocity from the spectra of each), then we can determine almost anything we wish about the orbits without ambiguity. But such systems are rare – and valuable. Usually (unless the system is very close to us) the linear separation between the pairs of a visual binary is very large (that's why we can see them separately) and so the speeds of the stars in their orbits are too slow for us to measure the changes in radial velocity. Typically, orbital periods of visual binary stars are of the order of years – perhaps many years. Stars whose binarity is detected spectroscopically are necessarily moving fast (typically their orbital periods are of the order of days), which means they are close together – too close to be detected as visual binaries.

Of course, in addition to the periodic variations in radial velocity, which give rise to periodic Doppler shifts in the spectra, the system as a whole may have a radial velocity towards or away from the Sun. The radial velocity of the system – or its centre of mass – relative to the Sun is called, naturally, the *systemic velocity*, and is one of the things we should be able to determine from spectroscopic observations. I shall be using the symbol V_0 for the systemic velocity, though I have seen some authors use the symbol g and even refer to it as the "gamma velocity". [By the way have you noticed the annoying tendency of the semi-educated these days to use technical words that they don't know the meaning of? An annoying example is that people often talk of "systemic discrimination", presumably because they think that the word "systemic" sounds scientific, when they really mean "systematic discrimination".] We must also bear in mind that the actual observations of the star are made not from the Sun, but from Earth, and therefore corrections must be made to the observed radial velocity for the motion of Earth around the Sun as well as for the rotation of Earth around its axis.