The double cluster in Perseus, h and χ Persei. These twin open clusters each contain between 300–400 very young stars.

ters form the basis of a very accurate method of distance determination. The **moving cluster method** is, apart from trigonometrical parallax, the only direct means of measuring distances to normal stars, and it can be used out to far greater distances (Fig. 6·5). The method relies on the fact that all stars in a cluster move in parallel paths in the same direction through space; but, because of perspective, these paths appear to meet at a convergent point. Plotting the proper motions of cluster stars reveals the position of this convergent point. A measure of each cluster member's radial velocity, when combined with a knowledge of the direction of the convergent point, yields the transverse velocity; and from comparison with the proper motion the star's distance can be found. The accuracy inherent in this method lies in the large number of stars considered. By using over 150 member stars, the distance to the Hyades, the nearest open cluster, can be measured to an accuracy of a few per cent. The most recently derived distance of some 45 pc forms the basis of all successive distance measurements, right out to the most remote galaxies.

In measuring the distance to a far-flung star cluster whose proper motion is not detectable, the essential step is to compare its average stars with the members of the Hyades. In practice, H–R diagrams are drawn for both clusters, using absolute magnitudes for the Hyades stars, and apparent magnitudes for the distant cluster. Considering ordinary main sequence stars in each case, the degree to which the cluster stars are fainter than those of the Hyades is due to their greater distance. By exactly matching the cluster stars to the Hyades – a process called **main sequence fitting** – we can see how much fainter they appear to be, and consequently how much more distant they are. In the case of very distant clusters, the obscuring dust also creates considerable dimming and reddening, and this too must be taken into account.

Such measurements, along with parallax determinations of distances to nearby stars, enable very detailed H–R diagrams to be built up, and absolute magnitudes derived for almost all types of star. In fact, the distance to any star – whether a member of a cluster or not – can be estimated by comparing its spectral type and apparent magnitude with the stars on such an absolute magnitude H–R diagram. This technique of distance measurement is known as **spectroscopic parallax**.

Spectroscopic parallax can be used as a tool for mapping the Galaxy. In this case it involves measuring the distances to 'stellar associations', stars of the same spectral type which form loose, unbound groups in space (the five inner stars of the Plough, for example). Such associations disperse very quickly; since they cannot exist for long, those which are recognizable must comprise very young stars – O and B supergiants – which have strayed little from their birthplaces.

Mapping the distribution of these associations shows that they are not spread at all uniformly. As well as occupying the thinnest region in the galactic plane, they are concentrated into clumpy bands – a distribution shared by other youthful objects such as nebulae and young open clusters. All these objects are in fact 'spiral tracers', because the bands they delineate are the nearest spiral arms of our Galaxy. There are three local arms, or portions of arms, historically named the Sagittarius, Orion and Perseus arms, after the general directions in which they lie. Today it is recognized that the arms picked out by the spiral tracers are more extensive than their names would suggest. The Sun is associated with the stars in the Orion arm, whose identity as a *bona fide* arm is currently in dispute: there are indications that it may be merely a bridge between the Sagittarius and the Perseus features.

It is no coincidence that the spiral arms contain extremely young objects. Astronomers believe that arms are zones of compression which travel around the disc of a galaxy and trigger the gas into forming stars. Glowing nebulae and dark, clumpy clouds trace the line of this compression wave. We will now turn our attention to these regions.