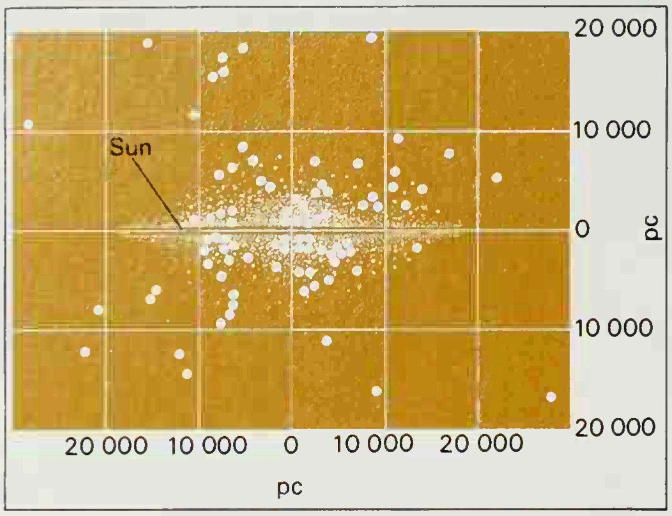

Fig. 6·3: The distribution of globular clusters around our Galaxy. These objects are the most prominent tracers of the galactic halo.

are often called 'high velocity stars', this is really a consequence of the Sun's high velocity relative to them, and because the orbits are in different planes.

Many halo stars are still more readily identifiable, for they are RR Lyrae variable stars. Their brightness ($M_v = 0{\cdot}5$) qualifies them as excellent halo tracers, and their distances can be immediately ascertained from their apparent magnitudes. All the halo stars and RR Lyrae field stars share essentially the same distribution as the globular clusters, with a gradient of increasing metallicity towards the disc. There still remains a slight mystery concerning the metal-rich RR Lyrae stars, which are found in the field population, but do not appear to be present in even the most metal-rich globular clusters.

By combining local counts of halo stars with an overall picture of star densities in the halo, we can derive a figure for its mass. Current estimates put this at about 10 per cent of the mass of the disc, but this figure could be uncertain by a factor of at least ten, because of our lack of knowledge as to what constitutes the halo. There are indications that the halo may contain streams of hydrogen gas, connected in some way with the streamers in our Local Group of galaxies (see page 198): how much mass might they contain? Astronomers have also to consider the unseen white dwarf stars which must populate the halo, for they too could contribute significant mass. In fact, there are several theorists who believe that the disc of a galaxy like our own would be unstable unless surrounded by a massive halo with perhaps ten times the mass of the disc, but it is difficult to envisage what form this mass might take. Suggestions ranging from old red dwarfs to mini-stars – stars insufficiently massive to have ever commenced nuclear reactions – have been put forward; but all of these are undetectable with present techniques.

There is now increasing evidence that the total mass of the Galaxy may be very much larger than previously supposed. Determinations of the velocity of some very distant stars (particularly of one of the RR Lyrae type) for which the absolute magnitude may be accurately determined, suggest that total mass may amount to about twice the mass of the galactic disc, i.e. somewhere around $1{\cdot}5 \times 10^{12}$ solar masses overall. This is in accordance with the discovery that many galaxies are surrounded by 'coronae' of gas which also make a contribution to their total mass.

For some time there has also been the question of whether the halo – or other parts of the galaxy – could contain any of the so-called 'Population III' stars. It was suggested that these were stars which had formed from the primordial hydrogen and helium remaining after the Big Bang, and which could themselves have provided some of the heavier elements present – albeit at low amounts – in the old Population II stars. There is now some slight evidence that such stars may still exist in very low numbers, but that the vast majority are long extinct. However, the contribution of such stars to the early evolution of the universe could have been very considerable as they may have been responsible for some of the microwave background radiation (see page 206).

The disc of our Galaxy

The disc was the last part of our Galaxy to be formed, and, in a sense, it is still forming. Young stars are created even now in the central plane of the disc; although the majority of the disc stars have by now reached sedate middle age. Like the halo, the disc shows an age gradient from its outermost regions inwards, with younger objects occupying successively smaller distances above the galactic plane. The oldest disc stars, presumably the first to form after the Galaxy's sudden collapse, have a total spread above and below the plane of some 700 pc. By way of comparison, those O stars which have recently formed have a thickness in the plane of only 80 pc. The distribution of all the other stars lies in between these two extremes, although our Sun, very much a middle-aged member of the Galaxy, has an orbit which strays by only 80 pc above and below the plane.

The vast majority of disc stars are only $0{\cdot}1\ M_{\odot}$, and spend almost their entire lives as faint red dwarf stars. With absolute magnitudes of about $M_v = +15$, they are extremely difficult to detect, and we can only pick out those which lie within 100 pc of the Sun. On the other hand, bright young O and B stars shine out like beacons all around the Sun's neighbourhood, and to great distances beyond. They give an impression of being very numerous, when in fact they are rarities among stars; it is their great intrinsic brilliance ($M_v = -8$ to -10) which makes them stand out.

Unlike the halo, where stars appear to be spread out uniformly, the disc has an uneven distribution of stars. Clumping and clustering are the rule here. Young stars are found in groups called 'galactic' or 'open' clusters (to distinguish them from the more compact and populous globular clusters), or looser aggregates called **stellar associations**. Some of these open clusters are easily visible to the unaided eye. The Pleiades, or Seven Sisters, shine like a tiny jewel-box of stars in Taurus, and were deemed worthy of mention in the Chinese records of the twenty-fourth century BC. Also in Taurus are the V-shaped Hyades, the nearest star cluster to the Sun, whose distance is the foundation-stone of the current extragalactic distance scale.

In all, over 700 open clusters have been listed, the