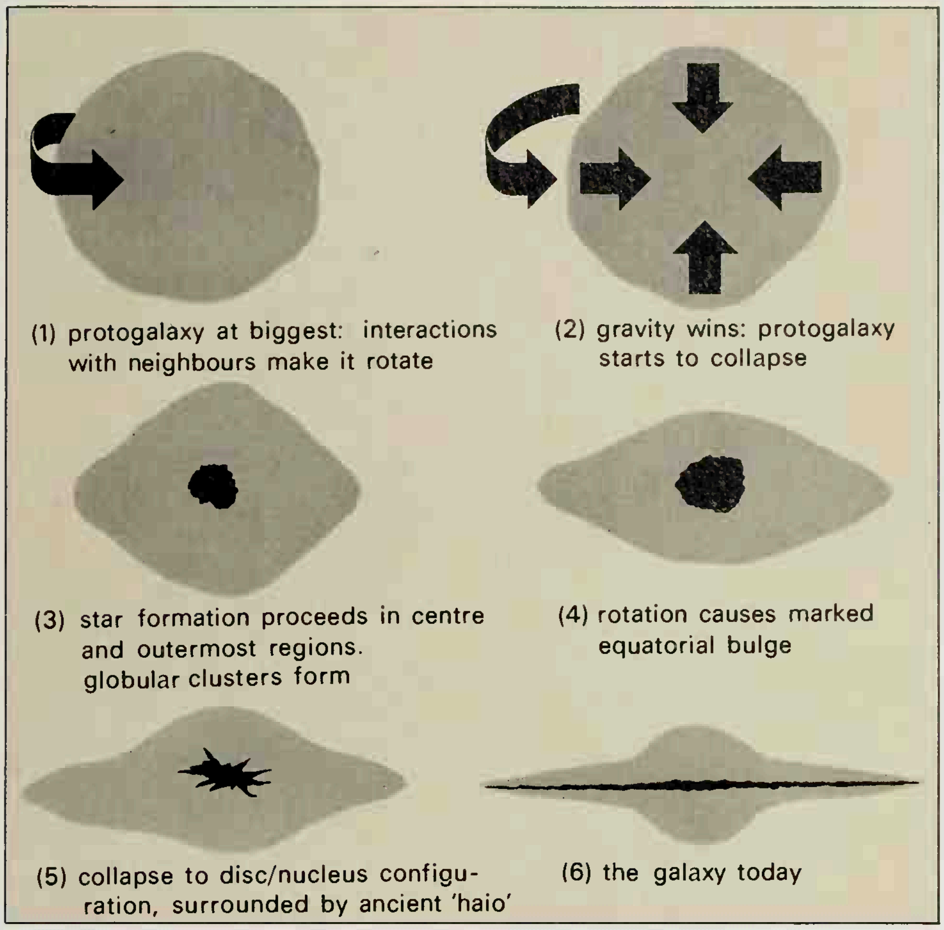

Fig. 6·2 above: *Stages in the formation of a galaxy like our own. In (1), the protogalaxy begins to rotate under the gravitational influence of its neighbours. At stage (2), it starts to collapse under its own gravity, spinning faster as it does so. By (3), the first stars have formed in globular clusters, left stranded by the shrinking protogalaxy, while a great burst of star formation takes place in the dense central regions (4). Rotation flattens the galaxy into a disc (5). Our Galaxy currently appears as in (6), with star formation still taking place in the outer regions.*

some time, this lump of gas, or **protogalaxy**, had been taking part in the expansion of the young universe, growing steadily larger until it was able to exert influence on, and be influenced by, its neighbours – other protogalaxies lying close by. The nature of these interactions is speculative, but it is possible that the young cloud may have been set into slow rotation by the interplay of forces, and its gas stirred up into turbulent motion.

Our protogalaxy probably reached a maximum diameter of 100 kpc before its own gravity slowed and then halted its expansion. The expansion of the cloud changed to a slow collapse, which proceeded increasingly quickly as gravity took over. Towards the centre, where collapse was most rapid and the turbulence greatest, the gas density became high enough for the first stars to be born, forming the nuclear bulge of our Galaxy (Fig.6·2).

The first stars were quite unlike the stars we are used to dealing with today. They were formed only from hydrogen and helium (some 75 per cent and 25 per cent by mass, respectively), the two elements present in the protogalaxy gas. Some of these stars were extremely massive, perhaps more than 100 $M_\odot$, and so they went through their life cycles very rapidly, ultimately exploding as supernovae. Heavy elements – some processed inside the stars, others produced in the supernova explosions themselves – were spewed out into the surrounding medium, enriching the gas which was to form the next generation of stars. Today, this enrichment of the interstellar medium still continues. It gives valuable clues as to the age of stars.

Not all the stars which formed were as massive as these. In the outer regions of the protogalaxy, gas clouds of 10^5 or even 10^6 $M_\odot$ began to fragment into individual, normal-sized stars. Possibly as a result of the slow rotation and smaller turbulence in these outer regions, or because there were insufficient stars forming nearby to disrupt these huge gas clouds by their ultraviolet radiation, enormous clumps of stars formed together. Today we still see these globular clusters marking the farthest outposts of our Galaxy.

As the collapse of the protogalaxy continued, ever more rapidly, the gas drew away from the outermost regions, leaving the globular clusters stranded. To conserve angular momentum, the young Galaxy spun faster and faster as it shrank, gradually developing a distinct bulge around its equator. Had star formation been rapid and efficient at this stage, the Galaxy might have been frozen into this ellipsoidal shape forever; for, dynamically speaking, stars interact little with their surroundings once they have been formed. However, sufficient gas remained to shape our Galaxy into the way it is today.