CHAPTER SIX

The Galaxy

On a dark, moonless night, away from the glare of city lights, the heavens themselves seem ablaze. Even familiar constellations, like the Plough or Orion, are difficult to trace on the crowded vault, and countless faint stars cover every fragment of the inky black sky. Yet the sky is not completely dark. Threading its way among the stars is a narrow, misty band of light which spans the sky from horizon to horizon. In some places the band becomes so faint as to be almost invisible; in others so dense and glowing that it looks like a nearby cloud. To the astronomers of old, unhampered by the dubious blessing of artificial lights, it was an important and prominent feature. Its shape suggested to them a path, a road, or a river, and they devised legends and stories to describe and explain it. One such legend ascribed its origin to milk spilt from the breast of the goddess Juno when nursing the thirsty infant Hercules; hence the name *Via Lactea*, the Milky Way.

However, not until the early years of the seventeenth century did a picture of the real nature of the Milky Way begin to emerge. It was then that Galileo directed the newly-invented telescope towards the luminous band, and found that its light derived from countless thousands of stars, too faint to be seen individually without optical aid. Little more progress than this was made in the following century and a half, because successive generations of telescopic observers busied themselves with the nearby Moon and planets, leaving philosophers to grapple with the problems of the remote stars. Among them, Thomas Wright of Durham (1711–86) and Immanuel Kant (1724–1804) made the far-sighted suggestion that the Milky Way might represent the extremities of a vast, flattened star system in which we live.

Sir William Herschel (1738–1822) – widely regarded as the greatest observational astronomer of all time– was not satisfied with such a qualitative assessment. In 1784, with the aid of his sister, Caroline, he undertook to count all the stars visible through his great telescope, in order to determine just how they were distributed over the sky. A survey covering the whole sky would have taken a prohibitively long time, as his telescope had a field of view only 8 arc minutes across – a quarter of the size of the Full Moon. So Herschel decided to make sample counts in some 700 regions, widely scattered over the sky, which he believed would give a representative picture.

Herschel found that the stars increased in number towards the plane of the Milky Way, reaching a maximum density in the plane itself. A great distance above and below the Milky Way, the stars were spread thinly. Perhaps, Herschel reasoned, the stars are arranged in a kind of grindstone- or lens-shaped system, with the Sun somewhere towards the centre. Then, by looking along the diameter of the disc, we would see nearby stars scattered all over the sky, while ever more remote stars became blurred with distance into a misty band. As only relatively close stars inhabited the regions above and below this diameter, we should see them spread thinly over the sky.

Although Herschel himself came to doubt this model in his later years, and nineteenth-century astronomers gave it little support, we now know that it is essentially correct. One of its greatest stumbling-blocks was in accounting for the patchiness in the Milky Way itself. Herschel believed the gaps in the Milky Way to be true voids in space where there were no stars; places where we could see through our star-system to the greater universe beyond. But his successors considered it to be too great a coincidence that so many long, starless tunnels were centred on the Sun. Instead, they envisaged the Milky Way as a thin, rather broken ring of stars which crossed a smaller belt of stars containing our Sun.

As we shall see later, the star-voids turned out to be almost the reverse: regions of dense, obscuring material which appeared black because they blotted out the light from distant stars. So there is no need to explain coincidences; Herschel's 'lens' was right, and the nineteenth-century conception wrong.

Herschel had no way of ascertaining the dimensions of his star-lens, or Galaxy, as it was becoming known (from the Greek *galaxias kyklos*, meaning milky circle). The first star distance was not measured until 1838, sixteen years after Herschel's death; and so he could only make a rough estimate. The way in which stars were distributed suggested to him that the long diameter of the lens was some 800 times the average separation between stars, while the short diameter was only 150 times this distance. Taking as he did, the Sun-Sirius separation to be an average distance, Herschel arrived at a star-system measuring 8 000 by 1 500 light-years – over ten times smaller than the Galaxy as we conceive of it today.

The story of how our Galaxy increased its bounds over the years is a long and fascinating one, and we will touch on fragments of it as we explore our star system's contents and structure. However, now it is time to make the step to the present: to examine the