Part Three

The Physics of the Stars

"If we are not content with the dull accumulation of experimental facts,
if we make any deductions or generalizations,
if we seek for any theory to guide us,
some degree of speculation cannot be avoided"
—Sir Arthur Eddington, 1920

The 19th century witnessed enormous advances in our understanding of the sun and the stars. At the beginning of that century, even as distinguished an astronomer as William Herschel could seriously advance the view that the sun was a habitable world whose surface was obscured by thick clouds of radiant brilliance. As the century drew to a close, an entirely new stellar universe had emerged. The sun and the stars were fiery furnaces powered by their own self-gravity and destined to end their relatively brief lives as cold dark lumps of dense matter. This somewhat pessimistic picture of the stars was painted with the help of the new tool of spectroscopy, which split the light of the stars to reveal their chemical compositions and hint at their temperatures. The newly developed laws of thermodynamics appeared to govern their evolution and seal their fates.

As the 20th century dawned, astronomers had accumulated a mountain of spectroscopic data on the stars, but lacked a suitable theory to make sense of it all. The first great advance was the realization that two dramatically different types of stars existed. Familiar stars like the sun might seem large, but they were dwarfed by a population of immense stars, thousands of times larger and more luminous than the sun. Some of these stars had grossly distended atmospheres and average densities many times less than that of air. This realization was shortly followed by the discovery that there also existed an entirely different class of stars with opposite characteristics. These stars were the size of the earth, but had masses comparable with that of the sun. It was the new discoveries of the atom and its components—the

electron, proton, and neutron—that eventually explained how nature managed to accommodate all of these totally different stellar types. Many of the discoveries that shaped these new views of the stars directly involved Sirius and its curious companion.