Preface

Due to the efforts of a new global breed of planet hunters who move across time zones sharing ideas and technology with unprecedented ease, the number of planets known to circle other stars is now well over 60, and counting. We live in an era in which the detection of extrasolar planets has ceased to be a novelty and, instead, has become a challenge to the planetary theorists and theoretical astrophysicists attempting to explain them. Even during this book's two-and-a-half-year gestation period, I've been astounded not just by the frenetic pace of discovery, but by the mind-boggling variety of what astronomers have found. The discoveries range from protoplanetary disks to full-fledged planetary systems, but few, if any, appear to resemble our own Solar System.

The planets that have been discovered thus far seem to be gaseous giants that for the most part are in very close orbits around their host (or parent) stars. Some have orbital periods of only a few days. It's as if Jupiter, the most massive planet in our Solar System, were suddenly displaced from its nearly 12-year orbit around our Sun into an orbit that allowed it to circle our star in less than a week. The discovery of such planets presents theorists with many challenges, not the least of which is determining how the planets and planetary systems might actually have formed. In fact, these startling findings have required astronomers to rethink the very definition of the word "planet." Heretofore a planet (not including smaller objects such as asteroids, comets, and meteoroids) was loosely defined as any body that orbits a star but does not generate its own light, and generally has a maximum mass only a few times that of Jupiter. Given the latest data, this definition will have to remain very much in flux.

Detecting extra-solar planets is first and foremost a testament to the skill, hard work, and technological prowess of the world's astronomical community. Over the span of the twentieth century, technological developments enabled astronomers to expand their observations to cover almost the entire electromagnetic spectrum. Astronomers greatly benefited from the development of both larger-aperture optical telescopes and the power of computer processing to crunch their newly acquired data. The development of radio astronomy after World War II allowed for the combination of signals from more than one radio telescope. This technique of signal combination was later incorporated into optical telescopes and is a key part of present and future planet-detection technologies. Within the next 40 years, astronomers hope to be able to image and resolve surface details of Earth-like planets from both the ground and space. Progress has been and will continue to be staggering. Within the last hundred years, we will have gone from the 100-inch (2.5-meter) Hooker telescope atop Mount Wilson in California, to the Overwhelmingly Large Telescope (OWL), a 100-meter ground-based optical telescope now being planned by the European Southern Observatory that may see completion in 2016.

As the technology advances and the number of observed extra-solar planets increases, so will the number of questions. Already, there has been much debate over whether the "planets" that have been indirectly detected are actually planets. Besides forcing us to reconsider our definitions, this new information will likely have us asking, time and again, some of the fundamental questions of astronomy: How do planets form? How did our own Earth and Solar System form? When and why did Earth become habitable? Obviously, these are questions for which we still have—and may forever have—only incomplete answers. But the march of new technologies cannot be underestimated, for they will likely revolutionize our understanding of the Milky Way galaxy and our role in it.

Toward the end of the book, I speculate on some of the tantalizing questions that may be at least partially answered in the next few decades. Given our new tools, we may soon be able to directly image and remotely characterize the nature of many extra-solar planets. From distances light years away, will we detect vegetation? Will we find a pattern to what types of stars develop habitable planetary systems? What are the prospects of finding intelligent life around other Sun-like stars? From there, the questions only get more complex and involve the nature of our very existence: Why do we live in a Universe clumped into galaxies, with stars, circled by bodies we term planets, where the cycles of life and death as we understand them seem to play such a significant role? Does life on Earth, in some small way, mirror the cycles of birth and death in our own Sun and other stars like it? And, finally, are we, as a species, instinctively driven to leave Earth and our Solar System to avoid the inevitable destruction brought on by our own dying star?

The sheer number of stars that may produce planetary systems and the growing number of planets that we now know circle other stars are daunting, to say the least. Yet astronomy is singular in the fact that almost like no other science or subject, the more one knows, the more one appreciates not only the long hours of research being done nightly at observatories around the world, but also our Solar System's own history from protostellar nebula to protoplanetary disk to the formation of our own habitable planet. A night at an observatory is a humbling experience, not only because of the technologies and calculations involved in navigating the skies overhead, but because of the size and scope of what *is* overhead.

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