Preface

This book is designed to show how physical principles can be used at the advanced undergraduate level to understand astronomical systems such as planets, stars, galaxies, and the universe as a whole. It emerges from a pair of courses at Rutgers University that attract not just astrophysics students but a broad audience of physics and engineering students. The organization is therefore "physics-first": we start with key principles of physics and then examine applications to astronomical systems.

At Rutgers, each half of the book constitutes a coherent semester-length course; while there is a little overlap (notably with cosmology in Chaps. 11 and 20), the two halves are largely independent and complementary. Part I focuses on gravity, because this is the dominant force in many astronomical systems and it governs many types of motions we observe. The goal of Chaps. 2–11 is to develop a progressively richer understanding of gravity and the way astrophysicists use gravitational motion to investigate mass.

Part II centers on one of the "big questions" we humans ask. *Why are we here?* is admittedly beyond the realm of physics, but a related question is within our reach: *How did we come to be here?* As the Sun was forming, various elements came together in the right combination to form a rocky planet with a tenuous atmosphere. On this planet Earth, the energy from the Sun and the gas in the atmosphere were just right to allow the emergence of life. The energy that sustains us originates deep inside our star, thanks to $E = mc^2$. The atoms that comprise our bodies were forged in previous generations of stars. Literally, we are star dust. The goal of Chaps. 12–20 is to understand the roles that electromagnetism as well as gas, atomic, and nuclear physics play in this remarkable story.

I hope this book will help you learn to think like an astrophysicist. Rather than memorizing facts about specific astronomical systems, you will learn to break the systems into pieces you can analyze and understand using material that should be familiar from introductory physics and vector calculus. (The necessary physics topics are reviewed as they arise; vital aspects of vector calculus are reviewed in Appendix A.) Then you will be equipped to investigate interesting systems that you

encounter in the future, even if they are not addressed in this book. Astrophysics is a dynamic field of research—and one in which you can understand the physical principles that underlie even the newest discoveries. So let's have fun!

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