

Preface

The whole universe has been a laboratory for the physicists. The motions of the planets in the solar system led Sir Isaac Newton to develop his laws of mechanics. Similarly, the theories of Special and General Relativity are tested in this cosmic laboratory. The physical processes inside a star have enriched our knowledge on nuclear and particle physics. Astrophysics is a branch of applied physics. However, in recent decades, this cosmic laboratory is used for research on chemistry and biology as well. Thus, astrochemistry and astrobiology, two subbranches, have emerged out. Astrochemistry describes the chemical processes in interstellar medium, planets, and in objects that are cooler than a normal star. Astrobiology has emerged out with the discovery of a large number of planets that appear to have an environment appropriate for the origin and evolution of life. Both the physical and chemical processes in a planet offer the possibility of initiating biological processes. Therefore, all the branches of science—physics, chemistry, biology, etc.—are applied to astronomy in order to answer an eternal question of mankind “Is anybody out there?” This exciting development that initiated a new era in astronomy has taken place due to the discovery of a large number of planets outside the solar system. These are the new worlds beyond our own. This has revolutionized our knowledge and understanding about planets, their climates, formation, composition, etc.

I am a professional astrophysicist trained to write highly technical research papers. Unfortunately, current research has become so technical that even another professional astrophysicist cannot understand a research paper fully unless she or he works on the same area of research. Such a technical research paper is reviewed, discussed, and cited by the astrophysicists working on the same area or field. However, when I deliver a lecture in a conference attended by colleagues with expertise on different aspects of astrophysics, I need to make the content quite a bit general. Similarly, when I deliver a lecture to a group of graduate students of science, I need to make the scientific descriptions and explanations even more general. Often the technical aspects are described by introducing analogy with events or objects that are easily understood by the students with basic or advance

knowledge on physics and mathematics. However, the task becomes gradually more difficult as the exposure and background of the audience change. From colleagues who work on the same area of research, to the colleagues who work on the same subject but on different area, to scientists working on different subjects, to students with background in physics or astrophysics, to students without specialization on physics, and finally to the students without any science background at all, the degree of difficulties in explaining the most recent developments in scientific research increases severalfold. Therefore, it is the most difficult job, a daunting task to describe and explain the most recent developments in science to laymen.

However, a scientist cannot escape her or his responsibility in reaching to the common people, in sharing the excitement of new discoveries to the common tax payers who contribute in funding most of the research works. On the other hand, the common men are always curious to know the newest discoveries, the newest developments in science and technology. It is no less than a thriller to most of them irrespective of their profession or academic background. As a consequence if scientists do not attempt to reach to the laymen, nonscientists often attempt to bridge the gap by writing popular science book. Once a news reporter, while interviewing me, enquired about my topic of research. I replied “I work on extra-solar planets, also on Brown Dwarfs.” The next day it was published “Professor Sengupta works on extra-solar planets also known as Brown Dwarfs”! So scientific documents written by nonscientists may often have a danger of misinterpreting scientific results, even exaggerating the consequence of a new discovery and thus misleading and confusing the common people. This book is my humble effort to fulfill my responsibility of sharing the excitements of the most recent developments and discoveries on astronomy, especially on the planetary science. This is a new experience to me and so it has been a challenging task. On the other hand, by accepting this challenge, I have certainly become more vulnerable to criticism by professional astronomers.

This book is a culmination of several lectures that I delivered to a wide range of audiences—from experts working on my area of research to school students. Often I could not reply or explain several brilliant questions or inquiries by them during or immediately after my lectures. When I found an answer or a possible explanation after several days or months, I was unable to convey it to them. The frustration prompted me to think of writing this book. While writing this book, I imagined that I was delivering a lecture to an audience consisting of three different groups of people: to a group of scientists who were not aware of the current developments in the field of astronomy and in particular of the planetary science; to a group of science students or amateur astronomers who had no exposure to technical aspects and terminologies of advance research; and to a group of laymen who were averse to any unnecessary complexities and did not care about scientific terminologies and mathematical expressions. The first group of people may criticize me for not being able to explain many things properly, the second group may embarrass me by asking several questions beyond my knowledge and understanding and by contradicting my explanations, while the third group may prove that the “Emperor has no cloth.” All are welcome.

This book should be read like a fiction or a story book. But unlike a fiction, all the objects and events described here are real. Also, unlike a story book, each chapter of this book is self-content. Therefore, readers may skip a chapter if it appears to be boring. For this purpose and for reminding the readers some important and related processes, some of the descriptions or explanations are intentionally repeated instead of asking the reader to go back to previous chapters. I hope the experts in this field will pardon me for this intentional repeats. I have put all my efforts to avoid any grammatical errors in the language. However, a few mistakes may still remain. I apologize for that. I hope the scientific contents of the book should dominate the mind of a reader over its literacy value if any.

At the end of the book, a list of websites has been provided. This is no way a comprehensive list but I took help from these websites. These websites may be considered as references for further reading. For the benefit of science students, some simple mathematical relationships and formulae are provided at the end. The main book, however, does not have any reference to these appendices. Therefore, readers without science background should skip these.

Quite a few publishers who invited me to write and publish a book with them strongly suggested to write a textbook and politely refused my proposal for publishing a popular science book for the laymen although astronomy is always a popular subject. I understand that the main reasons are the uncertainty in the marketing of a popular science book and my inexperience in writing any book before, text or popular. Springer has taken that risk and I am thankful to them for publishing the book. I thank Dr. Ramon Khanna, senior astronomy editor of Springer, for several suggestions and guidance.

The amateur astronomers around the world play a vital role in astronomy. Many of the comets, asteroids, and Near Earth Objects are discovered by them. They take active part in planet hunting and in the search for extraterrestrial life (SETI). While professional astronomical organizations such as NASA and European Space Agency (ESA) or European Southern Observatory (ESO) are very generous in providing permission to publish spectacular images of celestial objects, I thought publishing a few images taken by amateur astronomers would not only offer appreciation to their contributions but also might generate interest to common people towards making astronomy as a hobby. I am grateful to Mr. Efrain Morale Rivera of Aguadilla, Puerto Rico, for kindly providing permission to publish some astronomical images from his huge collection.

Ms. Sandra Rajiva, Mrs. Catherina Williams, and Ms. Aarti Dwivedi took the pain to read quite a few drafts of the manuscript and corrected the grammatical errors and suggested several changes in the language. I express my gratitude to them. Apart from the direct help that I received in completing the manuscript, a large number of astronomers motivated and inspired me. Prof. Ronald E. Taam has been a constant inspiration for me. I have learned a lot on various areas of astrophysics from him. I have learned a lot about extra-solar planets and Brown Dwarfs while collaborating with Dr. Mark S. Marley of NASA, AMES. The lengthy, penetrating, and illuminating discussions with Prof. Frank H. Shu during and after my lectures at Academia Sinica, Institute of Astronomy and Astrophysics,

Taipei, have enhanced my knowledge in great extent. I am also thankful to Prof. Vinod K. Gaur for many discussions that enriched my knowledge on the geology of the Earth and Mars. Back in my own country, working in a research institute which has the credit for the first false alarm of extra-solar planets reported some 150 years ago certainly has an advantage. I thank the present director of my Institute, Dr. P. Sreekumar, for his encouragement. Last but not the least I thank my wife Srirupa who took the responsibility of keeping the home in order single-handedly besides managing her career as a teacher.

I shall consider myself successful in this new venture if after reading this book the readers realize by their heart the urgent need of protecting our world, the Earth—an extremely rare planet born and privileged by cosmic coincidence and blessed by a divine process called life.

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The Search for Habitable Planets

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