Space-Time, Relativity, and Cosmology

Space-Time, Relativity, and Cosmology provides a historical introduction to modern relativistic cosmology and traces its historical roots and evolution from antiquity to Einstein. The topics are presented in a non-mathematical manner, with the emphasis on the ideas that underlie each theory rather than their detailed quantitative consequences. The tests and experimental evidence supporting the theories are explained together with their predictions and their confirmation.

The discussion of the Special Theory begins by stating the Principle of Relativity and its roots in the ideas of Galileo and Newton, followed by deriving its main consequences, including the relativity of simultaneous events, time dilation and length contraction and the equivalence of mass and energy. The General Theory of Relativity and its consequences when applied to the large-scale structure of the universe are discussed, including its tests and striking predictions. The discussion of modern relativistic cosmology includes the Cosmological Principle, possible geometries of space-time, and the consequences of Hubble's observations leading to the Big Bang hypothesis. The last section of this chapter presents a brief overview of some of the most exciting research topics in the area of relativistic cosmology, concluding with a description of the deficiencies of the Big Bang and a possible resolution.

This textbook is intended for undergraduate students undertaking a science course in non-science majors. It is also accessible to advanced high school students, as well as the non-scientist layman who is concerned with science issues.

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To Mariana

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Acknowledgments

This book grew out of a course that was created by Frederick Cummings and Peter Kaus in 1982, and which I "inherited" after their retirement in the early 1990s. The course format makes it easy to include new developments in the subject matter, and uses these changes to provide a beautiful example of the evolution of scientific theories. This attractive combination has proved a successful lure for students, who will fill a large lecture hall every time the course is offered. I have strived to maintain a similar approach in the present publication, so any success it might have should be credited to the original designers.

I am very grateful to both Cummings and Kaus for having introduced me to the challenging and rewarding field of teaching non-science majors, as well as for the many discussions about the foundations of relativity, the development of scientific theories and physics in general.

This book is dedicated to the memory of my dear friend and colleague, Lynne Deutsch, who opened new eyes to the sky.