Preface

Two of the most important advances in physics and astronomy in the past ten years are 1) the discovery that the expansion of our universe is speeding up, at just the right amount to render our universe spatially flat, and 2) the precise measurement of the cosmic microwave background radiation by the WMAP satellite, which supports the inflationary theory of the universe advanced by Alan Guth almost thirty years ago. No less significant is the discovery that neutrinos have a tiny mass, in the range that is completely consistent with the total amount of matter in the universe according to a theory known as leptogenesis. This also supports the inflationary theory indirectly, for without something like the leptogenesis theory to generate matter, the inflationary theory would leave behind almost no matter in the present universe.

I attempt to explain these important advances in this book. It is aimed at the layman who is curious about science, and does not assume any prior exposure to physics, mathematics, and astronomy beyond that at the high school level. More involved concepts which may require a bit more knowledge of physics and/or mathematics are relegated to an appendix of endnotes at the back of the book.

According to the theory of inflation, our universe started some 13.7 billion years ago from a tiny speck with no matter and very little energy. In other words, from a very tiny world which was almost empty. What made it grow explosively in size, in energy, and in matter content will be explained in the text, but the emptiness of the early universe also reminds me of the emptiness emphasized by Zen Buddhism. I am neither a Buddhist nor a Buddhism scholar, but I think the similarity and difference between these two notions of emptiness are amusing enough for at least a cursory comparison. This is why the first five chapters of the book contain a brief introduction to Buddhism. It is also the reason why the word Zen appears in the title of the book. The bulk of the book, however, is on the science of cosmology, and not on the philosophy of Buddhism.

The cover painting makes an attempt to depict some important features of an inflationary cosmology. The mountain is an artistic rendition of the 'mountain curve' in Fig. 42, which summarizes some important features of modern cosmology. The steep cliff on the left represents the inflationary period when an explosive growth of the universe occurs; its barrenness and the presence of the pagoda are there to remind us of the emptiness of the early universe. The gentler slope on the right of the mountain depicts the classical Big Bang periods, first dominated by radiation then by matter, where the richness of the present universe began to emerge. The altitude at any point in the mountain represents the wave number, which is inversely related to the size of a disturbance of the universe. It is this disturbance originated in the inflationary era that generates the fluctuations of the microwave radiation observed by WMAP, and acts as the seed for the galaxies and stars to be formed later. The position of the clouds across the mountain tells us roughly the observed size of these disturbances. The idea of using a mountain to describe many of the important

features occurred independently to James Bjorken, who developed the connection between the mountain and many important features of cosmology much more extensively than is sketched here. The idea of the cloud is due to him. I am much indebted to him for explaining to me the other features of the connection not discussed in this book.

The beautiful painting is executed by my old friend Nora Li, to whom I owe a deep gratitude. There are many other people to thank for suggestions to improve the early drafts. Among them I should mention Bill Chan, John Crawford, Chi-Fang Chen, David Jackson, David Kiang, Jonathan and Lilian Lee, Kelvin Li, Siu-Kay Luke, Tung-Mow Yan, and my wife Cynthia. Special thanks should go to James Bjorken, Wu-ki Tung, and my daughter Phoebe, who have each read large parts of the manuscript and made detailed suggestions for changes. Without them the book would have been in much worse shape. Last but not least, I am grateful to my editor Ian Seldrup, who is skillful, patient, sympathetic, and very willing to help.

With the launch of the Planck satellite next year, and with the many other instruments both in preparation and in the design stage, much more data will be available in the coming years to vastly expand our knowledge of cosmology. I hope this book serves to prepare readers for these exciting events to come in the near future.

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