PREFACE

Five dimensions represents a unique situation in modern theoretical physics. It is the simplest extension of the four-dimensional Einstein theory of general relativity, which is the basis of astrophysics and cosmology. It is also widely regarded as the low-energy limit of higher-dimensional theories which seek to unify gravity with the interactions of particle physics. In the latter regard, we can mention 10D supersymmetry, 11D supergravity and higher-D string theory. However, the view of our group is pragmatic: we need to understand 5D physics, to put 4D gravity into perspective and to show us where to go in higher dimensions.

This book provides an account of the main developments in 5D physics in recent years. In a sense, it is a sequel to the omniverous volume *Space-Time-Matter* published in 1999. However, the present account is self-contained. So are the chapters, which each deal with a separate topic and has its own bibliography. The major topics are cosmology, quantum physics and embeddings. There are currently two approaches to these topics, namely those provided by induced-matter theory and membrane theory. The former uses the fifth dimension in an unrestricted manner, to provide an explanation for the mass-energy content of the universe. The latter uses the fifth dimension to define a hypersurface, to which the interactions of particle physics are confined while gravity propagates freely into the "bulk". Physically, these two versions of 5D physics are differently moti-

vated, but mathematically they are equivalent (one can always insert a membrane into the former to obtain the latter). Therefore, in order to be general, this volume concentrates on the mathematical formalism.

Some knowledge of tensor calculus is presumed, but each chapter starts and ends with a qualitative account of its contents. Many of the results presented here are the result of a group effort. Thanks are due to the senior researchers whose work is described herein, notably H. Liu, B. Mashhoon and J. Ponce de Leon. Acknowledgements should also be made to associates from various fields including T. Fukui, P. Halpern and J.M. Overduin. Gratitude is further owed to a cadre of enthusiastic graduate students, notably D. Bruni, T. Liko and S.S. Seahra. Much of this book was written during a stay with Gravity-Probe B of the Hansen Physics Laboratories at Stanford University, at the invitation of C.W.F. Everitt. Any omissions or errors are the responsibility of the author.

Theoretical physics can be an arcane and even boring subject. However, the author is of the opinion that the fifth dimension is fascinating. Where else can one discover that the universe may be flat as viewed from higher dimensions, or that spacetime uncertainty is the consequence of deterministic laws in a wider world? Such issues provide a healthy shake to the bedrock of conventional physics, dislodging the plastered-over parts of its edifice and providing a stronger foundation for future work. Physics and philosophy are not, it appears, separate. This book provides technical results whose success

leads inevitably to the insight that there is more to the world than is apparent, provided one looks…

Paul S. Wesson