Preface

Classical Mechanics is the branch of theoretical physics that deals with the motion of massive bodies under the influence of forces, whereby — one should add — relativistic effects or quantum effects are not important in the physical situation under consideration. The nonrelativistic circumstances require that all speeds are very small compared with the speed of light; but there is, of course, an extension of classical mechanics to the relativistic domain. When disregarding quantum effects we refrain from applying the methods of classical mechanics to phenomena on the scale set by atoms; but there is, of course, quantum mechanics for that purpose. Both relativistic mechanics and quantum mechanics turn into classical mechanics when, respectively, the speeds are small or the scales are large.

To quite some extent, classical mechanics deals with the physical phenomena that are the most familiar and the most intuitive, such as falling stones and swinging pendulums. As a natural tradition, then, the physics student's first exposure to theoretical physics is in lectures on classical mechanics. This has historical reasons because classical mechanics has its roots in the 16th and the 17th century and pre-dates all branches of Physics in maturity, but it also has factual reasons: In classical mechanics the student encounters for the first time universal principles that apply throughout all of physics and learns about concepts of general importance and usefulness. A solid knowledge of classical mechanics is the basis for all subsequent studies of physics.

The course on classical mechanics plays yet another important role in the physics curriculum. It is the student's first serious encounter with physics spoken in its natural tongue, the language of mathematics: A solid command of calculus and linear algebra is indispensable for the physicist, and so is a good knowledge of trigonometry and the basic special functions. While students are expected to be somewhat familiar with these mathematical tools when embarking on classical mechanics, good skills and confidence in using the tools are only developed by lots of practice. It is important that the learning student works out many of the exercises that are included here or can be found in textbooks. You do not learn to play the violin by watching a violinist perform; you must try your own hands on the instrument.

These *Lectures on Classical Mechanics* grew out of a set of lecture notes for a second-year undergraduate course that I taught at the National University of Singapore (NUS) in recent years. The presentation is rather detailed and does not skip intermediate steps that — as experience shows — are not so obvious for the learning student.

Prior to this course, students would have gone through the usual first-year overview of physics, partly a review of pre-university physics and partly a preview of coming attractions, and thus know quite a bit about classical mechanics, albeit in simple contexts and handled with elementary mathematical methods. Accordingly, the reader is expected to know basic facts, concepts, and notions of physics. Some of that material is covered here as well, in particular matters that are central to classical mechanics and deserve a systematic exposition.

A set of lecture notes is not a monograph on the subject and is not meant to be one. Rather, its purpose is to give a solid introduction and prepare the student for further studies on her own. Accordingly, there is no ambition of, and no attempt at, treating each and every aspect of classical mechanics in these notes — they just represent what I could and would deal with in one semester. The material of this book is my personal selection for that one-semester second-year course, presented in full during twenty-three two-hour lectures. Other lecturers will surely omit some of the material of my choice in favor of topics that I did not choose to include. What I selected is, in fact, much material for one semester; one might wish to spread it out over one and a half semesters and cover additional topics in the remaining half of the second semester, perhaps introducing the students to relativistic mechanics or deterministic chaos.

The feedback I received from students in class, from the Ph.D. students and postdoctoral fellows who conducted tutorial sessions, and from colleagues in the NUS Department of Physics and elsewhere was invaluable and led to many improvements of the text. While I am much obliged to all of them, I can only name a few: Dai Jibo, Han Rui, Hu Yu-Xin, Le Huy Nguyen, Lee Kean Loon, Len Yink Loong, Li Xikun, Hui Khoon Ng, Seah Yi-Lin, Shang Jiangwei, and Ye Luyao represent this large crowd.

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This book would not exist without the outstanding teachers, colleagues, and students who taught me so much. I dedicate these lectures to them.

I wish to thank my dear wife Ola for her continuing understanding and patience by which she is giving me the peace of mind that is the source of all achievements.

Singapore, January 2015 *BG Englert*