

# Preface

In many research fields, both in fundamental and applied physics, classical mechanics plays, even today, a key role. However, the traditional way of teaching mechanics often confines applications to old-fashioned pendulums, springs, or rotating cylinders. The goal of this book is to illustrate classical mechanics mostly by examples arising from *contemporary physics* — although we have included a few standard problems that cannot be ignored. The exercises and problems that are gathered here are the result of our teaching experience, in lectures, exercise classes, and written and oral exams.

This book is written mainly for undergraduate physics students. They will find material to test their understanding of physical concepts taught in lectures, to improve their ability to solve concrete problems, and also a way to discover some aspects of modern physics which should prove useful in the rest of their curriculum (for instance, links with statistical mechanics or quantum physics are emphasized when relevant). We have chosen to give complete solutions, with explicit calculations and many physical comments, so that the book can be used by the students on their own. In the same spirit, we recall, for most problems, basic notions in the form of “reminders”. We hope that instructors will find here some useful material that can be adapted for the preparation of homework problem sets or exams.

We have given an indication of the level of difficulty of the exercises. In principle, the easiest ones (\*) can be solved by first-year university students. Those of intermediate difficulty (\*\*) require a deeper knowledge of classical mechanics. A few exercises and problems (\*\*\*) have a more technical character. The reader may work on these problems using the solutions in order to widen his/her knowledge of classical mechanics but also of modern physics.

The themes we have chosen illustrate our personal interests, and, for a number of them, have been inspired directly by our research field (in particular the problems of Chapter 9), but also by discussions with colleagues or by articles we have read. They offer a (necessarily limited) panorama of a few applications of classical mechanics to modern physics. All problems are independent of each other; however, we have stressed in the solutions the links that exist between problems dealing with similar topics.

We have emphasized concrete applications (i.e. calculations of numerical values, estimates of orders of magnitude, interpretation of experimental data) in order to insist on the experimental character of physics, which is often not fully appreciated by students. In the same vein, we have given a number of reading suggestions at the end of the solutions, especially recent research articles (most of which can be found freely on the internet, especially on the arXiv preprint server). We believe that this feature of the book will reinforce in some of our readers their taste for physics.

It is probable that a few misprints remain in the text. Readers noticing them are invited to point them out to us by sending an e-mail to the address [dgo@irsamc.ups-tlse.fr](mailto:dgo@irsamc.ups-tlse.fr); we thank them in advance for their help.

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