

Foreword

Among all subfields of physics, the most familiar to each of us is undoubtedly classical mechanics. Archimedes floating in his bath, Newton watching the fall of an apple, Galileo muttering “and yet it moves” have become universal characters. Their discoveries are part of common wisdom, and accepted by everyone as natural and fundamental rules.

But can we make sure that we really understand mechanics? Basic principles are written in a few lines and their simplicity is amazing. However, their domain of applicability is huge, ranging from molecular motion to galaxy dynamics. In order to master mechanics in all its diversity, one thus needs to use it; in academic terms, one needs to solve problems. But which ones? Facing traditional exercises, the reaction of students is most often: “the calculations are too heavy!” However, the examiner is often kind enough to add at the very end of the problem the recommendation “Interpret the result physically”. But this is not sufficient to unveil to the students the appeal of hypothetical cones rolling inside vibrating cylinders.

The reflection themes proposed by David Guéry-Odelin and Thierry Lahaye are the complete opposite of the usual stereotyped exercises. In this book the readers will encounter particles, atoms, or planets, evolving in simple force fields such as gravity or Coulomb repulsion. In each text, the authors start with a well-defined physical question and guide their readers by estimating relevant orders of magnitude. Of course, calculations are not absent — studying the stability of Lagrange points implies some suffering — but they are never pointless. Above all, the authors show a true delight in bringing us to the discovery of hidden aspects of the dynamics of simple objects: a ball can stay in stable equilibrium on a saddle, atoms can be cooled when illuminated by laser beams, non-dissipative motion can occur in the presence of friction forces, and so on.

Classical mechanics is a lively subject. Many problems encountered in the present book refer to discoveries that occurred during the last two decades. The readers will thus learn mechanics at its best level, which is important for short-term academic success, and will discover pieces of contemporary research, which may be more important in the longer term for career preparation. The authors have managed to reach this double goal because they are both teachers and actors in this scientific adventure. Several chapters refer to their research field, and some are directly inspired by their own work. I sincerely hope that the passion that David Guéry-Odelin and Thierry Lahaye have put into this book will stimulate the curiosity of their readers, and teach them the pleasure of understanding how, beyond formalism, new physical phenomena can emerge.

Jean Dalibard

Researcher at CNRS

Professor at École Polytechnique