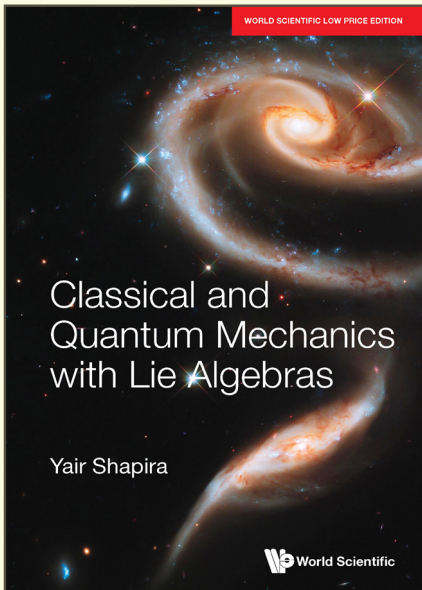


Classical and Quantum Mechanics with Lie Algebras



By **Yair Shapira**
(Technion - Israel Institute of Technology, Israel)

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ABOUT THE BOOK

How to see physics in its full picture? This book offers a new approach: start from math, in its simple and elegant tools: discrete math, geometry, and algebra, avoiding heavy analysis that might obscure the true picture. This will get you ready to master a few fundamental topics in physics: from Newtonian mechanics, through relativity, towards quantum mechanics.

Thanks to simple math, both classical and modern physics follow and make a complete vivid picture of physics. This is an original and unified point of view to highlighting physics from a fresh pedagogical angle.

Each chapter ends with a lot of relevant exercises. The exercises are an integral part of the chapter: they teach new material and are followed by complete solutions. This is a new pedagogical style: the reader takes an active part in discovering the new material, step by step, exercise by exercise.

The book could be used as a textbook in undergraduate courses such as Introduction to Newtonian mechanics and special relativity, Introduction to Hamiltonian mechanics and stability, Introduction to quantum physics and chemistry, and Introduction to Lie algebras with applications in physics.

READERSHIP

Undergraduate and graduate students in Mathematics, Physics, and Chemistry.

CONTENTS

- **Introduction to Newtonian Physics:**
 - Introduction to Newtonian Mechanics: Energy-Work
 - Angular Momentum and Its Conservation
 - Stability in Geometrical Optics

- **Towards Stability in Classical Mechanics:**
 - Poincare Stability in Classical Mechanics
 - Cantor Set and Its Applications
 - Is The Universe Infinite?
 - Binary Trees and Chaos Theory
- **The Binomial Formula and Quantum Statistical Mechanics:**
 - Newton's Binomial and Trinomial Formulas
 - Applications in Quantum Statistical Mechanics
- **Introduction to Relativity:**
 - Introduction to Special Relativity: Momentum-Energy
 - Towards General Relativity: Spacetime and Its Coordinates
- **Introduction to Quantum Physics and Chemistry:**
 - Introduction to Quantum Mechanics: Energy Levels and Spin
 - Quantum Chemistry: Electronic Structure
- **Introduction to Lie Algebras and Their Applications:**
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 - Design Your Lie Algebra
 - Ideals and Isomorphism Theorems
 - Exercises: Solvability and Nilpotency
 - Nilpotency and Engel's Theorems
 - Weight Space and Lie's Lemma and Theorem
 - Cartan's Criterion for Solvability
 - Killing Form and Simple Ideal Decomposition
 - Hamiltonian Mechanics: Energy and Angular Momentum
 - Lie Algebras in Quantum Mechanics and Special Relativity
- **Appendix: Background in Calculus:**
 - Functions and Their Derivatives
 - Polynomials and Partial Derivatives
 - Matrices and Their Eigenvalues
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ABOUT THE AUTHOR

Yair Shapira got his BSc and MSc in Math from the Hebrew Univ., Jerusalem, Israel, In 1989. He also got his DSc in Applied Math from the Technion, Haifa, Israel, in 1994. Then, he was at the Los Alamos national laboratory and the Technion, and wrote a few books in applied math, including *Solving PDEs in C++* (SIAM, 2012). He is mainly interested in numerical methods, object-oriented programming, and mathematical physics.

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