

Preface

This work will introduce the wave equations in higher dimensions at an advanced level addressing students of physics, mathematics and chemistry. The aim is to put the mathematical and physical concepts and techniques like the wave equations, group theory, generalized hypervirial theorem, the Levinson theorem, exact and proper quantization rules related to the higher dimensions at the reader's disposal. For this purpose, we attempt to provide a comprehensive description of the wave equations including the non-relativistic Schrödinger equation, relativistic Dirac and Klein-Gordon equations in higher dimensions and their wide applications in quantum mechanics which complements the traditional coverage found in the existing quantum mechanics textbooks. Related to this field are the quantum mechanics and group theory. In fact, the author's driving force has been his desire to provide a comprehensive review volume that includes some new and significant results about the wave equations in higher dimensions drawn from the teaching and research experience of the author since the literature is inundated with scattered articles in this field and to pave the reader's way into this territory as rapidly as possible. We have made the effort to present the clear and understandable derivations and include the necessary mathematical steps so that the intelligent and diligent reader is able to follow the text with relative ease, in particular, when mathematically difficult material is presented. The author also embraces enthusiastically the potential of the LaTeX typesetting language to enrich the presentation of the formulas as to make the logical pattern behind the mathematics more transparent. In addition, any suggestions and criticism to improve the text are most welcome. It should be pointed out that the main effort to follow the text and master the material is left to the reader even though this book makes an effort to serve the reader as much as was possible for the author.

This book starts out in Chap. 1 with a comprehensive review for the wave equations in higher dimensions and builds on this to introduce in Chap. 2 the fundamental theory about the $SO(N)$ group to be used in the successive Chaps. 3–5 including the non-relativistic Schrödinger equation, relativistic Dirac and Klein-Gordon equations. As important applications in non-relativistic quantum mechanics, from Chap. 6 to Chap. 12, we shall apply the theories proposed in Part II to study some

important quantum systems such as the harmonic oscillator, Coulomb potential, the Levinson theorem, generalized hypervirial theorem, exact and proper quantization rules and Langer modification, the Schrödinger equation with position-dependent mass and others. We shall illustrate two important applications in relativistic Dirac and Klein-Gordon equations with the Coulomb potential in Chaps. 13 and 14. As crucial generalized applications of Dirac equation in higher dimensions, we shall study the Levinson theorem, generalized hypervirial theorem and Kaluza-Klein theory in Chaps. 15–17. Some conclusions and outlooks are given in Chap. 18. Some useful reference materials such as group theory, group representations, fundamental properties of Lie groups and Lie algebras, the angular momentum theory and the confluent hypergeometric functions are sketched in Appendices A–E.

This book is in a stage of continuing development, various chapters, e.g., on the quantum gravity, on the Kaluza-Klein theory, on the supersymmetry and string theory, on the high dimensional brane will be added to the extent that the respective topics expand. At the present stage, however, the work presented for such topics should be complete enough to serve the reader.

This book shall give the theoretical physicists and researchers a fresh outlook and new ways of handling some important and interesting quantum systems in several branches of physics. This book can be used by graduate students and young researchers in physics, especially theoretical and mathematical physics. It is also suitable for some graduate students in theoretical chemistry.

Mexico city, Mexico

Shi-Hai Dong



<http://www.springer.com/978-94-007-1916-3>

Wave Equations in Higher Dimensions

Dong, S.-H.

2011, XXV, 295 p., Hardcover

ISBN: 978-94-007-1916-3