

Group Representation for Quantum Theory



This book explains the group representation theory for quantum theory in the language of quantum theory. Group representation theory is a fundamental mathematical tool for quantum theory, in particular, for quantum information. Quantum theory requires so many aspects of group representation theory. There are so many books for group representation theory. Most of books based on the mathematical viewpoint focus only on a part of group representation used for quantum theory. In particular, they do not focus on the projective representation while any physical realizable symmetry is written as a projective representation. At least, no mathematical book covers the whole required topics of group representation theory for quantum theory. Some of them are written in a too general framework while several typical examples are required for quantum theory. At least, no mathematical book covers the whole knowledge of group representation required by quantum information. In contrast, many physical books cover a larger part of group representation for quantum theory, but they skip the mathematical details so that the reader cannot understand the mathematical essence of the group representation. This book resolves both problems. It covers a larger part of group representation theory required by quantum theory with mathematical details in a unified framework in the language of quantum theory. This way, the readers can easily understand the whole structure of group representation. This book starts with basic of quantum theory. Then, it introduces the basics of group representation and discuss the case of the finite groups, the symmetric group, e.g. Next, this book discusses Lie group and Lie algebra. This part starts with the basics knowledge, and proceeds to the special groups, e.g., $SU(2)$, $SU(1,1)$, and $SU(d)$. After the special groups, it

discusses a general theory. Using this knowledge, this book explains the Bosonic system, which has the symmetries of Heisenberg group and the squeezing symmetry by $SL(2, \mathbb{R})$ and $Sp(2n, \mathbb{R})$. Finally, as the discrete version, this book treats the discrete Heisenberg representation which is related to quantum error correction.

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