

# The quantum Rabi model: solution and dynamics

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**Abstract.** This article presents a review of recent developments on various aspects of the quantum Rabi model. Particular emphasis is given on the exact analytic solution obtained in terms of confluent Heun functions. The analytic solutions for various generalisations of the quantum Rabi model are also discussed. Results are also reviewed on the level statistics and the dynamics of the quantum Rabi model. The article concludes with an introductory overview of several experimental realisations of the quantum Rabi model. An outlook towards future developments is also given.

## 1. Introduction

80 years ago Rabi [1] introduced a model to discuss the effect of a rapidly varying weak magnetic field on an oriented atom possessing nuclear spin. The simplest case corresponds to a two-state system. The atom is treated as quantised, and the field is treated as a classically rotating field. The effect of a non-rotating, alternating field was later discussed by Bloch and Siegert [2], who found a shift in the position of the resonance – now called the Bloch-Siegert shift. This shift has been observed in experiments with a driven superconducting qubit [3].

Jaynes and Cummings [4] introduced a similar quantum model in 1963 describing a two-level atom interacting with a quantised mode of an optical cavity. Their initial goal was to study the relationship between the quantum theory of radiation and the corresponding semi-classical theory. Despite its simplicity, the quantum Rabi model was not regarded as exactly solvable. To solve the model, a rotating wave approximation

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## **Table of Contents The Quantum Rabi Model Solution And Dynamics Arxiv**

1. Understanding the eBook The Quantum Rabi Model Solution And Dynamics Arxiv
  - The Rise of Digital Reading The Quantum Rabi Model Solution And Dynamics Arxiv
  - Advantages of eBooks Over Traditional Books
2. Identifying The Quantum Rabi Model Solution And Dynamics Arxiv
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an The Quantum Rabi Model Solution And Dynamics Arxiv
  - User-Friendly Interface
4. Exploring eBook Recommendations from The Quantum Rabi Model Solution And Dynamics Arxiv
  - Personalized Recommendations
  - The Quantum Rabi Model Solution And Dynamics Arxiv User Reviews and Ratings

- The Quantum Rabi Model Solution And Dynamics Arxiv and Bestseller Lists
- 5. Accessing The Quantum Rabi Model Solution And Dynamics Arxiv Free and Paid eBooks
  - The Quantum Rabi Model Solution And Dynamics Arxiv Public Domain eBooks
  - The Quantum Rabi Model Solution And Dynamics Arxiv eBook Subscription Services
  - The Quantum Rabi Model Solution And Dynamics Arxiv Budget-Friendly Options
- 6. Navigating The Quantum Rabi Model Solution And Dynamics Arxiv eBook Formats
  - ePub, PDF, MOBI, and More
  - The Quantum Rabi Model Solution And Dynamics Arxiv Compatibility with Devices
  - The Quantum Rabi Model Solution And Dynamics Arxiv Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of The Quantum Rabi Model Solution And Dynamics Arxiv
  - Highlighting and Note-Taking The Quantum Rabi Model Solution And Dynamics Arxiv
  - Interactive Elements The Quantum Rabi Model Solution And Dynamics Arxiv
- 8. Staying Engaged with The Quantum Rabi Model Solution And Dynamics Arxiv
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers The Quantum Rabi Model Solution And Dynamics Arxiv
- 9. Balancing eBooks and Physical Books The Quantum Rabi Model Solution And Dynamics Arxiv
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection The Quantum Rabi Model Solution And Dynamics Arxiv
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine The Quantum Rabi Model Solution And Dynamics Arxiv
  - Setting Reading Goals The Quantum Rabi Model Solution And Dynamics Arxiv
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of The Quantum Rabi Model Solution And Dynamics Arxiv
  - Fact-Checking eBook Content of The Quantum Rabi Model Solution And Dynamics Arxiv
  - Distinguishing Credible Sources

13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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