



# Feynman's Thesis: A New Approach to Quantum Theory

*Richard Feynman*

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## **Feynman's Thesis: A New Approach to Quantum Theory** Richard Feynman

Richard Feynman's never previously published doctoral thesis formed the heart of much of his brilliant and profound work in theoretical physics. Entitled *The Principle of Least Action in Quantum Mechanics*, its original motive was to quantize the classical action-at-a-distance electrodynamics. Because that theory adopted an overall space time viewpoint, the classical Hamiltonian approach used in the conventional formulations of quantum theory could not be used, so Feynman turned to the Lagrangian function and the principle of least action as his points of departure.

The result was the path integral approach, which satisfied -- and transcended -- its original motivation, and has enjoyed great success in renormalized quantum field theory, including the derivation of the ubiquitous Feynman diagrams for elementary particles. Path integrals have many other applications, including atomic, molecular, and nuclear scattering, statistical mechanics, quantum liquids and solids, Brownian motion, and noise theory. It also sheds new light on fundamental issues like the interpretation of quantum theory because of its new overall space time viewpoint.

The present volume includes Feynman's Princeton thesis, the related review article *Space Time Approach to Non-Relativistic Quantum Mechanics* [*Reviews of Modern Physics* 20 (1948), 367-387], Paul Dirac's seminal paper *The Lagrangian in Quantum Mechanics* [*Physikalische Zeitschrift der Sowjetunion*, Band 3, Heft 1 (1933)], and an introduction by Laurie M Brown.

Contents: Least Action in Classical Mechanics: The Concept of Functional; The Principle of Least Action; Conservation of Energy. Constants of the Motion; Particles Interacting Through an Intermediate Oscillator; Least Action in Quantum Mechanics: The Lagrangian in Quantum Mechanics; The Calculation of Matrix Elements in the Language of a Lagrangian; The Equations of Motion in Lagrangian Form; Translation to the Ordinary Notation of Quantum Mechanics; The Generalization to Any Action Function; Conservation of Energy. Constants of the Motion; The Role of the Wave Function; Transition Probabilities; Expectation Values for Observables; Application to the Forced Harmonic Oscillator; Particles Interacting Through an Intermediate Oscillator; Space Time Approach to Non-Relativistic Quantum Mechanics; The Lagrangian in Quantum Mechanics.

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