Preface to first edition

This book gives a thorough investigation on formulating and solving quantum mechanical problems by the complex-extended analytical mechanics that extends canonical variables to complex domain. With this complex extension, we show that quantum mechanics becomes a part of analytical mechanics and hence can be treated integrally with classical mechanics. Complex canonical variables are governed by Hamilton equations of motion, which can be derived naturally from Schrödinger equation. Using complex canonical variables, a formal proof of the quantization axiom $\boldsymbol{p} \to \hat{\boldsymbol{p}} = -\mathrm{i}\hbar\nabla$, which is the kernel in constructing quantum-mechanical systems, becomes a one-line corollary of Hamilton mechanics. The derivation of quantum operators from Hamilton mechanics is coordinate independent and thus allows us to derive quantum operators directly under any coordinate system without transforming back to Cartesian coordinates. Besides deriving quantum operators, we also show that the various prominent quantum effects, such as quantization, wave-particle duality, tunneling, atomic shell structure, Aharonov-Bohm effect, and spin, all have the root in Hamilton mechanics and can be described entirely by Hamilton equations of motion.

Bohr's view about the wave function ψ is that due to its expression in terms of imaginary numbers, wave function is not susceptible to pictorial interpretation; and even the derived real functions like densities and currents are only to be regarded as expressing the probabilities for the occurrence of individual events. Accordingly, orthodox (Copenhagen) quantum mechanics contain no statement regarding the objective constitution of matter corresponding to the conception of particles and fields employed in classical physics. There are no "electrons" or "atoms" in the sense of distinct localized entities beyond the act of observation; without measurement, there is no objective existence. Orthodox quantum mechanics asserts that electrons and "atoms" only exist in the instant of measurement ; nothing can be said between measurements.

Since Max Born's statistical interpretation of wave functions, there has been the long-standing problem of "interpretation of Schrödinger equations". However, the emphasis should not merely be on "interpretation": The right problem to set is

"What is the Schrödinger equation ? "

In quantum mechanics one can only compute the expectation of physical quantities. Because orthodox quantum mechanics does not possess equations of dynamics, when one learns quantum mechanics, one has to develop one's own personal sense or picture to interpret the theory. It is safe to say that the lack of the equation of dynamics has been the primary source of controversies about the interpretations of quantum mechanics, although it has the equation of propagation of probability, i.e., the Schrödinger equation. Therefore, a plausible answer to the problem of "what is the Schrödinger equation ? " relies on the help of establishing equations of dynamics compatible with Schrödinger equation.

The readers will find in this book that the equations of dynamics compatible with Schrödinger are just the classical Hamilton equations extended to complex domain. By employing complex-extended Hamilton equations, there will be no ambiguity at all in understanding the motion of quantum particles, in other words, we no longer need the so-called "interpretation". Everything becomes transparent and every quantum mechanical problems can be solved by the well-established methods in analytical mechanics. The following figure highlights the features of complex mechanics.

The book is written with the expectation that through the bridge of complex mechanics, any student familiar with engineering mechanics will find that he already possesses the ability to handle quantum-mechanics problems even though he did not take a related course of quantum mechanics.

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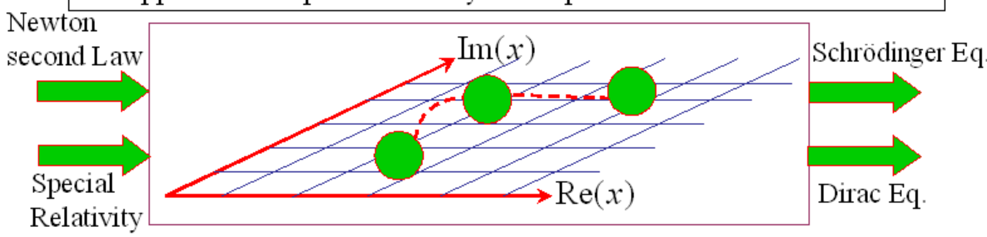
Complex Mechanics

1. Quantum mechanics is nothing but the application of Newton mechanics to complex domain, whereas relativistic quantum mechanics is nothing but the application of special relativity to complex domain.



2. If quantum mechanics is right (so far, it is), we have to admit the fact that physic laws truly happen in complex space.

3. In the near future, the education of quantum mechanics will become

Quantum Mechanics = **Classical Mechanics** + **Complex Variable**