Operator Mechanics: A New Form of Quantum Mechanics Without Waves or Matrices

Abstract: Quantum mechanics was created with the matrix mechanics of Heisenberg, Born, and Jordan. Schroedinger's wave mechanics shortly followed and allowed for simpler and more powerful calculations. Both Pauli and Dirac introduced a formulation of quantum mechanics based on operators and commutation relations, but it was never fully developed in the 1920's. Instead, Schroedinger formulated the operator approach with his factorization method, which later was adopted by the high-energy community as supersymmetric quantum mechanics. In this talk, I will explain how one can formulate all of quantum mechanics algebraically by a proper use of the translation operator. I will give examples of how one can compute spherical harmonics algebraically, how one can find harmonic oscillator wavefunctions, and will even describe a new Cartesian operator-based derivation of the wavefunctions of Hydrogen. I will end with a proposal for a novel way to teach quantum mechanics, focusing first on conceptual ideas related to superposition, projective measurements, and entanglement, then developing more conventional topics like spin, harmonic oscillator, angular momentum, interacting spin models, central potentials, particles in a box and so on. This is the subject of a book in progress entitled Quantum Mechanics without Calculus.

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