PHYSICS COLLOQUIUM

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Operator Mechanics: A New Form of Quantum Mechanics without Waves or Matrices
NOVEMBER 5| 2:30 PM
130 HAHN HALL NORTH
ZOOM LINK: HTTPS://VIRGINIATECH.ZOOM.US/S/96084996911

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 in 1940, which later was adopted by the high-energy community as supersymmetric quantum mechanics in the 1980s.

In this talk, I will explain how one can formulate nearly all of quantum mechanics algebraically by a proper use of the translation operator on top of Schroedinger's factorization method. I will give examples of how one can compute spherical harmonics algebraically, how one can find harmonic oscillator wavefunctions, and will even describe an operator-based derivation of the wave functions of Hydrogen. This approach ends up being a representation-independent way to do quantum mechanics. I will end with a description of a novel way to teach quantum mechanics, focusing first on conceptual ideas related to superposition, projective measurements, complementarity, and entanglement. Then developing more conventional topics like spin, harmonic oscillator, angular momentum, central potentials, LIGO and so on. Such a course inevitably focuses much more on the experiments of quantum mechanics, which are often neglected, or given short shrift in conventional treatments.

This is the subject of a book in progress entitled Quantum Mechanics without Calculus.