

The physics behind quantum operators

Ana María Cetto and Luis de la Peña

*Instituto de Física, UNAM, Mexico, Circuito de la Investigación Científica, CU, 04510
México, DF, Mexico*

A novel physical explanation is proposed for the emergence of the quantum operator formalism, from the perspective provided by stochastic electrodynamics (SED). We recall that according to SED, an otherwise classical, charged particle subject to a binding force reaches a stationary state of motion under the combined effect of the random electromagnetic zero-point radiation field (ZPF) and its own radiation reaction. In this work we focus on one such stationary state, and take into account that the zpf has taken control of the particle motion, acting as a driving force on it. The particle responds to a certain set of modes of the field, precisely to those that may take it to a different stationary state. A Hamiltonian analysis of this response, in which the Poisson bracket $\{x, p\}$ must now be taken with respect to the canonical field variables, allows us to derive the basic quantum commutator $[x, p] = i\hbar$. We discuss the implications of these results with regards to the physical meaning of the Heisenberg formulation of quantum mechanics.