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Quantum Theory and the Two Foundational Dichotomies

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Six independent programs of research have led to recognize two dichotomies as the foundations of Physics: one on the kind of infinity, potential or actual, another on the kind of theoretical organization, problem-oriented or deductive-axiomatic. In 1930, first Dirac formulated quantum theory. Contrary to popular belief it was a problem-oriented theory and its mathematics was algebraic, hence essentially referring to the mathematics of only potential infinity. Hence its basic choices were opposite of Newton mechanics'ones (deductive organization and actual infinity). But it was based on a naive analogy (between the commutators and the Poisson brackets of the Hamiltonian of the system). The subsequent formulation (von Neumann 1932) was accepted as the definitive theory. It uses the Hilbert space of functions based on actual infinity and its organization is deductive. Hence, this formulation reaffirmed the fundamental choices of Newton's mechanics. Unsurprisingly, by overshadowing Dirac's formulation, it became the new paradigm of theoretical physics, although its author, after writing his book, "confessed"to disbelieve in Hilbert space as the suitable mathematics for quantum theory. In 2008, Morchio and Strocchi provided, within a C*-algebra, a mathematical connection between commutators and Poisson brackets. Thus, Dirac-Morchio-Strocchi's formulation (whose problem is which is the Hamiltonian of a physical system?) formally departed from Newtonian paradigm and constitutes the alternative to von Neumann's formulation. Finally, the hidden variables of quantum theory have been recognized; however, they are at not the physical level but the scientific-philosophical level: the two dichotomies, which the author of a theory must determined through choices.

Author: DRAGO, Antonino

Presenter: DRAGO, Antonino

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