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Editorial: Applications of Quantum Mechanical Techniques to Areas Outside of Quantum Mechanics

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Editorial on the Research Topic

Applications of Quantum Mechanical Techniques to Areas Outside of Quantum Mechanics

The recent quantum information revolution has tremendous consequences not only for physics. It stimulates the use of quantum formalisms in various areas outside of quantum physics: cognition, psychology, economics and finance, microbiology and genetics. This approach is known as quantum-like modeling. For cognition, this modeling should be sharply distinguished from attempts to represent information processing by the brain through quantum physical processes (cf. with works of Penrose and Hameroff). For microbiology and genetics, quantum-like modeling should be distinguished from quantum biophysics. In the quantum-like approach a biological system (brain, cell) is considered as a black box processing information in accordance with the laws of quantum information and probability.

In psychology one can now claim that quantum probability has reached the mainstream. Ideas from quantum field theory now reach into applications to biology and medicine and economics and finance. One of the papers in this special issue, by Marcer and Rowlands, does look at so called "nilpotent quantum mechanics" a form of quantum field theory. The use of a functor in natural language semantics, as proposed in the work of Sadrzadeh derives also from quantum field theory.

The overarching theme in the applications considered here in this special issue, is the use of the so called "quantum-like paradigm." As pointed out in the article by Khrennikov, social science is confronted with probabilistic and "entangled" systems. In this special issue, the paper by Lawless looks specifically at entanglement in his treatment of the interdependence of teams.

Each of the papers accepted for publication under our research topic "Applications of quantum mechanical techniques to areas outside of quantum mechanics," highlights a particular facet of this new multi-faceted area of research.

Plotnitsky's paper in our collection of papers is maybe the contribution which provides for an overarching thinking template on all the work published here. The papers in our special issue assume that the mathematical modeling of a social science bound phenomenon is possible. But interestingly enough, as Plotnitsky remarks, even if we were to question such an assumption, it will not necessarily lead to halting the use of mathematics in such modeling but rather it may result in new modeling and even, maybe, new mathematics? The paper by Aerts et al. far from claiming that mathematical modeling is impossible, does propose that new mathematical structures may well be needed (structures which go beyond quantum structures) to model cognition.

The idea of "probability waves," a novel intuitive concept when quantum mechanics was being formulated, was born out of the double slit experiment. This brings us neatly to think about the multiple cases of violations of the law of total probability. The wave function is a fantastic device which helps us to understand that there is no unique position, until a measurement is made. As the paper by Flender carefully lays out, understanding this uncertainty lies at the heart of so called temporality. Temporality is a key ingredient in non-chronological time (what Flender calls "time of acausality") and it seems to define also information. The paper by Yukalov and Sornette comes back to the interference effect which is the result, from what they call, an inconclusive event. Inconclusive events, as they rightly point out, underlie many human decisions too. One may argue that their paper transcends some of the results presented in this special issue, as the model they propose can be used for both quantum measurements AND decision making.

In the paper by Broekaert and Busemeyer the authors propose a Hamiltonian based quantum-like model which allows for the temporal evolution of memory states. Time is not the usual physical time variable, but it is rather used for the temporal ordering of states. The paper also carefully spells out the issue of closed and open systems. Open systems have now also been considered in areas other than psychology, such as political science and economics. The paper by Khrennikov provides for an overview.

Narens considers orthomodular lattice modeling in behavioral science. The article queries why there may be a link between the conservation principle and psychology and it also wonders why Hilbert space based quantum probability may be relevant to psychology.

Gabora and Kitto's contribution develops a so-called quantum theory of humor (i.e., the cognitive aspect of humor is considered). An experimental study is set up to start defining the state space of "humor."

The work by Moreira and Wichert compare several models which explain violations of the well know sure-thing principle in expected utility.

We hope this special issue provides for a rich addition to the problem of modeling social science phenomena with the help of the quantum-like paradigm.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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