AN APPROACH TO THE STRUCTURAL UNIFICATION OF QUANTUM MECHANICS AND RELATIVITY

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The unification of quantum mechanics and relativity into a single mathematical structure has been a vexing problem for the last eighty years. By its nature, the unification problem is a problem in physics, but a less ambitious attitude consists in viewing it as a purely mathematical problem. This is the subject of the present talk.

The idea consists in finding the simplest generalization of nonrelativistic quantum mechanics (in Schrodinger's picture) without asking whether this generalization is physically justified or not. If a structural unification of relativity and quantum mechanics does exist at an experimentally accessible scale (meaning down to 10^{-18} m) the hope is that it might be compatible with the simplest possible generalization of nonrelativistic quantum mechanics. The problem thus reduces to finding the simplest generalization in question.

Work on this project began in the late sixties in collaboration with Aage Petersen at Yeshiva University in New York. After some initial results, our work had to be interrupted. A new breakthrough was needed to continue. This happened some ten years ago.

The idea consists in generalizing Schrodinger's quantum mechanics by extending the field of complex numbers over which Hilbert space is built to a much richer algebra – named the algebra of quantions. The mathematical unification takes place without effort because the new number system (the quantions) is inherently relativistic.

The main results obtained so far are the fundamental differential equations of physics: Schrodinger's and Dirac's equations. Thus, while these equations are postulated in standard physics, they are theorems in the quantionic approach.

The objective of the lecture is to indicate the mathematical steps that lead to these results. Clearly, the proofs must be omitted, as they are far from trivial. They are however available in great detail in two books on the subject.