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Wave Functions on Space-Time

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In non-relativistic quantum mechanics, a wave function depends on one time variable. A suitable relativistic generalization is a wave function that depends on a separate time variable for each particle, i.e., for N particles, it depends on N space-time points. Such a function is called a multi-time wave function. The study of these wave functions and their evolution equations is interesting from many perspectives, e.g., from a non-rigorous formal perspective as well as from a rigorous mathematical physics one. It is furthermore relevant for "standard" quantum (field) theory (i.e., on the level of wave functions, operators and quantum fields), as well as for the foundations of quantum mechanics, e.g., for Bohmian Mechanics, GRW and many worlds. In this talk I present an overview of the recent work of R. Tumulka and myself on the subject. The main questions I discuss are how and what kind of interaction can be implemented in the framework of multi-time wave functions and how these wave functions are related to quantum field theory and the Tomonaga-Schwinger approach.

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