Guest Lecture

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Multi-time wave equations -- the challenge of a quantum mechanical time evolution in many variables

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Abstract: The basic object in quantum physics is a wave function which usually depends on one time variable and N space variables for N particles. However, such an object is not covariant under the Poincare group, the basic symmetry group of (special) relativity. A straightforward generalization which fixes this problem is to let the wave function \( \psi = \psi(x_1,\ldots,x_N) \) depend on one *spacetime* variable \( x_i \) per particle. Because of the presence of N time variables \( t_i = x_i^0, i = 1,2,\ldots,N \) \( \psi \) is called a "multi-time wave function". As natural as this concept may sound, one is led to a range of challenging physical and mathematical problems, such as: How can one define a consistent and interacting time evolution in the multiple time \( (x_i^0) \) variables? Which types of PDEs work for that? What is the physical meaning of \( |\psi|^2 \) at unequal times?, and: Are there new possibilities for evolution equations which are specific to the multi-time formalism? This talk will provide a non-technical overview of recent progress concerning these questions.