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Fadeev-Jackiw quantization of non-autonomous singular systems

Hervé Mohrbach
Université de Lorraine, France

The quantization of constrained systems was first considered by Dirac who elaborated on a Hamiltonian approach with a categorization of constraints and the introduction of the Dirac brackets. More recently Faddeev and Jackiw have proposed an alternative approach based on the symplectic formalism and Darboux theorem which can often avoid many of the steps of Dirac method. Both approaches were developed for autonomous constrained systems only. Gitman and Tyutin, via notably the introduction of a conjugate momentum of time, could extend Dirac approach and brackets for the case of non-autonomous singular systems. In this presentation an extension of the Faddeev-Jackiw method in order to solve the problem of time dependent constraints will be considered. For that purpose a time parameter is introduced to treat the real time as a dynamically variable, which is accompanied by the emergence of a gauge symmetry. This one is fixed with the help of a supplementary variable that plays the role of a new conserved Hamiltonian. From it, we deduce a generalization of the Hamilton equations for non-autonomous systems that lead to the correct equations of motion. With this extension of the usual Hamiltonian formalism we can obtain the most general form of the Schrödinger equation, valid for singular non-autonomous systems as well. The method is exemplified by the quantization of the damped harmonic oscillator and applied to the relativistic point like particle in an external electromagnetic field. This system meets specific difficulties such as a null Hamiltonian and the presence of a gauge symmetry due to the arbitrary choice of the time parametrization. We will see that the Faddeev-Jackiw approach for non-autonomous systems can be straightforwardly applied to this case. The quantization method could be generalized to a particle moving in a curved space and more generally to the case of time invariant reparametrization systems.

Biography

Hervé Mohrbach is Professor of Physics at the University of Lorraine. He has published more than 50 papers in theoretical physics in reputed journals.

herve.mohrbach@univ-lorraine.fr

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