# A sum of paths treatment to quantum graphs and quantum random walks

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Quantum graphs form a very interesting class of problems, which can be used to mimicate different systems in quantum mechanics. It has been used to describe transport in complex molecules, to analyze analytically features of quantum chaos, and even as proposals for quantum cosmological models. The system is basically composed by a set of sites (the nodes) connected to each other by a set of bonds. The connectivity structure describes its underlying topology. The dynamics is given by the time evolution of quantum states along such structure. In this contribution, we first show how to implement a sum over paths solution for the problem, deriving its exact Green function and then obtaining all the information about the quantum system. Different applications are discussed. Second, we explore the close relation between quantum graphs and the relatively recent idea of quantum random walks. From a direct mapping, we show how to extend the techniques of sum over paths, used in the quantum graphs, to the case of quantum random walks. Moreover, we introduce the concept of ``step operators'' and ``path operators''. From them we are able to identify the infinite many trajectories contributions in a given quantum random walk, in the same spirit of the Feynman path integrals formalism. Simple examples are worked out in detail.