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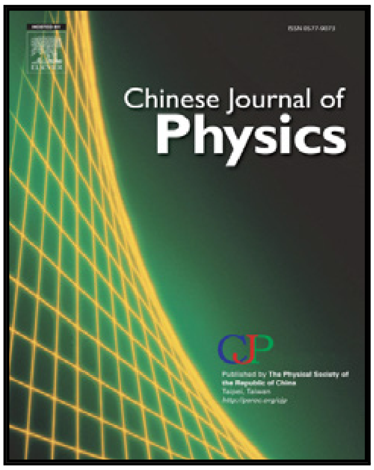

Classical and quantum wave dynamics on time-dependent geometric graph

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Classical and quantum wave dynamics on time-dependent geometric graph

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Abstract

. Geometric graph composed from a ring and a segment is considered. We deal with the Schrödinger (quantum) and the wave (classical) operators at the edges and the Kirchhoff conditions at the internal vertex. The lengths of the graph edges varies in time. Time evolution of a wave packet is studied in classical and quantum cases.

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1 Introduction

Low-dimensional models of quantum systems are rather powerful and popular tool of studying of many physical phenomena. Although it was suggested as early as in 30-th, it became widely used starting from 80-th (see, e.g., [1,2]). Since this time, it allows to find many results which are mathematically rigorous and have interesting physical applications (see, e.g., [3–8] and references therein).

As for time-dependent graph and time-dependent boundary conditions for the Schrödinger equation, it was studied less. At the same time, it is interesting, e.g., from the point of view of quantum Fermi acceleration [9, 10]. Particularly, it was pointed out in [10] that the problem of 1D box with a moving wall can be mapped onto that of an harmonic oscillator with time-dependent frequency confined inside the static box. Another approach to a network with time-dependent conditions at the edges is in [11, 12]. A version of time-dependent boundary condition is given by time-dependent point-like potential which reduces to some condition at a point. Three dimensional time-dependent δ-interactions were studied in [13] and in [14] in relation with the problem of ionization under periodic perturbations. These investigations were made in the framework of the theory of self-adjoint extensions of symmetric operators [15,16]. It is interesting that in dimension one the family of point perturbations of the Laplacian is richer than in dimension two and three, and includes δ and δ' perturbations, as well as their combinations. It is related to the fact that, in contrast to 1D case, for higher dimensions, the derivative of the Green function, playing the role of the deficiency element in the construction of point-like potential, does not belong to L_2 space. It is possible to introduce the point-like