Quantum-Quasiclassical Method for Few-Body Processes in Atomic and Nuclear Physics

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In a series of works by V.S. Melezhik with co-authors [1], [2], [3], [4], [5], [6], a computationally efficient quantum-semiclassical method was developed for the quantitative analysis of various few-body quantum problems. The key idea of this approach goes back to works [7], [8] where it was applied to the molecular dynamics. In this approach, part of the variables (describing the quantum dynamics of a light particle) is described by the time-dependent 3D Schrödinger equation, which is integrated simultaneously with the classical Hamilton equations for the remaining variables of the entire few-body system of several interacting particles.

The main part of the report is devoted to recent results obtained with this method: the prediction of the possibility of obtaining accelerated and twisted atoms by using elliptically polarized strong short-wave laser pulses [9], [10] and the study of the spectral structure of halo nuclei during their Coulomb and nuclear breakup [11], [12]. We discuss the computational aspects of the method, its computational efficiency and possible applications.

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