Nonadiabatic Effects within the Standard Adiabatic Born–Oppenheimer Approach

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Nonadiabatic effects are general phenomena and are therefore of both fundamental and practical interests. The concept of "nonadiabatic transitions" related to "adiabatic states" is very basic in natural sciences. The concept of adiabatic states was first proposed in molecular physics, where it leads to the Born–Oppenheimer approximation, and has then widely used in physics and chemistry. Nowadays, it is recognized that the concept of nonadiabatic transitions is multi-disciplinary and plays an essential role in state/phase changes in various fields of physics, chemistry, biology, and even in social sciences, including economics.

The great majority of theoretical treatment of inelastic processes based on nonadiabatic transitions are performed within the standard adiabatic (Born–Oppenheimer) approach, which is the natural extension of the Born–Oppenheimer approximation.

There are two kinds of nonadiabatic effects: nonadiabatic transitions between discrete states and nonadiabatic couplings between discrete and continuum states. Although the remarkable progress has been achieved in studying both kinds of nonadiabatic effects, there are some remaining problems in this field, in particular, the quantum approach to the electron translation problem. The new method has been recently proposed for the quantum solution of the electron translation problem within the standard adiabatic approach. The formalism of the method and its applications to different inelastic processes will be presented.