Atomic and Molecular Siegert States in a strong electric field

Toru Morishita
Institute for Advanced Science, The University of Electro-Communications
toru@pc.uec.ac.jp

The ionization of atoms and molecules by a static electric field is one of the fundamental problems in quantum mechanics. A new wave of interest in this problem over the past two decades has been motivated by the appearance of intense low-frequency laser pulses. The ionization of atoms and molecules by laser pulses is the first step for a variety of strong-field-induced rescattering phenomena of current interest, such as the generation of high-order harmonics and high-energy photoelectrons. An accurate quantitative description of this step is obviously required. Recently, we have established an efficient theoretical and computational method for calculating Siegert states in a static electric field, which are the solutions of the stationary Schrödinger equation satisfying the regularity and outgoing-wave boundary conditions, based on the adiabatic expansion in parabolic coordinates. This makes it possible to calculate the Siegert eigenvalue $E = E - i\Gamma/2$ defining the energy E and ionization rate Γ as well as the transverse momentum distribution of ionizing electrons with respect to the field direction. In this work we present the basics of the Siegert state method and some illustrative calculations of the Siegert states for some atomic and molecular systems. We also discuss atomic and molecular dynamics, including chemical reactions via an exceptional point of Siegert states.