Effects of a fast, short, and intense laser pulse on the electron charge transfer in atomic collisions

R. Cabrera-Trujillo

Instituto de Ciencias Física, Universidad Nacional Autónoma de México, Ap. Postal 48-3, Cuernavaca, Morelos, 62251, México

Charge transfer processes are fundamental to the understanding of matter neutralization in atomic and molecular interactions. Due to the polarizability of the material, charge transfer can be enhanced or suppressed during the interaction with electromagnetic radiation. Furthermore, charge transfer has different contributions arising from the radial and rotational regions of the potential interaction in the collision, which depend on the mass of the target and projectile. Since these effects appear in a very short time (femtoseconds), the dynamics must be carried out outside the Born–Oppenheimer approximation. In this work, we present a review of the total and state-to-state charge transfer results for He^{2+}, Li^{+} ions colliding with hydrogen and tritium atoms for collision energies from 100 eV/amu up to 10 keV/amu, assisted by a fast, short and intensity laser. Our study is based on an electron-nuclear dynamic treatment. A discussion is presented for isotope effects in the low-energy region and the increase of the total electron exchange cross-section for low projectile collision energy when compared to the laser-free case. In general, the longer the laser pulse, the larger the electron capture probability. At very low collision energies all pulse widths have an effect on the charge transfer process. For processes in the atto-second region, our findings suggest that to enhance the laser-assisted charge exchange, the best collision energy region for short pulses is in the low energy region. Finally, a review on the transmission and reflection coefficients for a wave packet that collides with an attractive impurity (e.g. a quantum dot, a perturbation on a waveguide, etc.) in the presence of an intense, ultra-fast Gaussian laser pulse of moderate intensity is presented. We discuss different scenarios where these results can be of interest.

The author acknowledges support from PAPIIT-DGAPA-UNAM IN-106-617 and to the FEMTO13 organizing committee.

References:

[1] F. J. Dominguez-Gutiérrez and R. Cabrera-Trujillo, *J. Phys. B* **48**, 135202 (2015).

[2] F. J. Dominguez-Gutiérrez and R. Cabrera-Trujillo, *Eur. J. Phys. D* **68**, 226 (2014).

[3] R. Cabrera-Trujillo and F. J. Dominguez-Gutiérrez, *REDS* **167**, 464 (2012).

[4] R. Cabrera-Trujillo, *Rad. Effects and Defects in Solids (REDS)* **164**, 402 (2009).

[5] F. Anis, V. Roudnev, R. Cabrera-Trujillo, and B. D. Esry, *Phys. Rev. A* **73**, 043414 (2006).