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Strong-field physics and attoscience

Dejan B Milošević
University of Sarajevo, Bosnia and Herzegovina

With the development of the laser technique in 1980's it becomes possible to generate strong laser fields using table-top laser systems. Applying such fields to atoms and molecules new processes such as above-threshold ionization and high-order harmonic generation were discovered. These processes enable insight into the space and time scale of atoms: it becomes possible to track atomic-scale motion of electrons and control these processes on the attosecond (1 as = 10^{-18} s) time scale. New area of science – attoscience – was born in 1990's. By the turn of millennium intense ultrashort light pulses comprising merely a few wave cycles became routinely available and found their application in exploring the properties of matter. In this talk I will explain the physics of strong-field processes and present new achievements of this area of science. Particular emphasis will be on a specific laser field configuration, the so-called bicircular field. Bicircular field consists of two coplanar counter-rotating circularly polarized fields of different frequencies which are integer multiples of the fundamental frequency. With such a field it is possible to investigate and control atoms, molecules and nanostructures in two dimensions (contrary to the one-dimensional case for a linearly polarized field). I will present examples of application of such field to investigate molecular structure and orientation. With bicircular field it is possible to generate circularly polarized coherent x-rays which are used to investigate properties of magnetic materials etc.

milo@bih.net.ba