Analysis and control of the dynamics of molecules and nanoparticles

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The dynamics of molecules and nanoparticles in intense laser fields is of great scientific interest. Ionization is the most fundamental of the processes induced by intense femtosecond laser pulses. Molecules and nanoparticles are suitable model systems to investigate the ionization dynamics due to their unique properties. The nuclear degrees of freedom in a molecule enable to study the rotational and vibrational excitation of molecular cations and dissociative ionization. Nanoparticles show a strong nonlinear behavior in intense laser fields leading to interesting phenomena, such as the ejection of fast electrons. We will report on the control of the ultrafast ionization and dissociation dynamics of molecules as well as on the electron emission dynamics of isolated nanoparticles. The following issues will be discussed:

- Control of the internal degrees of freedom of N_2^+ following chirped pulse multiphoton ionization of molecular nitrogen is investigated, where we find a strong influence of the chirp of the laser pulse on the rotational state distribution of N_2^+ $(B\ ^2\Sigma_u^+, v = 0)$.
- Ultrafast ionization dynamics of C_2H_4BrCl and C_3H_6BrCl is studied with respect to control the dissociative ionization of bromochloroalkanes using shaped laser pulses (λ = 804 nm).
- Electron emission dynamics of isolated NaCl nanoparticles has been investigated using femtosecond dual-pulse laser excitation (τ = 85 fs, λ = 804 nm). An enhanced electron emission and an increase in the electron kinetic energy are observed for characteristic time delays indicating an enhanced coupling of the laser pulses to the nanoparticle.
- The waveform control of the electron emission from isolated SiO_2 nanoparticles is investigated using intense, few-cycle (τ < 5 fs) laser fields. A significant increase in the cut-off in the electron energy spectra of SiO_2 nanoparticles as compared to Xe for the same laser conditions is observed.