Analysis and control of the electron dynamics of isolated nanoparticles

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We report on experiments on the interaction of isolated NaCl and SiO_2 nanoparticles with strong femtosecond laser fields employing dual pulse laser excitation and waveform-control of few-cycle laser fields, respectively. The emitted electrons are detected by velocity map imaging allowing the simultaneous measurement of their kinetic energy and angular distribution. A beam of isolated nanoparticles is formed using state-of-the-art aerosol preparation techniques and aerodynamic lens focusing. The electron emission dynamics of isolated NaCl nanoparticles is 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 ($4 \cdot 10^{14}$ W/cm^2), few-cycle (τ < 5 fs) laser fields. In the experiments 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. The asymmetry of the electron emission along the laser polarization axis shows a pronounced dependence on the carrier-envelope phase (CEP) of the few-cycle waveform-controlled light field. The role of field enhancement near the nanoparticle surface for the extended cut-off and the observed CEP dependence is discussed.