A new test of optical tunnel ionization

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Synopsis Optical tunnel ionization is a powerful phenomenon at the core of attosecond science. Experiments in circularly polarized light at 800 and 1400 nm avoid electron recollision and provide a means to directly observe the tunneled electrons. We compare the measured electron wavepacket in argon to the predictions of tunneling theory.

Optical tunnel ionization is important for attosecond science. In a strong laser field, tunnel ionization and subsequent recollision leads to numerous attosecond processes. Applications of recollision include imaging of electron orbitals in atoms [1] and molecules [2, 3].

Structural imaging of atoms and molecules requires a precise understanding of the tunneled electron features. Although tunneling has been investigated experimentally and theoretically for many years, the structure of the tunneled electron itself has received less attention. Previous experiments in linearly polarized light [4] uncovered considerable distortion due to the ion Coulomb potential.

We use circularly polarized light to test tunneling without the complexity of recollision. Concentrating on argon, we measure the lateral momentum of the tunneled electron. The lateral momentum is least affected by the laser field and should give the most direct test of tunneling. Using 800 and 1400 nm light and a range of intensities we present experiments spanning the Keldysh parameter values $0.38 \leq \gamma \leq 1.08$. The experimental measurements are compared with theoretical calculations including integration in time and space of the Gaussian laser beam.

References

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