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Ionization dynamics of atoms by strong, ultra-short laser pulses

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The multiphoton double ionization of He is observed to be far more efficient than would be expected based on the second electron leaving some time after the first, at a significantly higher intensity, in an uncorrelated sequence. Therefore some sort of correlated two-electron process, called non-sequential ionization (NSI), is required. NSI has been modeled theoretically using everything from 'exact' full spatial 3D (and model 1D) quantum calculations to completely classical trajectory representation. A commonly studied quasi-classical, rescattering scheme reproduces the general characteristics of the observations, but it fails at the threshold. Its predicted intensity for the onset of NSI is at least a factor of two too high. A new resonance process that addresses this problem has been developed and tested on a 1D model for which exact solutions are easily obtained. This model's NSI threshold behavior leads to the prediction of a path to double ejection that involves a new laser-induced doubly excited (autoionizing) state. The analysis of the results, particularly in relation to NSI in real He measurements, will be presented.