Rescattering quantum orbits with negative travel time

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In the computation of transition amplitudes in intense-laser--atom processes, the integralsć over the ionization and rescattering times are frequently carried out with the help of steepest-descent (saddle-point) approximation. For fixed final state (e.g., a free electron with specified momentum **p** in the case of above-threshold ionization), solution of the pertinent saddle-point equations yields several (complex) ionization and rescattering times. It is not always clear, which ones of the several solutions to take into account and which ones to discard, but it used to be taken for granted that the (real part of) the ionization time has to precede the (real part of) the rescattering time. For an elliptically polarized laser field, we show that negative-travel-time solutions have to be included in order to get good agreement with an exact numerical evaluation of the integrals. Moreover, and the more so the longer the laser wavelength, these solutions cause a distinctive qualitative feature in the electron's momentum distribution, which is reminiscent of a coffee bean split along the direction of the major component of the elliptically polarized field. The novel solutions have large imaginary parts and correspond to goings-on in the below-the-barrier region. This example shows that the close relation between the saddle-point quantum orbits and the simple-man trajectories becomes questionable if the former have large imaginary parts.

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