Coherence Effects in Nonlinear Thomson Scattering by Electrons Born from the Same Atom

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We investigate theoretically nonlinear Thomson scattering by multiple electrons ionized from individual atoms during a short high-intensity laser pulse. The emitted light is influenced by the distance that the electrons move apart from each other during the passage of the pulse, owing to coherence effects. We examine trajectories of electrons born from the same atom via successive ionizations as the laser pulse ramps up. While the overall trajectory of an individual electron is influenced by the ponderomotive force, we find that the separation between electrons arises mostly from stronger and differing initial drift velocities associated with the moment of ionization in the laser field. In the case of helium, we find that the separation between its two ionized electrons becomes appreciable (compared to emitted wavelengths) primarily along the dimension of laser linear polarization. This distorts the angular emission patterns of nonlinear Thomson scattering in comparison with emission from individual free electrons. Radiation scattered perpendicular to the laser polarization tends to add constructively, while radiation scattered along the direction of linear laser polarization tends to add incoherently. This effect becomes more pronounced for atoms with higher numbers of ionized electrons. The effect influences primarily the lower harmonic orders.