Nonlinear Thomson Scattering Measured on the Full Emission Sphere

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We use photon-counting to measure nonlinear Thomson scattering from low-density electrons in an intense laser focus. The electrons are donated from helium backfilled at 10^{-2} Torr. The 800 nm laser reaches an intensity of a few times 10^{18} W/cm^2 with a pulse duration 35 fs and focal-spot radius $w_0 = 4\ \mu$m. The azimuthal and longitudinal polarization components of the second harmonic are measured across much of the full emission sphere. The data show, for the first time experimentally, emission structure in the 'northern' and 'southern' hemispheres, where the 'north pole' aligns with the direction of laser propagation. Photons scattered from a 100-μm region in focus are collected using a 5-cm-focal-length lens. Alignment must be maintained when rotating the photon-collection system along the longitudinal direction of the emission sphere.

Asymmetries between emission into the 'northern' and 'southern' hemispheres are associated with the relativistic electron figure-8 motion. While traversing the top and bottom of figure-8, electrons move against the direction of laser propagation, and while passing through the center of figure-8, they move with the direction of laser propagation.