DAMOP09-2009-000131

Abstract for an Invited Paper
for the DAMOP09 Meeting of
the American Physical Society

Photoemission out the side of a relativistic laser focus by individual free electrons[1]

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The quantum wave packets of free electrons naturally spread, quickly reaching the scale of optical wavelengths. Moreover, an electron wave packet born through ionization in an intense laser focus is pulled apart by sharp field gradients. Different parts of the same electron wave packet may even be propelled out opposite sides of the laser focus. The question naturally arises as to how wave packets scatter laser radiation if they undergo such highly non-dipole dynamics. If one uses quantum probability current (multiplied by the electron charge) as a source current for Maxwell's equations, the radiated field is strongly suppressed by severe interferences. This approach predicts dramatic suppression of radiation scattered out the side of an intense laser focus, relative to what one would expect if electrons are treated as point charges. We present theoretical arguments and give a progress report on an experiment designed to test for this distinction in photoemission rates. The result may shed light on the fundamental question of what constitutes a quantum measurement.

[1]In collaboration with Justin Peatross, Brigham Young University.