Measuring quantum radiation reaction and electron—positron cascades in laser-matter interactions

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Strong-field quantum electrodynamics (QED) processes are predicted to play a role in the interaction of next-generation high-intensity (> 10^23W/cm^2) laser pulses with matter. In particular quantum radiation reaction will play a major role in the motion of the electrons and positrons in the plasma created in the laser focus. The emitted hard-photons resulting in this radiation reaction can also generate pairs, resulting in a cascade and so the creation of dense pair plasmas. We will discuss laser absorption caused by quantum radiation reaction and electron-positron cascade development in next-generation (intensity > 10^23W/cm^2) laser-matter interactions, comparing the predictions using quantum and classical radiation reaction models. We will also investigate experiments possible with current high-intensity (10^21W/cm^2) lasers. Signatures of quantum radiation reaction on a counter-propagating energetic (1GeV) electron beam will be discussed. In particular we will quantify the degree of broadening of the energy spectrum of the beam due to quantum stochasticity.