Strong-field QED in laser-electron beam collisions

David A. Reis
Stanford PULSE Institute

Strong-field light matter interactions are ubiquitous in the optical regime, where tunnel ionization leads to such phenomena as high-harmonic generation and above-threshold ionization. For x rays, nonlinear interactions have only recently become accessible using free-electron lasers such as the LCLS[1, 2]. At sufficiently high fields, even the vacuum becomes nonlinear. Here tunnel ionization of the vacuum can produce copious electron-positron pairs at field strengths comparable to the electron mass in a Compton wavelength[3]. Such fields are orders of magnitude away from what is possible with even the most intense lasers, but are expected to occur in various astrophysical phenomena as well as in beam-beam collisions in future lepton colliders. Importantly, they can also occur in the collisions of high energy electrons or photons with a strong laser field.

In this talk, I will discuss efforts to systematically explore the strong-field regime of QED, including at the FACET-II facility at SLAC. I will describe what we expect to see and how this differs qualitatively from perturbative QED, such as was studied two decades ago on the seminal SLAC Experiment-144, including multi-photon Breit-Wheeler pair production [4, 5], Fig. 1.


Figure 1: Intensity dependence of multiphoton Breit-Wheeler from E144 experiment.