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Stopping, Straggling, and Blooming of Directed Energetic Electrons in Hydrogenic and Arbitrary-Z Plasmas[1]

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The interaction of directed energetic electrons with hydrogenic and arbitrary-Z plasmas is analytically modeled. These calculations reveal new features of the strong coupling between energy loss, straggling, and blooming, results which are important for fast ignition (FI), electron preheat in ICF, and electron penetration in relativistic astrophysical jets. Scattering enhances energy transfer along the initial electron direction and substantially reduces the penetration. Enhanced energy deposition occurs in the latter portion of the penetration and is inextricably linked to straggling and blooming. The Z dependence of these effects is very strong and electron scattering effects, ignored in previous calculations, are as important as scattering from the ions for DT plasmas; for higher Z plasmas, such as Be or CH in capsule ablators, scattering is dominated by ions. Penetration, blooming, and straggling are most easily parameterized and understood in terms of the *total* ρR through which the electrons propagate; little sensitivity is found on density or temperature gradients. As a concrete example for the case of electron preheat, 100 keV electrons are found to penetrate through 280 μm of DT, which is characteristic of proposed direct-drive ice thickness at the NIF. For astrophysical jets, for which n$\sim$10/cm^3, the penetration of 1 MeV electrons is of order 10,000 light years. For the case of FI in a 300 g/cm^3 DT plasma at 5 keV, 1 MeV electrons penetrate 14 μm with a lateral blooming of 5 μm. Such results will be important, among other reasons, for evaluating the requirements of fast ignition as well as determining tolerable levels of electron preheat.

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