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Pitch Angle Dynamics and Synchrotron Emission of Runaway Electrons in Quiescent and Disrupted DIII-D Plasmas

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We present the validation of theoretical models for the pitch-angle probability distribution function (PDF) of runaway electrons (RE), through simulations of synchrotron radiation (SR) in DIII-D quiescent [1] and disrupted [2] plasmas for which the energy PDF is known from measurements but the pitch-angle PDF is poorly understood. SR of RE in magnetically confinement fusion plasmas is important because it provides a limiting mechanism of the maximum energy that RE can reach, and because it can be used as a diagnostic to infer parameters of the RE energy and pitch-angle PDFs. Recent studies using the SR synthetic diagnostic [3,4] showed that SR depends on the RE energy, and more strongly on their pitch-angle PDF. Our simulations of RE in quiescent plasmas recover the typical visible SR in DIII-D when the spreading in the initial RE pitch-angle is less than the predicted by simplified theory that only consider the balance of electric field pinching in pitch angle and collisional pitch-angle scattering. We also present results of simulated infrared SR of RE in DIII-D disrupted plasmas after following their dynamics for tens of ms to find a better estimate for their pitch-angle PDF that takes into account the full-orbit dynamics of RE [5], SR energy losses, the acceleration of the electric field, the magnetic field geometry, and collisions with the background plasma and impurities through the use of experimental impurity density profiles.

[1] C. Paz-Soldan et al., PRL 118, 255002 (2017); [2] E. M. Hollmann et al., PoP 22, 56108 (2015); [3] L. Carbajal et al., PPCF 59, 124001 (2017); [4] D. del-Castillo-Negrete et al., PoP accepted (2018); [5] L. Carbajal et al., PoP 24, 042512 (2017)

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