

GEC18-2018-000315

Abstract for an Invited Paper
for the GEC18 Meeting of
the American Physical Society

Electron Sheaths and Fireballs¹

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Sheaths form to balance electron and ion losses from plasmas. Because electrons are much more mobile than ions, most sheaths are ion sheaths. These act to reflect electrons back into the plasma and accelerate ions toward the boundary. Although less common, a number of novel sheath structures including electron sheaths, double sheaths and anodic double layers (aka fireballs) can form near electrodes biased positive with respect to the plasma. These structures exhibit interesting properties, such as self-organization, wave excitation and global influence on bulk plasma properties. They can also be utilized for applications such as flow control, electron sources, control of plasma electron energy distributions, and plasma surface modification. This presentation will review a number of recent advances in our understanding of sheath structures near biased electrodes, including the existence of an electron presheath [1] and associated electron Bohm criterion [2], as well as the excitation of instabilities at both the ion and electron plasma frequencies in the electron presheath. It will also review recent progress in understanding fireball formation including a new model for the onset [3], as well as its validation from two-dimensional particle-in-cell simulations and a novel non-invasive laser collision induced fluorescence diagnostic [4]. [1] Yee, Scheiner, Baalrud, Barnat and Hopkins, PSST 26, 025009 (2017) [2] Scheiner, Baalrud, Yee, Hopkins and Barnat, Phys. Plasmas 22, 123520 (2015) [3] Scheiner, Barnat, Baalrud, Hopkins, Yee, Phys. Plasmas 24, 113520 (2017) [4] Scheiner, Barnat, Baalrud, Hopkins, and Yee, Phys. Plasmas 25, 043513 (2018)

¹Work supported by US DOE grants DE-AC04-94SL85000 and DE-SC0016473.