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Transitions between Thermionic, Field, and Vacuum Space Charge Limited Emission.[1] CALEB DARR, ADAM DARR, Purdue University, SARAH LANG, lang29@purdue.edu, ALLEN GARNER, Purdue University
— Electron emission is critical in operation of high power microwave and directed energy devices, and as a mechanism for gas breakdown for atmospheric microplasmas. While previous studies have unified field emission (FE) with space-charge limited emission (SCLE) [1], electrodes operate at nonzero temperature, motivating this study to derive a simple theory unifying SCLE, FE, and thermionic emission (TE). Specifically, we unify FE and TE, modeled by General Thermal Field (GTF) equation [2], with SCLE in vacuum, represented by the Child-Langmuir (CL) law. The asymptotic solutions for FE, CL, and TE intersect at a nexus point that is highly sensitive to initial conditions, analogous to previous results for FE with SCLE and collisions [1]. The nexus point is uniquely defined by the emitter temperature, gap distance, or voltage and acts a guidepost for identifying operating regimes. Temperatures above the nexus limit causes emission to transition from TE to FE to CL, while lower temperatures exhibit FE to CL. Ultimate extension to include collisions will be discussed. [1] A. M. Darr, A. M. Loveless, and A. L. Garner, Appl. Phys. Lett. 114, 014103 (2019). [2] K. L. Jensen, J. Appl. Phys. 102, 024911 (2007).

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