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Deriving Scaling Laws for Transition from Avalanche to Streamer Discharge[1] HAOXUAN WANG, AMANDA LOVELESS, ALLEN GARNER, Purdue University — Recent theoretical studies have derived a single theoretical framework examining the transitions between quantum space-charge limited emission (SCLE), SCLE at vacuum (Child-Langmuir law), SCLE with collisions (Mott-Gurney law), field emission, and Paschen's law (PL) [1]. Reducing gap size to microscale causes a deviation from PL since Townsend avalanche no longer drives breakdown. Increasing gap size or pressure causes an avalanche to streamer transition (AST). This study explores the feasibility of deriving simple scaling laws accounting for AST to incorporate into the existing breakdown/emission theoretical framework [1]. We apply Meek's criterion to predict the conditions necessary to achieve AST for microscale gaps of air and calculate the necessary overvoltage using PL. We also nondimensionalize Meek's criterion to assess the feasibility of deriving a universal theory for breakdown transition. Calculations of ion head radius and space charge field needed for AST and the resulting implications on theoretical development and device design will also be discussed. [1] A. M. Loveless, et al., Trans. Am. Nucl. Soc. 121, 399-401 (2019). HW gratefully acknowledges support from a Purdue Ross Fellowship.

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Haoxuan Wang
Purdue University

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