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On the deviations of similarity laws in low-temperature discharges[1] YANGYANG FU, JANEZ KREK, DE-QI WEN, PENG ZHANG, JOHN P. VERBONCOEUR, Michigan State University — Similarity laws have powerful potential in parameter prediction in similar discharges. However, for different discharge conditions, the similarity laws may not be always valid, which narrows their applicability. In this work, factors causing the deviation of similarity laws in low-temperature discharges are investigated using different simulation models. First, using the spatially-averaged Kinetic Global Model framework, the effects of the nonlinear reaction processes (stepwise ionizations and three-body collisions) are evaluated. It is found that, when compared to modeling results, the similarity relations will overestimate the species densities when the nonlinear reaction processes are included, and agree well with them when the nonlinear reaction processes are excluded. Second, using a two-dimensional fluid model, the effects of the nonlinear processes and the electron energy distribution functions (EEDFs) on the scaling of the spatially-dependent species densities are studied in geometrically similar gaps. Third, using the PIC/MCC code, OOPD1, the evolutions of the EEDFs in similar discharges are also presented. The similar discharges can only be obtained with the correct EEDFs.

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Yangyang Fu
Michigan State University

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