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Transition of low-temperature plasma similarity laws from low to high ionization degree regimes*

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Similarity laws are often employed when the characteristics of two or more discharge systems are compared. The classical similarity laws were previously validated and applied for weakly ionized plasma discharges [1, 2]. However, similarity relations are not valid for all plasma regimes [3, 4]. Especially for strongly ionized regimes, scaling laws are not well understood. In this study, we evaluate the transition characteristics of low-temperature plasma similarity laws from low to high ionization degree regimes. The similarity relations of plasma density and ionization degree in geometrically similar gaps are presented. It is found that deviations of classical scaling laws occur as the ionization degree increases from low to high. For low pressures, the similarity laws hold until a higher ionization degree than for high pressures. The time-dependent scaling of the charged species and the electron energy distributions in two geometrically similar systems are also compared.

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