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A simple analysis on the abnormal behavior of the argon metastable density in an inductively coupled Ar plasma

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The abnormal behavior of the argon metastable density during the E-H mode transition in argon ICP discharge was investigated. Lots of investigations including global models expected that during and after the mode transition of ICP discharge, the density of metastable increases with applied rf power (i.e. electron density). However, recent direct measurement of metastable density revealed that the metastable density of argon decreases with the applied power during and after the mode transition. This result may not be explained by the previous global model which is based on the assumption of the Maxwellian electron energy distribution function (EEDF). In this paper, to explain this abnormal behavior with simple manners, a simple global model taking account of the effect of the non-Maxwellian EEDFs incorporating into a set of coupled rate equations is proposed. The result showed that the calculated metastable density taking account of non-Maxwellian EEDF and its evolution during the transition has an abnormal behavior with electron density and is in good agreement with the previous measurement results, indicating the close coupling of electron kinetics and the behavior of metastable density. The proposed simple model is expected to provide qualitative kinetic insight to understand the behavior of the metastable density in various plasma discharges which typically exhibit non-Maxwellian distribution.