Ion-Collision Emission Excitation Cross Sections for Xenon Electric Thruster Plasmas

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Abstract

Energetic xenon ion collisions with neutral atoms play an important role in electric thruster plasma radiation at low electron temperatures. The respective emission excitation cross sections are necessary for the derivation of plasma parameters from the observed radiance. We present apparent emission excitation cross sections for near-infrared $5p^66p$ to $5p^6s$ transitions of neutral xenon impacted by singly and doubly charged xenon ions. The cross sections were measured over a laboratory energy-per-charge-number range of 100 to 900 eV, a range that covers typical Hall effect thruster discharge voltages. The cross sections are derived from ion beam luminescence spectra produced at single-collision conditions and at pressures for which radiation trapping effects were shown to be negligible. The $\text{Xe}^{2+}$ cross sections are significantly higher than those of $\text{Xe}^{2+}$ and increase with energy throughout the investigated range. The $\text{Xe}^{2+}$ cross sections plateau at approximately 600 eV. The cross sections are incorporated in a collisional-radiative model. The calculations of near-infrared spectra demonstrate that the sensitivity of the model diagnostic with respect to electron temperature increases with ion energy.

Keywords: Charged Particles, Computations, Cross Sections, Electric Propulsion, Electron Energy, Emission, Energetic Properties, Excitation, Hall Thrusters, Ion Beams, Low Temperature, Luminescence, Near Infrared Radiation, Plasmas Physics, Reprints, Xenon.