Atomic processes at Jupiter: Ion and secondary-electron transport from swift ion precipitation into the Jovian upper atmosphere

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Understanding and control of plasma and gaseous environments, such as those in astrophysical environments, technical plasmas, and fusion energy devices, rests in large part on modeling, simulation, and diagnostics based on fundamental atomic processes. In this presentation, a description is given of recent work to provide a wide and detailed range of atomic data for inelastic processes in the interaction of swift ions precipitating into the atmosphere of Jupiter.

In particular, a rich ion population exists in the magnetosphere of Jupiter, with species originating from the Galilean moons and as well from the solar wind. These populations give rise to precipitation of ions, accelerated by Jupiter's prodigious magnetic field, into the planet's upper atmosphere. Evidence of this precipitation comes directly from observations of auroral x-ray line emission in the polar regions coming from radiative de-excitation following charge transfer between the precipitating ions and atmospheric molecules.

Therefore the need exists for data describing secondary-electron production in 0.01 to 25 MeV/u O^{q+} (q=0-8) [1] and S^{q+} (q=0-16) + H_2 [2] collisions motivated by observation of the precipitation of these ions, originating largely from the volcanos of Io, into the Jovian upper atmosphere. In particular, MeV/u O and S ions slowdown in their passage through the atmosphere, produce secondary electrons, heat atmospheric molecules, lead to dissociation of H_2, and contribute to the atmospheric currents, linking the Jovian ionosphere and atmosphere. Incorporation of such data into models has been timely in light of the arrival of the NASA Juno probe at Jupiter in July 2016 with the unique orbital characteristics to enable observations of the precipitating ion populations and their interactions with the upper atmosphere.

We have also extended the data to include H^{q+} (q= -1,0,1) impact of H_2 [3] owing to the *in situ* observation by the Juno spacecraft. Particularly for protons, the consequences of the energy deposition in the Jovian atmosphere of this charged particle precipitation has not been adequately studied and requires comprehensive data not heretofore available.

References

[1] D.R. Schultz, N. Ozak, T.E. Cravens, and H. Gharibnejad, At. Data Nucl. Data Tables, **113**, 1 (2017); D.R. Schultz, H. Gharibnejad, T.E. Cravens, and S.J. Houston, At. Data Nucl. Data Tables **126**, 1 (2019)

[2] H. Gharibnejad, D.R. Schultz, T.E. Cravens, and S.J. Houston, At. Data Nucl. Data Tables (2019) in preparation

[3] D.R. Schultz, H. Gharibnejad, T.E. Cravens, and S.J. Houston, At. Data Nucl. Data Tables (2019) in preparation