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Reference laboratory data for astrophysics

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Most objects in space are too distant to be studied in situ. Therefore, emission spectroscopy is one of the primary methods used. The generation of excited species responsible for this emission can be induced either by radiation from nearby stars or by collisions with other particles. In our Solar System, planets and small bodies are constantly exposed to photon irradiation from the Sun. These reactions produce a significant number of secondary electrons with relatively low energies, which in turn induce further excitations, ionizations, and dissociations.
Electron-impact excitation reactions provide a valuable remote diagnostic of neutral gases and the physical environments of planetary atmospheres and small bodies in the Solar System [1–2]. The resulting emission spectra strongly depend on both the collision energy and the target molecule [3], and they yield distinct spectral fingerprints across the infrared, visible, and ultraviolet ranges.
The importance of these collisions has been demonstrated in several publications, where they played a crucial role in key discoveries [4–6]. The information encoded in the spectra can reveal properties of the surrounding environment. However, astronomical environments such as atmospheres or comae contain many different species, with multiple excitation–emission processes occurring simultaneously. As a result, astronomical spectra are highly complex. To extract meaningful data, reliable databases of reference emission spectra and emission cross-sections are essential. Laboratory experiments focused on electron-induced fluorescence [2,7] provide such data, as they allow controlled and repeatable studies of individual compounds. Laboratory of Electron Induced Fluorescence at the Department of Experimental Physics is one of a few laboratories in the world able to produce comprehensive data of this type.

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