ABSTRACT

UV Emission Cross Sections by Electron Impact with Application to Planetary Astronomy

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In the upper atmospheres of the Jovian and Terrestrial planets a dominant mechanism for energy transfer occurs through electron collision processes with both neutral and ionic species leading to UV radiation. In response to the need for accurate collision cross sections to model spectroscopic observations of the Terrestrial and Jovian planetary systems, our program has established UV instrumentation for routinely measuring absolute emission cross sections of stable and radical gases. Analysis of observations of planetary atmospheres and astrophysical by Hubble Space Telescope, Galileo, Cassini and FUSE require accurate measurements of collision cross sections. UV emission cross sections cannot be established by theory.

In this conference we concentrate on the recent results for the species H_2, O, SO_2, H_2O N_2 and H, the most important atomic and molecular species in the Jovian and Saturnian planetary systems. Recent Planetary Atmospheres' applications of experimental model spectra and electronic cross sections results from our laboratory program at the Jet Propulsion Laboratory, California Institute of Technology were: 1) the basis for developing atomic and molecular models used in the interpretation of Galileo UVS observations of Jupiter (Ajello et al., 1998; Pryor et al.,1999), Voyager observations of Saturn and Titan (Hall et al., 1992), HST observations of Io (Clarke et al., 1994a), Galileo SSI observations of Jupiter and Io (Geissler et al., 1999), HST observations of Jupiter, Europa and Ganymede (Clarke et al., 1994b; Prange et al., 1997) and HUT observations of Jupiter (Ajello et al., 2001) and 2) calibration of flight UV Spectrometers on Galileo Orbiter (Ajello et al., 1988), Cassini Orbiter (Esposito et al., 1999; Ciocca et al., 1997) and Polar Spacecraft UV Imager (M. Torr et al., 1995).

We have been able to verify to HIGH accuracy the transition probabilities and cross sections for principal quantum numbers n=2 and 3 of H_2 We have measured the entire optically-thin UV spectrum of H_2 from 75-165 nm at 100 eV, identifying new rotational line features up to n = 7 Rydberg number and providing benchmark 100 eV cross sections and predissociation yields for the B,B',B'',C,D,D',D''states (n=2 to 5) (Jonin et al., 2000; Liu et al., 2000, 2001. Our recent study of H Lα is considered a benchmark improvement of the classical work from threshold to 200 eV by Long, Cox and Smith (1968). The biggest surprise was the influence of significant cascade contribution from higher lying ns, np, nd states near threshold (~27% at 14 eV). The latest atomic beam technology was developed, providing an atomic H density three orders of magnitude greater than past work. The knowledge gained from the atomic H experiment has been put to use in the construction of an atomic O experiment. We report on the Electron Impact Studies on Atomic Oxygen "Emission Cross Section of the OI $^3S \rightarrow ^3P$ Transition (130.4nm)" which appeared in J. Phys. B(Noren et al. 2001).