Collisional De-excitation of Molecular Hydrogen in the Interstellar Medium

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Abstract

With the new development of NASA ground- and space-based missions, peering into the universe with higher spatial and spectral resolution at infrared and sub-millimeter wavelengths has become possible and will be further enhanced in the near future. Molecular hydrogen is the most abundant chemical species in the universe and therefore plays a significant role in astrophysical environments such as starburst galaxies, interstellar molecular clouds, and star-forming regions. However, the scarcity of both accurate and complete data sets for rovibrational inelastic cross sections involving collisions with H_2 has set a serious limitation on the development of reliable astrophysical models. In particular, the investigation of cooling processes, molecular emission, and non-equilibrium effects in molecular gaseous nebulae and other molecular environments requires collisional de-excitation data for H-, He-, and H_2-impact on H_2. Recently, a number of observations, performed using the NASA Spitzer Space Telescope's infrared spectrograph, have identified emissions arising from pure rotational transitions in H_2. In order to identify, analyze and interpret these spectral lines, an accurate set of data for thousands of cross sections is needed, thus requiring large scale molecular physics computer codes to make extensive theoretical predictions. A sample of rate coefficients for quenching of rotationally- and vibrationally-excited H_2 will be presented.
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