Benchmark cross sections for excitation of the $X^1\Sigma_g^+ \rightarrow b^3\Sigma_u^+$ transition in molecular hydrogen

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We present a joint experimental and theoretical investigation of a fundamental process in atomic and molecular physics: electron impact excitation of molecular hydrogen's (H_2) most dominant transition ($X^1\Sigma_g^+ \rightarrow b^3\Sigma_u^+$). Excitation of this state is by far the main channel that causes the dissociation of H_2 into H + H atoms at low energies. The Convergent Close-Coupling (CCC) calculations [1] predicted significant, more than factor of two, disagreements with previously recommended cross sections [2]. Khakoo et al. [3] have recently designed a novel electron scattering instrument (an electron time-of-flight spectrometer, TOF), and have measured differential scattering cross sections for the excitation of the $X^1\Sigma_g^+ \rightarrow b^3\Sigma_u^+$ transition, as ratios to elastic scattering, with high precision. The recently developed TOF spectrometer does not suffer from transmission problems like conventional spectrometers. Using the present theoretical and experimental approaches, we have been able to get outstanding agreement between theory and experiment for the excitation of a molecule for a very important transition in this most basic of all molecules. This work heralds significant progress in electron-molecule scattering, as well as promoting our understanding of dissociation processes not found in atoms.

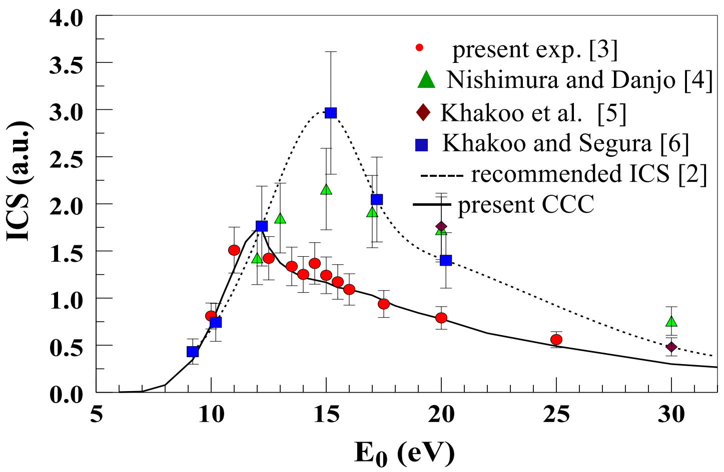

Fig.1 Integrated cross sections for excitation of the $b^3\Sigma_u^+$ state of H_2.

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