VIBRATIONAL EXCITATION OF HYDROGEN MOLECULES BY ELECTRON AND POSITRON IMPACT

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We report results obtained with the Schwinger Multichannel (SMC) Method [1] for the vibrational excitation of H_2 by low-energy electron [2] and positron [3] impact.

We also report a comparative study of both integral and differential cross sections detailing the differences in the vibrational excitation cross sections related to important dynamic aspects such as projectile charge and exchange (antisymmetry), which is absent in positron scattering. Using a set of SMC scattering amplitudes calculated at specific quadrature points for the internuclear distance, we have obtained vibrationally resolved cross sections in the adiabatic aproximation[6]. The vibrational excitation cross section is given by

$$\frac{d\sigma_{\nu\rightarrow\nu'}}{d\Omega}(\theta) = \frac{1}{8\pi}\frac{k_{\nu'}}{k_\nu} *$$

$$\iint \left| \int \chi_{\nu'}(R) f^{\rm Lab}_{\vec{k}_{\Gamma,\nu},\vec{k}_{\Gamma',\nu'}} \chi_\nu(R) dR \right|^2 d\Omega_{\vec{k}_\Gamma} d\phi_{\vec{k}_{\Gamma'}}$$

where ν and ν' are the vibrational quantum numbers of the molecule (initial and final vibrational states); Γ and Γ' are the eletronic channels; and R is the interatomic distance (irrotational molecule).

In the figures we show our theoretical results for excitation to the first excited vibrational state. The calculated integral and differential (5 eV) cross sections are shown in Figs. 1 and 2, respectively, and compared with existing experimental data. In Fig. 1, there is good agreement between theory and experiment for both positron and electron scattering. In Fig. 2, a sharp minimun at 90 degrees is noted in the e^+-H_2 croos section.

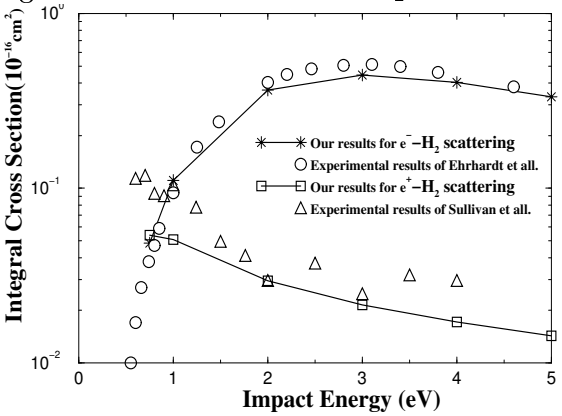

Fig. 1. Integral $0 \rightarrow 1$ vibrational excitation cross section of H_2 by e^- and e^+ impact. Present calculations: e^+, full line with squares; e^-, full line with stars. Experimental data: e^+, open circles[5]; e^-, triangles[4].

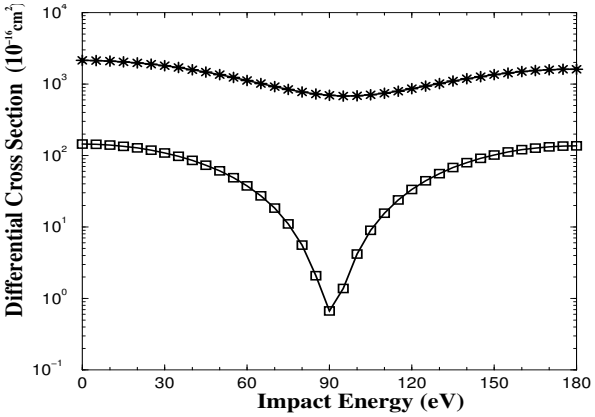

Fig. 2. Differential $0 \rightarrow 1$ vibrational excitation cross section of H_2 by e^- and e^+ impact at $E = 5.0eV$. e^+, full line with squares; e^-, full line with stars.

References

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