STUDY OF DISSOCIATIVE ELECTRON ATTACHMENT AND ION-PAIR CHANNELS IN H^- / H_2

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Dissociative electron attachment (DA) to H_2 has been studied by measuring the outgoing kinetic energy distribution of the H^- ions with H in the various nl exit channels. The electron energies E_e studied are 10-20 eV. In addition to the DA channels we detect ion-pair production (polar dissociation) at energies E_e above that reaction threshold (17.325 eV above the H_2, $v'' = 0$ ground state). Use is made of magnetically-confined electron and ion beams with trochoidal deflection to measure outgoing ion energies[1]. Detection of both the electron and ion currents is through analog detection (separate Faraday cups) and charge digitization. There are previous studies of H^- production (no energy analysis) as a function of electron energy [2,3].

Rich structure corresponding to the channels $H^- + H(nl)$, with n = 1-3 has been resolved, and will be presented. In addition, the ion-pair channel $e + H_2 \rightarrow H^+ + H^-(1s^2) + e$ was clearly detected by separate measurements of the H^+ and H^- energies. The energy distribution of the outgoing fragment ions may be calculated from the expression

$$E_l = \frac{\mu}{m_H}\Delta E_{CM} + \cos\theta\sqrt{\frac{4\mu}{M}E_o\Delta E_{CM}}\,. \qquad (1)$$

Here, E_l is the ion's laboratory energy, M is the total H_2 mass, and θ is the CM angle of the outgoing H^- ion relative to the CM velocity along the incident H_2 direction. ΔE_{CM} is the total CM energy available to fragment translational energy.

The energy spectrum for the ion-pair production channel is shown in Fig. 1. The expected fragment energies for both charges is calculated from Eq. (1) between $\theta = 0$ and $\theta = \pi$, and is indicated in the figure. The indicated range includes a ± 0.1 eV electron energy width. The difference in line shape for the H^+ and H^- ions is almost certainly related to beam shear in the trochoidal monochromator (the top and bottom plates were not biased symmetrically about zero center-line voltage). However, one has excellent stoichiometry, since the integrated counts in the two channels [76,407 (H^+) and 74,327 (H^-)] agree to 2.8%.

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References

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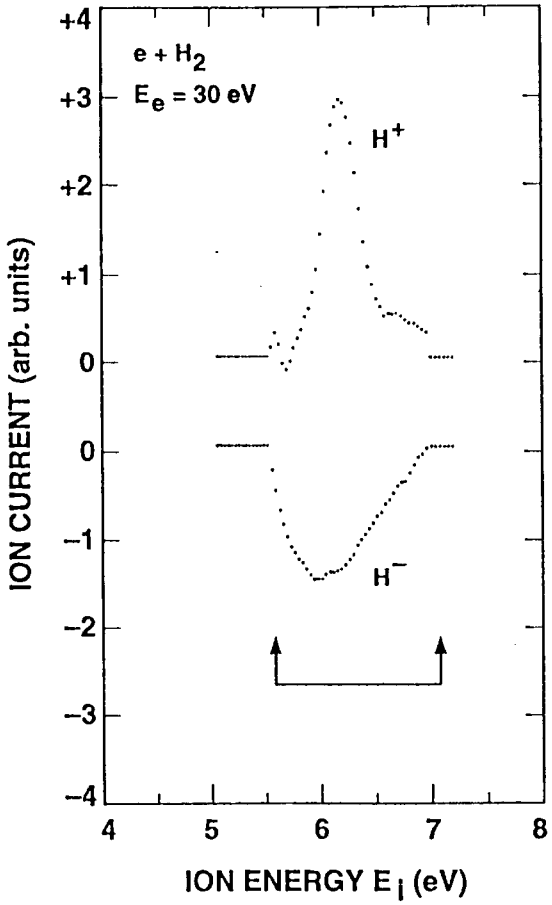

Figure 1. Experimental ion-pair production channel for electron-impact dissociation of H_2 at 30 eV electron energy. The expected energy distribution is from Eq. (1), and is shown by the arrows. The total signals of H^+ and H^- particles agree to 2.8%.