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 $n/\ell$ 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. 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.

Rich structure corresponding to the channels $H^-$ + $H(n\ell)$, 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

$$E_i = \frac{-\mu}{m_H} \Delta E_{CM} + \cos \theta \sqrt{\frac{4\mu}{M} E_e \Delta E_{CM}}. \quad (1)$$

Here, $E_i$ is the ion's laboratory energy, $M$ is the total $H_2$ mass, and $\theta$ is the CM angle of the outgoing $H^-$ ion relative to the CM velocity along the incident $H_2$ direction. $\Delta E_{CM}$ 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 $\pm 0.1$ 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