The method of laser-induced reaction has been used for the first time to detect rotational transitions. The astronomically important transitions of H$_2$D$^+$ and HD$_2^+$, respectively, have been recorded by observing the enhancement of their D/H isotope exchange reactions with p-H$_2$ upon rotational excitation in a cryogenic multipole ion trap. While the frequency for HD$_2^+$ is in good agreement with a previous, unpublished result, but more accurate, the frequency for H$_2$D$^+$ is some 60 MHz lower than the value from the same unpublished source ($b$).

The present H$_2$D$^+$ frequency has been fit together with previously published pure rotational transitions and with infrared ground state combination differences (GSCDs). $c$ Starting values for spectroscopic parameters were derived from energies up to $J = K_a = 7$ calculated ab initio because of the smallness of the data set. Since the molecular ion is fairly floppy, the Hamiltonian has been expanded in Euler functions up to 6th order. Omitting one GSCD because of a large residual, the remaining GSCDs were reproduced to almost 0.002 cm$^{-1}$ releasing only 7 parameters. Thus, for the first time this IR spectroscopic data has been reproduced within experimental uncertainties. The pure rotational transitions were fit overall within the reported experimental uncertainties. In Ref. $c$ the wrong 1$_{01} - 0_{00}$ transition frequency required 11 parameters to fit the pure rotational transitions within experimental uncertainties, albeit with somewhat larger residuals for the GSCDs than in the present work.


