Resonant ion pair formation in electron collisions with ground state molecular ions

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Resonant ion pair formation (RIP) has been observed and cross sections measured in CRYRING for electrons impacting on HD^+ and HF^+.

Resonant ion pair formation can be represented by $e + XY^+ \rightarrow XY^{**} \rightarrow X^+ + Y^- + KER$, where KER is the kinetic energy of release. It represents special stabilization channels of he compound states that are active in dissociative recombination. A study of RIP, which is characterized by only one final state, should lead to better understanding of the dynamics of stabilization of compound states. Experimental data from a well-defined initial state is especially favoured for comparison with theory. Storage rings are suitable facilities for such studies. Commensurate storage times prior interaction ensures that ion targets are relaxed to their ground vibrational levels and detection of negative fragments guarantees high signal to noise ratios. The measurements carried out at CRYRING have taken full advantages of this facility. By detecting the heavy negative ion fragment resulting from RIP in collision of vibrational cooled molecular ions with electron, i.e. D^- and F^+, clean data were obtained which allowed high quality extraction of the cross sections.

The HD+ cross section presents us with a sharp rise at the expected threshold of 1.9 eV, followed by 14 stunning peaks superimposed on a generally declining envelope which cannot be explained by "Standard" explanation. Rosenthal oscillations [1] caused by coherent phase interference in the product amplitudes due to non-adiabatic coupling of states occurring at pseudo-crossings of the molecular potentials at large internuclear separations is hypothesized. Such oscillations have been seen in ion-atom scattering for a number of cases [2]. A primary calculation based on this hypothesis produces similar cross section feature observed in the measurement. More sophisticated calculation is ongoing.

For HF^+, the rate coefficients of RIP are found to be an appreciable fraction of DR. It shows a strong peak at 0 eV and some low peaks. Comparison with DR shows correlation at a number of energy region and anti-correlation in some region. The ratio of RIP / DR is about 0.3 at 0 eV.

References

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