DISSOCIATIVE RECOMBINATION OF RARE GAS HYDRIDES

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The dissociative recombination of electrons with the rare-gas hydride ions, KrH^+ and XeH^+ has been studied at 300K using the FALP-MS apparatus at the Université de Rennes. It is found that KrH^+ has a small recombination rate ($<1.15 \times 10^{-8}$ cm^3s^{-1}, upper limit) while XeH^+ displays a fast rate of 8.3×10^{-8} cm^3s^{-1}. Merged beam measurements[1-4] and theoretical calculations[5,6] of HeH^+ recombination have found that these ions recombine with a fairly small rate ($< 5 \times 10^{-9}$ cm^3s^{-1},measured) and NeH^+ ions have been predicted theoretically to recombine slowly. We cannot measure ArH^+ recombination in our apparatus due to its rapid reaction with H_2 to form H_3^+ and this ion is too heavy to be studied in merged beam experiments as currently implemented. It is expected however, that this ion may also display a slow recombination rate. The reason for the inefficient electron capture by these rare gas hydride ions (RgH^+) is that they do not have suitable neutral state curve crossings that effect the rapid dissociative stabilization typically displayed by recombining molecular ions. Such crossings might be expected to arise from states that proceed to an ion pair limit, as for example is the case for H_2^+ where the ground state goes to a limit of H+H while the state responsible for the dissociative recombination has an asymptote of $H+H^-$. The asymptotic limits of the lighter RgH^+ ions are $Rg + H^+$, the ionization potentials for these atoms being greater than that for atomic hydrogen. Since no bound ground state Rg^- ions are found to exist, such states, likewise, do not exist. In the case of XeH^+, the ionization potential of Xe is less than that of H and so the lowest asymptote of the ion is Xe^++H. Thus it is possible that states going to this limit do exist and that such states could cross the ground state of the ion near its minimum. This would explain the large measured recombination rate. Adiabatic calculations by Petsalakis *et al*[7] of the potential energy curves of excited states of XeH show evidence of avoided crossings that signal the existence of such states.

1. F.B. Yousif and J.B.A. Mitchell, Phys. Rev. A 40, 4318, 1989.
2. F.B. Yousif *et al.*, Phys. Rev. A 49, 4610, 1994.
3. G. Sundstrom *et al.*, Phys. Rev. A 50, 2806, 1994.
4. J.R. Mowat *et al.*, Phys. Rev. Lett. 74, 50, 1995.
5. S.L. Guberman, Phys. Rev. A 49, R4277, 1994.
6. B.K. Sarpal *et al.*, J. Phys. B 27, 5943, 1994.
7. I.D. Petsalakis *et al.*, Mol. Phys.75, 805, 1992.

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