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Neutral Resonant Ionization in an H^- Plasma Source: Potential of Doubly-Excited H^-**

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All excited states of the H anion are doubly excited, with both electrons above the 1s orbital, and sets of $**H^-$ resonances occur at and below the energies of the $n=2, 3$ and 4 states of H. These states are unbound, with lifetimes of 100 femtoseconds or less, that only appear as enhancements in electron and photon reactive cross sections with H and H^- . One state, $**H^-$ ($2p^2\ ^3P^e$), is calculated to be bound at 9.7 meV with a several nanosecond lifetime, and was originally proposed as a metastable state of $**H^-$ to explain broadening of Lyman- α radiation in space plasmas. This state is thought to be unobtainable in terrestrial experimentation because its photonic production from H^- violates parity conservation, and the resonance does not show up in energy scans of electron-hydrogen collisions. Hydrogen plasmas are optically dense to Lyman- α radiation, creating an over-population of $*H(n=2)$ neutral atoms. Energy of 10.2 eV is stored in such $*H(2s)$ and is available to interactions throughout the source plasma volume during its 200 msec lifetime. The collision of two $*H(n=2)$ atoms is energetically open to the production of a doubly excited anion through neutral resonant ionization in which the $n=2$ electron of one atom transfers to one of the three open $n=2$ orbitals of the other atom.

A study of the collision dynamics of two $*H(2)$ atoms in the potential-energy versus separation (E vs r) plane shows that an ionic pair involving an $**H^-$ resolves at least three long-standing collision experiments. These required unphysical assumptions if only vertical transitions in (E vs r) are allowed. This same analysis shows the energetic pathway from the collision of two $*H(2)$ atoms to a doubly-excited anion/proton pair to a doubly excited hydrogen molecule which then has several paths to the unexcited ion pair. The experimental signal of this process in a plasma ion source is difficult to quantify because the $**H^-(2p^2\ ^3P^e)$ is never isolated and no specific optical emission is expected. However, the resulting H^+ , H^- should both have an energy of 3.77 eV.