A new simple exotic atom, $H^{-+}$: $e^+$ bound to $H^-$ in an atomic state

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York Univ — A beam of $H^-$ ions is directed along the axis of a solenoidal magnet winding. Within this magnet, cylindrical electrodes with applied potentials slow the ions to an energy of $\sim 50$ eV in a magnetic field of $\sim 0.13$ Tesla. This apparatus also acts as a charged particle trap. $e^+$ from a radioactive source are slowed in frozen neon, guided by magnetic fields and captured in this Surko-style accumulator with $\sim 10^7 e^+$ trapped and cooled for experiments. $H^-$ ions are directed through these $e^+$ producing long-lived $H^{-+}$ atoms. $H^{-+}$ is not bound in the charged particle trap and continues with the initial momentum of the $H^-$ ion into a metal plate. Upon impact the $e^+$ quickly annihilates into back-to-back gammas. Detection of these coincident gammas indicates $H^{-+}$ that traveled the 2 meter to the detector and indicates a survival time of $\sim 5\mu$s. Typically systems with antimatter bound to matter particles have short lifetimes (and hence wide transition widths) due annihilation. Rydberg states of $H^{-+}$, however, have the long radiative lifetimes of normal matter atoms because there is little overlap of the $e^+$ wavefunction with the core. The detected rates or $H^{-+}$ are consistent with those expected for radiative recombination.

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