Hydrogen Atom Collisions and Tomography of the Dark Age Universe

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February 3, 2006

Abstract

We present collision data for hyperfine level changing transitions in atomic hydrogen. Recent proposals[1] have suggested that observation of the red-shifted hydrogen 21 cm line could provide unprecedented information on matter density fluctuations in the early universe. If the spin temperature of atomic hydrogen falls below the temperature of the background radiation field (CBR), regions of dense primordial hydrogen absorb radiation at 21 cm. The resulting features could be detected with proposed next generation radio telescopes. However, the decoupling of matter and radiation temperature depends crucially on the collision properties of the hydrogen system[2]. Our calculated collision data, which significantly improves upon previous results, confirms that for $30 < z < 200$, 21 cm absorption is efficient and enables proposed tomography of the dark age universe. We also discuss the role of spin-exchange vs. long range dipolar spin changing transitions in determining the level populations of atomic hydrogen in the dark age epoch.

[1] Loeb & Zaldarriaga Phys. Rev. lett. 92, 211301 (2004).

[2] B. Zygelman, ApJ 622 1356 (2005).

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