COMPARING THE ORTHO-TO-PARA RATIOS OF H_2 AND H_3^+ IN DIFFUSE INTERSTELLAR CLOUDS

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The ratio between the populations of the two lowest rotational levels of H_2, $J = 0$ and $J = 1$, can be used to determine the temperature of interstellar gas (referred to as T_{01}). Likewise, a temperature can be inferred from the populations of the $(J, K) = (1, 0)$ and $(J, K) = (1, 1)$ states of H_3^+. However, the average temperatures derived from these methods ($T_{01} \approx 60$ K, $T(H_3^+) \approx 30$ K) do not agree. Theories predict that the deviation from a Boltzmann distribution in both species is due to collisions between H_2 and H_3^+ which can change the spin alignment. Recent laboratory results confirm this deviation from a thermal distribution, and provide a relationship between the (1,0)/(1,1) ratio of H_3^+ and the (1)/(0) ratio of H_2. We have made observations searching for H_3^+ in several sight lines with measured H_2 abundances for the purpose of determining this relationship in interstellar clouds. With such a relationship, we then show that IR observations probing the (1,0) and (1,1) states of H_3^+ can be used to estimate the H_2 temperature in highly extincted sight lines where UV spectroscopy is not possible.