INTERSTELLAR H_3^+ IN METASTABLE ROTATIONAL LEVELS

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A recent tentative detection of interstellar H_3^+ toward the Galactic center has revealed the possible presence of H_3^+ in a metastable rotational level $(J, K) = (3, 3)$.[a] The absence of H_3^+ in the lower (2, 2) and (2, 1) rotational levels during the same observation demonstrates a non-thermal populational distribution in which H_3^+ in the two lower levels relax to the lowest (1, 1) level by spontaneous emission due to a dipole moment induced by centrifugal distortion,[b] while those in the metastable (3, 3) level do not relax radiatively.[c] Such metastability is expected to occur also for rotational levels with $J = K = 5, 6, 7$ etc. and a few other levels. H_3^+ in the metastable levels thermalize only through reactive collisions with other species, mainly H_2, H, He and electrons. We discuss thermalization of H_3^+ and the resulting non-thermal population in the interstellar medium taking into account both the spontaneous emission and the collision and the production and destruction of H_3^+. Properly interpreted, H_3^+ in metastable rotational levels will provide us with a useful astrophysical probe to measure temperature and density of the interstellar medium with relatively high temperature.

[a] M. Goto, B. J. McCall, T. R. Geballe, T. Usuda, N. Kobayashi, H. Terada and T. Oka, *PASJ* **54**, 951 (2002)
[b] J. K. G. Watson, *J. Mol. Spectrosc.* **40**, 536 (1971)
[c] F. S. Pan and T. Oka, *ApJ* **305**, 518 (1986)