The 25th International Conference on

High Resolution Molecular Spectroscopy

Bilbao 2018 September 3rd–7th

Bizkaia Aretoa – UPV/EHU

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Accurate rotational frequencies of deuterated Ammonium ions (d_1–d_3) measured in a cryogenic ion trap

José Luis Doménech[1], Stephan Schlemmer[2], Oskar Asvany[2]

1) Instituto de Estructura de la Materia CSIC, Serrano 123, 28006 Madrid, Spain

2) I. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany

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Two of the most abundant nitrogen-bearing molecules in the interstellar medium are N_2 and NH_3. Their protonated ions NH_2^+ (diazenylium) and NH_4^+ (ammonium) can provide critical information on interstellar chemistry. While N_2H^+ has been observed in many different sources, and it is, in fact, used as a proxy for N_2, NH_4^+ being non-polar, cannot be observed through its rotational transitions. Nevertheless, it is predicted to be very abundant, since the proton affinity of NH_3 is very high, and it remains stable against collisions with the abundant H_2. However, deuterated variants of NH_4^+ (d_1–d_3) do possess small permanent dipole moments, and could be detected via rotational transitions. In fact, NH_3D^+ has been detected in space in Orion IRc2 and in the cold core B1-bS through its transition $J_K=1_0-0_0$ [1]. At the time of its detection, there were no laboratory data on the rotational spectroscopy of NH_3D^+ and the rest frequency was derived from an analysis of the high resolution IR spectrum of the ν_4 band [2]. The frequency was confirmed later by an accurate direct measurement in the mm-wave in a cryogenic ion trap in the Cologne laboratories [3]. In order to provide accurate rest frequencies for the other polar isotopologues, experiments have been performed in a cryogenically cooled ion trap using the state-dependent attachment of He atoms to ions as an action spectroscopy technique. Improved frequencies for NH_3D^+ as well as first direct measurements for $NH_2D_2^+$ and NHD_3^+ (guided by recent work by the group of D. Nesbitt [4]) have been obtained.

[1] Cernicharo et al. 2013 ApJL 771, L10
[2] Doménech et al. 2013 ApJL 771, L11
[3] Stoffels et al. 2016 A&A 56, 1
[4] Chang et al. 2018 JCP 148, 014304