ROTATIONAL SPECTROSCOPY OF THE DEUTERATED MOLECULAR ION SD^+ IN LABORATORY

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The laboratory production of a molecule and measurements of its precise rest frequencies are essential to detect interstellar molecules in space. In this study, seven rotational transitions of the deuterated molecular ion SD^+ have been measured in the 271–863 GHz region in the laboratory. This ion has been produced by DC-glow discharge using a mixture of D_2S and Argon in a free space cell under a temperature range of -140 to -160°C. The rotational, centrifugal distortion, spin-spin interaction, spin-rotation, and hyper-fine constants have been determined; the standard deviation of the residuals in the fitting is 109 kHz. The measured frequencies can now be used for astronomical detection.

We have investigated the line of SD^+ toward the quasar PKS 1830-211 by using the ALMA archive. The z = 0.89 molecular absorber exits in front of this quasar and SH^+ has been detected in the absorber [1,2]. There is a data set covering the 297 GHz region [3], which includes the N_J = 2_3–1_2 transition of SD^+ at 561 GHz under redshift. A weak feature having an S/N of 2 is located at the same velocity with the peaks of SH^+ and $^{34}SH^+$. The feature shows the column density of 3×10^{12} cm^{-2} using a dipole moment of 1.087 D [4] and assuming the excitation temperature of 5.14 K [1]. However, the column density provides an abundance ratio SD^+/SH^+ of 7%, which is overlarge considering the known deuterated species of ND $(0.07 - 0.7\%)$ and HDO (0.1%) [5]. Therefore, the present column density should be regarded as an upper limit of SD^+. To detect this deuterated ion, the transitions that come from the lowest rotational level N_J = 0_1 are awaited to be investigated because of the low excitation temperature of this absorber.

[1] S. Muller et al., A&A, 606, A109 (2017). [2] ALMA archive, 2017.1.00051. [3] ALMA archive, 2013.1.00020. [4] J. Senekowitsch et al., J. Chem. Phys., 83, 4661 (1985). [5] S. Muller et al., A&A, 637, A7 (2020).