

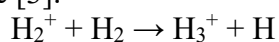
Possible observation of linear H₃⁺ in the laboratory

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H₃⁺ was discovered by J. J. Thomson in 1911 in the laboratory with a mass spectroscopic method, determined its structure by T. Oka in 1980 with infrared spectroscopy, and observed as an interstellar molecule by T. Oka in 1996. Now, we regard H₃⁺ as one of the most critical species in interstellar clouds because many complex molecules are produced via the reaction involving H₃⁺ [1].

We performed the ion mobility measurements after injecting H₂⁺ into a drift tube filled with normal H₂ gas at the liquid nitrogen temperature of 77 K using a very low-temperature drift tube mass spectrometer [2]. The following ion-molecule reaction produces H₃⁺ in the gas phase [3]:



This is one of the important reactions that produce H₃⁺ in molecular clouds, and it has been investigated in laboratories. We measured the arrival time spectra of H₃⁺ at various H₂ gas pressures and electric field strengths in the drift tube to obtain the reduced mobility of H₃⁺ in H₂ gas at 77K.

Arrival time spectra of H₃⁺ surprisingly split two components in weak electric fields. As the mobility of molecular ions depends on their molecular structure, we consider that two peaks correspond to two isomers, namely triangle and linear structures of H₃⁺. The ground state of H₃⁺ has a triangle structure confirmed with spectroscopic observation, and theoretical calculations proposed the first excited triplet state with a linear structure [4]. However, the energy of this triplet state is too high to be produced in the low-energy collision of H₂⁺ with H₂. Then the meta-stable linear structure in the electronic ground state will be the candidate. If this interpretation is correct, this result might be the first observation of linear H₃⁺ ions in experiments.

References

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- [2] H. Tanuma *et al.*, 2000, *Rev. Sci. Instrum.* 71, 2019.
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