THE FORMATION MECHANISMS OF D_3: AN INFRARED SPECTROSCOPIC INVESTIGATION

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In 1993, we reported observations of the infrared absorption spectra of D_3 with a difference frequency laser system in the frequency ranges around 3600 cm^{-1} ($3s^2A_1' \leftarrow 3p^2E'$) and 3900 cm^{-1} ($3d \leftarrow 3p^2E'$)[a]. The observed line shapes exhibited a broad non-Maxwellian velocity distribution, and the line shapes depended on the rotational states. At that time, the line shapes and the widths were not completely understood. Here we present a more detailed and consistent analysis.

Most lines of the 3600 cm^{-1} band appear to be a superposition of two components , broader and narrower features, for some transitions with an opposite phase. From a broader flat-topped line profile, it is concluded that D_3 carries excess translational energy of 0.4 eV and is formed through the dissociative recombination reaction of D_5^+ with electrons. The rotational dependence of the line shapes of the 3600 cm^{-1} band is brought about by a competition between the predissociation in the $3s^2A_1'$ state and the radiative decay in the $3p^2E'$ state. The shorter lifetimes of the $3d$ complex make the line shape of the 3900 cm^{-1} band simpler, a superposition of two absorption profiles with different widths. It is found that the widths of the lines of the 3900 cm^{-1} band are larger than those for the 3600 cm^{-1} band lines. The greater widths of the 3900 cm^{-1} band are attributed to unresolved spin-splittings. Attempts to observe similar absorption lines of H_3 were unsuccessful, presumably due to much shorter lifetimes.

[a] T. Amano and Man-Chor Chan, paper TD02, 48th International Symposium on Molecular Spectroscopy, Columbus, Ohio, 1993