TRIPLE TRANSITIONS IN SOLID HYDROGEN AND DEUTERIUM

M. MENGEL, B. P. WINNEWISSER AND M. WINNEWISSER, *Physikalisch-Chemisches Institut, Justus-Liebig-Universität, Heinrich-Buff-Ring 58, D-35392 Giessen, Germany*.

The infrared absorption spectrum of the solid hydrogens is well understood in terms of a pairwise multipolar induction mechanism leading to the infrared activity of single and double transitions. However, in recent experiments we have identified various triple transitions for the first time [a] [b].

There are two basic mechanisms for the simultaneous excitation of three hydrogen molecules upon absorption of one photon of radiation:

- Intensity transfer due to mixing of states.
- Three-body induced dipole moments.

The infrared activity of triple transitions due to intensity transfer resulting from mixing of states was suggested by Tipping *et al.* [c] As examples of this mechanism we present the transitions $Q_1(0) + Q_1(0) + S_0(0)$ and $S_1(0) + Q_1(0) + S_0(0)$ in both solid hydrogen and deuterium.

However, with this concept it is not possible to explain the triple transition $S_1(0) + Q_1(0) + Q_1(0)$ which we have also observed in both isotopic species of the hydrogen crystal. This transition is located at 12 788 cm^{-1} in solid para-H_2 and at 9123.5 cm^{-1} in solid ortho-D_2.

We present a theory of three-body induced dipole moments in order to account for the linestrength of this very remarkable transition. Experiments to observe the corresponding triple transition in solid HD are currently in preparation.

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[a] M. Mengel, B.P. Winnewisser, and M. Winnewisser, J. Mol. Spectrosc., *in press*, (1998).

[b] M. Mengel, B.P. Winnewisser, and M. Winnewisser, J. Low Temp. Phys. (Proceedings of the Cryocrystal '97 Conference), *in press*, (1998).

[c] R.H. Tipping, Q. Ma, and J.D. Poll, Phys. Rev. B **22**, 12314–12317 (1991).