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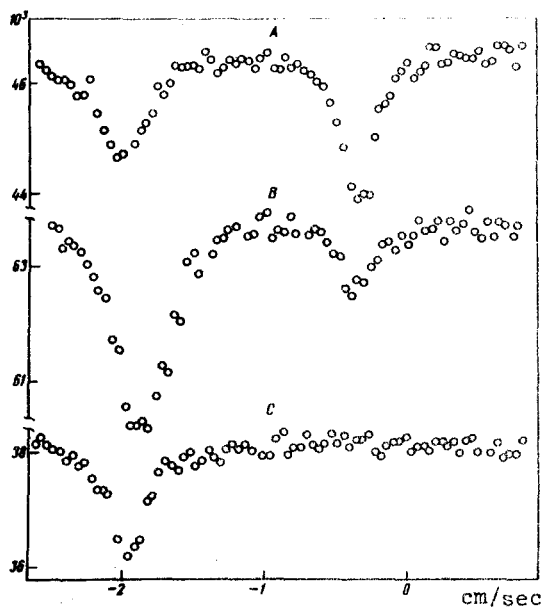
MOSSBAUER SPECTRA AND THE JAHN-TELLER PSEUDO-EFFECT IN M_2SbCl_6

A.Yu. Aleksandrov, S.P. Ionov, A.M. Pritchard¹⁾, and V.I. Gol'danskii
 Institute of Chemical Physics, USSR Academy of Sciences
 Submitted 3 November 1970; resubmitted 18 November 1970
 ZhETF Pis. Red. 13, No. 1, 13 - 15 (5 January 1971)

The purpose of the present investigation was to show, first, that crystals with a gross composition M_2SbCl_6 ($M = NH_4, Rb, Cs$) [1] contain two different antimony ions, Sb^{3+} and Sb^{5+} , and second, to show that in these crystals the diamagnetic octahedra $SbCl_6^{4-}$ are distorted in the manner observed in the iso-electronic XeF_6 [2] and $CsIF_6$ [3].

To prove this, we plotted the Mossbauer spectra for the cases $M = Rb$ and Cs at 77°K (the absorbers contained 10 mg/cm² of Sb), using a ^{121m}SnO₂ source (at $T = 300^\circ K$), with a line width $\Gamma = 2.7$ mm/sec. The spectra of their parameters are given in the figure and in the table.

Compound	Sb^{5+}		Sb^{3+}	
	Measured shift, mm/sec	Line width, mm/sec	Measured shift, mm/sec	Line width, mm/sec
A. Rb_2SbCl_6	-3.0 ± 0.2	2.8 ± 0.3	-19.3 ± 0.3	3.95 ± 0.3
B. Cs_2SbCl_6	-3.0 ± 0.2	2.8 ± 0.3	-18.5 ± 0.4	4.3 ± 0.3
C. $Rh(NH_3)_6Sb^{III}Cl_6$	--	--	-19.3 ± 0.3	2.8 ± 0.2



An analysis of the spectrum leads to the following main results:

1. In the spectra of A and B there are two resonant-absorption maxima whose parameters correspond [4, 5] to Sb^{3+} and Sb^{5+} .

2. The Sb^{5+} absorption line in Cs_2SbCl_6 has a relatively low intensity (spectrum of B), and the summary intensity of the absorption lines of Sb^{5+} and Sb^{3+} is approximately the same in spectra of A and B.

The relatively low intensity of the absorption line is obviously connected with the appreciable amplitude of the oscillations of antimony in the form of Sb^{5+} in the octahedral complex, a possible result of the dynamic Jahn-Teller pseudoeffect.

¹⁾ Physical-chemistry Laboratory, Oxford, England.

3. The Sb^{3+} absorption line in Rb and Cs salts is appreciably broadened, whereas the Sb^{3+} absorption line in $\text{Rb}(\text{NH}_3)_6\text{SbCl}_6$ (spectrum C) has no broadening compared with the source line. The quadrupole broadening of the Sb^{3+} line indicates that the SbCl_6^{3-} octahedra are distorted (static Jahn-Teller pseudoeffect).

We note in conclusion that the role of the cations apparently reduces to an effective change of the width of the forbidden band of the crystal, and hence to a change of the electron-vibrational interaction, on which are dependent the static distortion of the CbSl_6^{11-} octahedra and the dynamic phenomena in the M_2SbCl_6 crystal lattices.

The authors thank P. Day and V.A. Kuznetsov for supplying the samples of the compounds and E.F. Makarov for valuable discussions.

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MOLECULES IN AN ULTRA STRONG MAGNETIC FIELD

B.B. Kadomtsev and V.S. Kudryavtsev
 Submitted 13 November 1970
 ZhETF Pis. Red. 13, No. 1, 15 - 19 (5 January 1971)

In a very strong magnetic field, greatly exceeding 10^9 Oe (such fields can exist in neutron stars), an atom with an atomic number Z becomes strongly stretched along the magnetic field B [1 - 3]. Such atoms have a large electric quadrupole moment and should become bound into stable molecules. This makes possible the formation of molecules of a highly extraordinary type, in which the electron cloud becomes common, and all the electrons form a negatively-charged "needle," with the nuclei lying on its axis. We shall determine approximately the binding energy of such a molecule, disregarding the interaction of the atoms at large distances.

Let us consider first a diatomic molecule with nuclei lying on a single magnetic force line at distances R from one another, and having a charge Z each. Neglecting the exchange correction, the energy can be approximately expressed in the form (cf. formula (2) of [3]):

$$E = N \int \left\{ \frac{1}{2} \left(\frac{\partial \tilde{\psi}}{\partial \mathbf{z}} \right)^2 - \left(\frac{Z}{r} + \frac{Z}{|\mathbf{r} - \mathbf{R}|} \right) \tilde{\psi}^2 + \frac{N-1}{2} \left\langle \frac{1}{r_{12}} \right\rangle \tilde{\psi}^2 \right\} d\mathbf{r} + \frac{Z^2}{R}. \quad (1)$$

Here $\tilde{\psi}$ is the average wave function, so that $N\tilde{\psi}^2$ equals the average electron density, N is the number of electrons,

$$\left\langle \frac{1}{r_{12}} \right\rangle = \int \frac{1}{|\mathbf{r} - \mathbf{r}_2|} \tilde{\psi}^2(\mathbf{r}_2) d\mathbf{r}_2,$$

atomic units are used throughout.

The ground-state energy is determined by the minimum of the functional