

The Molecule of Sulphur and Its Raman Spectrum

Warren and Burwell¹ have recently shown that rhombic sulphur consists of S_8 molecules; the atoms in each molecule are located at the corners of a puckered octagon. We will now apply the methods based on group theory as developed by Wigner,² Tisza,³ and others for investigating the normal modes of oscillation of such a molecule. There are sixteen symmetry operations which transform the model into itself and these operations form the point group S_{8v} . There are seven irreducible representations for this group and the character Table I obtained from the general tables given by Tisza is given.

The significance of h_j , x_j' , n_i and n_i' is the same as that in a recent paper by Wilson.⁴ The activity or otherwise of these oscillations is also given in the last two columns of the table. P indicates a strong and well-polarized Raman line. D indicates a completely depolarized Raman line and f stands for a forbidden line. The table shows that we should expect two strong and well polarized lines and five depolarized lines in the Raman spectrum of sulphur.

Venkateswaran⁵ has recently obtained the complete Raman spectrum in which eight lines at 88, 114, 152, 185, 216, 243, 434 and 468 have been recorded. He has given good reasons to show that the lowest frequency is to be attributed to the lattice and not to the molecule. The molecular frequencies are therefore only seven and two amongst these, namely 216 and 468, have been found to be strong and well polarized in complete accord with our conclusions. These two represent the total symmetric vibrations A_1 . All the other five, namely 114, 152, 185, 243 and 434 should be completely depolarized according to the theory. The stronger of these (152 and 434) have been found to be so but data in respect of others are not given by Venkateswaran presumably because they are weak. The Raman spectrum data so far as are available may thus be taken to be in complete accordance with the model proposed by Warren and Burwell. Interpretation of the infra-red spectrum and a more detailed analysis of the vibrational modes and frequencies will be given elsewhere.

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April 13, 1938.

¹ Warren and Burwell, J. Chem. Phys. 3, 6 (1935).² Wigner, Göttinger Nachrichten, 133 (1930).³ Tisza, Zeits. f. Physik. 82, 48 (1933).⁴ Wilson, Phys. Rev. 45, 706 (1934).⁵ Venkateswaran, Proc. Ind. Acad. Sci. 4, 345 (1937).

Radioactive Iodine Isotopes

We have bombarded tellurium with 8-Mev deuterons and have found two new radioactive iodine isotopes, with half-lives of 13 hours and 8 days. The latter is created by two mechanisms: (1) by the decay of radio-tellurium and (2) by direct transmutation from stable tellurium. Process (1) is demonstrated by the fact that successive extractions of iodine, from the same solution of bombarded tellurium, show a growth of the 8-day period; this must therefore be associated with either I^{129} or I^{131} , as the second activity of a double decay: $Te^{128, 130}(d, p)Te^{129, 131}$; $Te^{129, 131} \rightarrow I^{129, 131} \rightarrow Xe^{129, 131}$. Process (2), which is known to occur on the basis of relative intensities, is the usual type of reaction: $Te^{128, 130}(d, n)I^{129, 131}$. Conclusive proof of this identification and interpretation has been furnished by the extraction of the 8-day iodine from tellurium which has been bombarded with neutrons. We cannot as yet state the period of the radio-tellurium from which this iodine grows.

Absorption measurements on the negative electrons emitted by the 8-day iodine indicate a maximum energy of 0.9 Mev; a gamma-ray is also present.

We have irradiated iodine with the fast neutrons from a lithium plus deuterons source and confirm the 13-day period reported for the same bombardment by Tape and Cork,¹ who surmised it to be due to I^{126} . We have chemically identified this activity as an iodine isotope, so that the assignment to I^{126} appears to be definite. (The antimony fraction of this same bombardment was inactive, while the tellurium precipitate exhibited a 10-hour half-life which can be ascribed definitely to Te^{127} . This tellurium period has been reported previously,¹ following neutron and deuteron bombardment of tellurium, but without definite isotopic identification.)

The yield of the 8-day iodine from $Te(d, n)I$ is very much larger than that of the strongest 13-day iodine that we have been able to produce by the reaction $I^{127}(n, 2n)I^{126}$.

This research has been aided by grants from the Research Corporation, The Chemical Foundation and the Josiah Macy Jr. Foundation.

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¹ G. F. Tape and J. M. Cork, Phys. Rev. 53, 676 (1938).

TABLE I.

	E	$2S^1$	$2C^2$	$2S^3$	C^4	$4\sigma_v$	$4C_2$	n_i	$R \& T$	n_i'	RAMAN	INFRA-RED
A_1	1	1	1	1	1	1	1	2	—	2	P	f
A_2	1	1	1	1	1	—1	—1	1	R_z	0	—	—
B_1	1	—1	1	—1	1	1	—1	2	T_z	1	f	$M_{L=0}$
B_2	1	—1	1	—1	1	—1	1	1	—	1	f	f
E_1	2	$\sqrt{2}$	0	$-\sqrt{2}$	—2	0	0	3	T_L	2	f	$M_{L=0}$
E_2	2	0	—2	0	2	0	0	3	R_L	2	D	f
E_3	2	$-\sqrt{2}$	0	$\sqrt{2}$	—2	0	0	3	—	3	D	f
h_j	1	2	2	2	1	4	4					
x_j'	24	0	0	0	0	2	0					
$h_j x_j'$	24	0	0	0	0	8	0					