Apparent Anomalous Isotopic Effect in Some Bands Associated with the Swan Bands

A NUMBER of weak bands have been noted in sources of carbon molecular spectra by Johnson¹ and by Fox and Herzberg². Because of their association with carbon spectra, these bands were attributed to the carbon molecule, and several of the stronger ones (λ 4770, 4836, 4911, 4997) tentatively identified as tail-bands of the Swan system. Measurements of the isotopic heads of the first three of these bands obtained from carbon enriched in the heavy isotope give some information concerning their nature and display an anomalously large isotopic shift.

The following positions of the heads of these bands were obtained from spectra of carbon containing 35 per cent ¹³C, taken on a 21-ft. grating spectrograph in the first order. The source was an end-on quartz capillary discharge in argon containing a trace of methane, activated by a 3 kw. transformer.

¹² C head	¹³ C head	Isotopic shift
4770.21 Å.	4764.77 Å.	
20,957.60 cm. ⁻¹	20,981.52 cm. ⁻¹	23.92 cm. ⁻¹
4836.16	4827.57	
20,671.80	20,703.59	36.79
4910.95	4893.92	
20,356.99	20,406.93	49.99

The values 23.92 cm.⁻¹ and 36.79 cm.⁻¹ are thought to be accurate to less than 0.1 cm.⁻¹, while the value 49.99 cm.⁻¹ is not so accurate because the band λ 4911 is much weaker than the other two.

The fact that only two heads were present, even in low dispersion spectra of carbon which contained 50 per cent ¹³C, is clear proof that the emitting molecule is not C-C, but contains only one carbon atom. The isotopic shift is very large, and can be explained only by the unreasonable assumptions of an infinitely heavy emitting molecule, so that the carbon has its maximum effect on the vibrational energy, combined with very large correction terms for the effects of anharmonicity and rotational shifts. The origin of the band system computed from the relative magnitudes of the isotopic shifts is near 21,500 cm.⁻¹, so that the 0,0 band is probably covered up by the 1,0 (λ 4737) Swan band.

From the occurrence of these bands in a wide variety of sources of carbon spectra, they must be due to carbon combined with a very persistent impurity; and from their occurrence in sources of high excitation, the emitting molecule should not be very complex.

These bands were noticed incidentally to measurement of the ¹³C spin, and on account of pressure of other work, no further research on them can be done at this laboratory.

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Diffraction of Ultra-Short Radio Waves

SOMMERFELD¹ has shown that in the study of the diffraction of electromagnetic waves at a sharp edge, account must be taken of the contribution to the diffracted field of the wave which is reflected at the

edge. Because of the variation in boundary conditions at the edge for radiation linearly polarized in different planes, Sommerfeld deduced that the shadow cast by a sharp edge should be deepest for radiation polarized with the electric vector parallel to the edge.

Wien² and Jentzsch³, amongst others, have observed this feature for waves in the visible spectrum. We have obtained the same result with ultra-short radio waves in the wave-band 2-3 metres. When such waves are propagated over hills with long ridge formations such as are found among the downs of south England, we have noted that the shadow behind the ridges is always appreciably deeper for horizontally polarized (electric vector horizontal) than for vertically polarized waves. Typical results obtained on a wave-length of 3 metres on Dunstable Downs are given in the accompanying table. For a fixed transmitter position situated on a plateau about 200 yards from the edge of a slope some 400 ft. in overall height, measurements of the vertical and horizontal electric field-strengths were made at a series of positions on the slope, the transmitting aerial being oriented according to the type of polarization under observation at the receiver.

Position	Field-strength in microvolts per metre		Ratio : vertical/horizontal fields	Remarks
	Vertical polarization	Horizontal polarization		
1	4500	4000	1.12	Gradual slope
2	2200	1800	1.22	
3	1000	800	1.25	
4	630	400	1.57	
5	320	180	1.78	
6	125	70	1.79	Steep slope
7	80	28	2.85	
8	36	16	2.25	
9	32	12	2.67	Gradual slope
10	40	14	2.85	
11	40	17	2.36	

It will be noted that near the top of the ridge (position 1) the vertical and horizontal electric field-strengths were approximately equal, but that on moving the receiver down the hill into the shadow, the vertical electric field increased relative to the horizontal electric field, and that finally, as the slope lessened, both fields increased slightly but the vertical electric field remained throughout greater than the horizontal field.

Similar results have been obtained on other hills devoid of trees. The presence of trees complicates the propagation characteristics of ultra-short radio waves, but it has been found that in the wave-band 2-3 metres, vertically polarized radiation appears, in general, to be the most efficient for conditions in which diffraction by hills is predominant.

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