LETTERS TO THE EDITORS

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Radio Observations of the Comet Arend-Roland

The observation of radio emission from the Comet Arend-Roland has been reported[1] at 600 Mc./s. and[2] at 27·6 Mc./s. The reported flux densities are of the order of 5 × 10^{-23} (private communication) and 5 × 10^{-22} W.m.$^{-2}$ (c./s.)$^{-1}$ respectively, or about 2 per cent and 3,000 per cent of the flux density of the quiet Sun. Observations[3] at 400 Mc./s. failed to detect any emission, though the sensitivity was high enough to detect a flux density less than 10^{-24} W.m.$^{-2}$ (c./s.)$^{-1}$.

Observations were made at Cambridge during periods between March 12 and May 13 in an attempt to detect radio emission from the comet at frequencies of 38 and 81·5 Mc./s., and by observing radio stars through its tail to derive information on the electron density, in the manner used by Hewish[4] in investigating the outermost layers of the solar corona.

Five different instruments were used. Two were interferometers of large resolving power used to detect any scattering of the radiation from radio stars situated behind the comet's tail. These instruments also enabled a very low limit to be placed on the radio emission from the head. The possibility of radio emission from the extended tail was investigated with interferometers of smaller resolving power, but these were of lower sensitivity, so the derived upper limit of intensity is greater.

In no case was any detectable effect observed; the upper limits of the flux density are given for the different periods in Table 1. A number of records were spoiled by intense emission from the Sun, and some at 38 Mc./s. by man-made interference; the best observations at this frequency were therefore obtained at night near lower culmination when the comet had moved sufficiently far north.

Solar emission also prevented the observation of three comparatively intense radio stars through the comet's tail. The observation of weaker stars was possible on a number of occasions between April 13 and May 13, but none of these was sufficiently well defined on the records to allow an individual measure of the scattering produced. It was, however, possible to show that there would be detectable changes in the record amplitude if all the weaker unresolved radio stars situated behind the tail were obscured or were subject to scattering greater than the resolution of the interferometer. No such effect was found, and it may therefore be concluded that the irregular variations of electron density in the tail of the comet were insufficient to produce scattering as great as ½° at 81·5 Mc./s. or 1° at 38 Mc./s.

Table 1

Frequency (Mc./s.)	Interferometer spacing (wavelengths)	Maximum diameter observable (degrees)	Dates	Upper limit to flux density of comet (× 10^{-24} W.m.$^{-2}$ (c./s.)$^{-1}$)
81·5	120	1/4	April 13–24	3
			April 25–May 8	0·5
	10	3	April 13–May 8	5
	5	6	March 12–20	60
38	60	1/2	April 11–23 (4 days)	3
			(3 days)	15
			April 26–May 4	0·5
			May 5–13	0·25
	10	3	March 31–April 24 (10 days)	40

The magnitude of the scattering produced by an irregular region depends on ΔN, the root-mean-square departure of the electron density from the mean value, and l, the scale of the irregular structure[4]. The present observations indicate that $\Delta N/\sqrt{l}$ is less than 100, when ΔN is measured in electrons per cm.^{3} and l in kilometres.

Optical photographs of the tail of the Comet Arend-Roland show structure as fine as 10,000 km., leading to an upper limit of 10^4 for ΔN; it is probable that finer structure exists, and the limit of ΔN would then be smaller.

G. R. Whitfield
J. Högbom

Cavendish Laboratory,
Cambridge.
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[1] Koeckelenbergh, A., *Int. Astro. Union Circ.* 1594 (1957).

[2] Kraus, J. D., *Int. Astro. Union Circ.* 1596 (1957).

[3] Seeger, Ch. L., Westerhout, G., and Conway, R. G., *Int. Astro. Union Circ.* 1599 (1957).

[4] Hewish, A., *Proc. Roy. Soc.*, A, **228**, 238 (1955).

Rotational Analysis of the Tantalum Oxide Bands

Bands of the tantalum oxide molecule have been photographed in the ultra-violet and the visible regions on a 21-ft. concave grating in the Department of Physics, University of Stockholm, in the first order, giving a reciprocal dispersion of about 1·2 A./mm. The previous analyses[1] are found to be incorrect. The revised analysis shows that the bands in these regions can be divided into two systems *A* and *C*. Bands of system *C* consist of two sub-systems with their (0,0) bands at $\nu\nu$24064 and 23348. Rotational structure of the (2,0), (3,1), (1,0), (2,1), (0,0) and (0,1) bands of system *A*, (1,0) and (0,0) bands of the sub-system ν24064 and (1,0), (0,0) and (0,1) bands of the other sub-system of *C* has been analysed. Bands of system *A* show only two branches each and are ascribed to the transition $c^2\Delta_{3/2}$–$a^2\Delta_{3/2}$. Strong *Q* branches are very prominent in all the bands of system *C*. Large Λ-type doubling is observed in the upper state levels and is found to vary linearly with *J* in the sub-system ν23348. The bands are ascribed to the transition $b^2\Pi$–$a^2\Delta$. All three states involved belong to Hund's coupling case (*a*). The vibrational and rotational constants obtained are given in Table 1.

Table 1. Constants of Tantalum Oxide

State	ω_e (cm.$^{-1}$)	$x_e\omega_e$ (cm.$^{-1}$)	B_e (cm.$^{-1}$)	α_e (cm.$^{-1}$)	r_e (A.)
$c^2\Delta$	903·01	4·15	0·3775	0·0019	1·743
$b^2\Pi$	898·5 896·0	4·1	0·3772	0·0019	1·744
$a^2\Delta$	1,031·7	5	0·4029	0·0020	1·687