# LETTERS TO THE EDITOR

## RADIO ASTRONOMY

### Occultation of the Crab Nebula by the Solar Corona at Centimetre Wave-lengths in June 1964

DURING the occultation of Taurus in June 1961 and 1962, centimetre wave-length observations were undertaken by U.S. Air Force Cambridge Research Laboratories scientists to investigate small-scale irregularities, if any, in the solar corona which might produce wide-angle scattering at metre wave-lengths and also be observed at centimetre wave-lengths. Results for 1962 were interpreted by Basu and Castelli[1] to indicate a progressive broadening of the source and a decrease in source intensity as the angular separation between Taurus and the Sun became smaller. The reverse tendency was noted on the egress part of the cycle. The broadened maximum extent of the source was found to be about 20 min of arc at $\lambda = 10$ cm.

In 1964, using the identical technique as in 1962, no apparent broadening or change in source intensity was detected.

Observational wave-lengths were 25 cm and 10 cm. Equipment consisted of conventional radiometers and a single 84-ft. parabolic antenna with a dual frequency linearly polarized feed. The pencil beam produced was less than 17·5 min of arc at $\lambda = 10$ cm and about 36 min at $\lambda = 25$ cm.

The observing technique used in 1962 and again in 1964 was to make 4 or 5 right ascension drifts of the source and/or solar contribution each day between June 10 and 20. Then, on control days during the final week of June, drifts were taken with the antenna directed at points in the sky corresponding to the angular separation between the Sun and the radio source, Taurus, during the actual occultation period.

During the occultation period, temperature calibrations were made before and after each drift. Sufficient time was allowed for each drift to establish a far-out steady sky level free from solar contribution. On the control days, equipment gains were adjusted to agree with those on corresponding data days. This was done using noise generator calibrations.

The solar flux was found for each day both locally and by referring to the Ottawa 2,800-Mc/s flux, and control day drifts were effectively normalized to comparison days in respect to solar contribution through the antenna side lobes.

Finally, the actual curves and control day curves were subtracted from each other. We were careful to reference curves at far-out zero points. For each day's equipment gain settings, linearity was determined and corrections were made where applicable.

The actual response curves due to Taurus alone after subtraction of the solar component were constructed by plotting signal levels taken at 6-sec intervals from the analogue records. At $\lambda = 10$ cm, points for plotting were read with an accuracy of $\pm 1$ sec. Half-power widths of the constructed response curves were read with an accuracy of better than $\pm 1\cdot5$ sec of time.

The time-width of each constructed drift due to Taurus alone at half-intensity level was compared with drifts made early or late in June when there was no question of solar contribution in the response drift.

It is also possible (and this has been done) to compute the angular extent of Taurus whether unbroadened or otherwise from the expression:

$$C^2 = A^2 + B^2$$

where $C$ = the actual source response where minutes of arc = (min of time) 15 cos declination; $A$ = the actual antenna half-power beam width; $B$ = the Gaussian source half-intensity width.

Theoretical maximum intensity calibration errors at $\lambda = 10$ cm of $\pm 3°$ K due to precision variable attenuator resettability and absolute calibration over the operating range in the 10-cm equipment scarcely apply. Practically, by peak calibration of many drifts of various sources with the same equipment, it is felt that in the present case the maximum probable relative intensity error is under $\pm 1\cdot5°$ K.

The validity of the whole method is based on the extraordinary stability of the antenna side lobes and on how well we are able to calibrate out the solar contribution.

Results are presented in Table 1.

Table 1

1964 = 10 cm

| Date | Source extent at half-intensity—min | | Source temp. at receiver | Signal percentage solar |
|---|---|---|---|---|
| | Time | Arc | | |
| June 3–5, control | 1·275′ | 4·6′ | — | 0 |
| June 11 | 1·25 | 3·1 | 24·7° K | 17 |
| June 12 | 1·25 | 3·1 | 23·8 | 18·8 |
| June 13 | 1·275 | 4·6 | 23·72 | 50 |
| June 14 | 1·275 | 4·6 | 24·04 | 57 |
| June 15 | 1·29 | 5·4 | 23·71 | 17·8 |
| June 16 | 1·25 | 3·1 | 24·68 | 14·3 |
| June 17 | 1·275 | 4·6 | 24·8 | 15·9 |
| June 26, control | 1·275 | 4·6 | 23·8 | 0 |

Uncertainty: time duration of drift half-intensity—3 sec. Angular extent of source possible error 2·8 min of arc. Intensity uncertainty limits 24° ± 1·5° K.

In 1963, other observers have detected no significant broadening at 6, 13, 18 and 21 cm. Air Force Cambridge Research Laboratories personnel did not repeat the 1962 measurements in the same form. Therefore, we can only assume that the 1963 evidence of others is correct for 1963. In view of the results of the present 1964 investigation, which seems to justify the method, an explanation is sought for our 1962 results. Such an explanation is not to be found in a comparison of the fluxes for the various days and years. However, it is significant that, in 1962, an active region was present at about 10° south of the solar equator. It is the southern corona which is probed by the measurement at the time of minimum angular separation of the Sun and Taurus. At the Union Radio Scientifique Internationale General Assembly in Tokyo, Japan, in 1963, Vitkevich commented on an unusual scattering effect observed on June 10, 1962, at metre wave-lengths and lasting for several hours.

It is anticipated that similar investigations will be continued in the coming year.

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[1] Basu, S., and Castelli, J., *Nature*, **197**, 885 (1963).

## ASTRONOMY

### Lunar Luminescence

IN a recent article, Kopal[1] has directed attention to a report by Sir William Herschel[2] of 'volcanoes' in the neighbourhood of the lunar crater Aristarchus seen in April of 1787. Both he and Middlehurst[3] note the similarity between Herschel's description and two recent reports by Greenacre[4,5] of reddish luminescence near Aristarchus in October and November 1963. In Table 1 are listed 16 additional transient luminescent events in the vicinity