Occultation of the Crab Nebula by the Solar Corona in June 1963

IN a recent communication, Basu and Castelli[1] described observations at wave-lengths of 10 cm and 25 cm of the occultation of the radio source in Taurus, the Crab Nebula, by the solar corona in June 1962. The results were interpreted as indicating a progressive increase in the angular diameter of the source with decreasing angular distance from the Sun, due to scattering by irregularities of electron density in a non-uniform corona.

Several observers have demonstrated that such an effect occurs at metre wave-lengths; for example, Hewish[2,3] and Vitkevitch[4] have shown that, over the range of wave-lengths 1·9–7·9 m, and for radial distances less than 12 solar radii, the results are in accord with a simple scattering theory in which the angular extent of the scattered distribution (defined as the brightness distribution produced when a point source is viewed through the corona) is proportional to the square of the wave-length. Assuming this dependence on wave-length to hold down to centimetre wave-lengths, and extrapolating from the metre observations of Hewish, values $\sim 2''$ at 10 cm and $\sim 10''$ at 25 cm are derived for the expected angular diameter (between e^{-1} points) of the Gaussian scattered distribution at distances ~ 5 solar radii from the Sun. From their observations Basu and Castelli inferred angular diameters of 20′ at 10 cm. and 25′ at 25 cm, which therefore cannot be accounted for by the simple theory.

In view of this discrepancy, observations of the Crab Nebula were undertaken in June 1963 using the twin 90-ft. dishes of the California Institute of Technology's Owens Valley Radio Observatory. The two antennæ were used as an east–west interferometer of spacing 680λ operating at a frequency of 1,660 Mc/s (18 cm wave-length). Any increase in angular diameter of the source, observed with the interferometer, results in a decrease in the recorded source response which may be interpreted directly in terms of the angular extent of the scattered distribution. With the arrangement described here, the quiet Sun was largely resolved and gave a contribution to the total response which was only a fraction of the response due to the source itself. In the absence of an appreciable solar contribution it was possible to detect scattering angles as small as 0·7′. The source was observed daily at several different hour angles during the period June 11–19, conjunction occurring on June 14–15 (Fig. 1). In order to allow for the solar contribution, additional observations of the response were made each day with the antennæ directed towards the positions which the source took relative to the Sun on each of the occulting days. The contribution was at all times less than 15 per cent except on June 15 when the solar response was 25 per cent of that due to the source. As the angular separation of source and Sun decreased, the gain was decreased by measured amounts (always less than 0·4 db) to preserve the same detector levels in the presence of solar noise. The response of the source *3C 123* was observed each day and used to correct for small changes in receiver sensitivity.

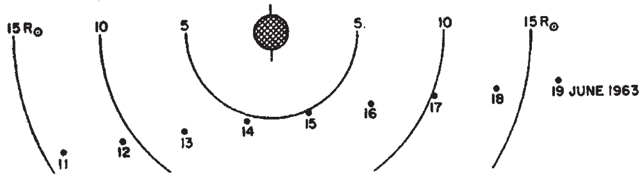

Fig. 1. Position of the Crab Nebula relative to the Sun at 12 noon P.S.T. $R_{\odot}$, Solar radius

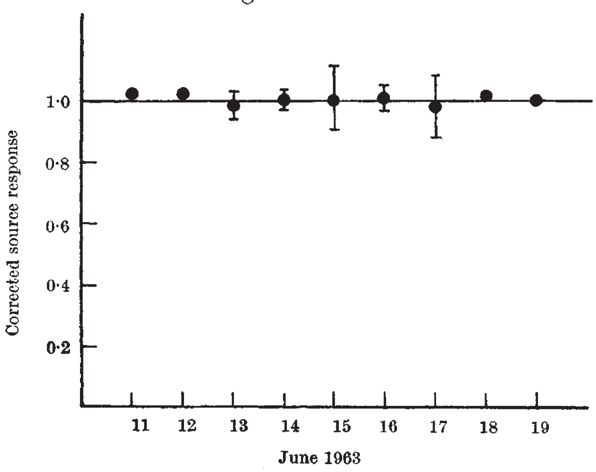

Fig. 2. Corrected response of the Crab Nebula. The error limits indicate uncertainties in removing the solar contribution. Results for hour angles ± 1 h have been combined in this figure

When the foregoing factors were taken into account in the analysis, no positive evidence for a variation in the source response, corresponding to an increase in angular diameter, was found (Fig. 2). The corrected source response remained constant to within 12 per cent, enabling an upper limit of 1·2′ to be set to the angular diameter of the scattered distribution in the east–west direction. The observations recorded here, therefore, give no evidence for the existence of enhanced scattering at centimetre wave-lengths which cannot be accounted for by the simple theory applicable at metre wave-lengths.

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PHYSICS

Charge Transfer and Excimer Formation

THE general properties of excited dimers, or excimers, have been well established[1–4]. In concentrated solutions of some polycyclic aromatic hydrocarbons, a singlet excited molecule can interact with an unexcited neighbour to produce the excited dimer, or excimer. This excimer can then break up into de-excited monomer molecules with the emission of a characteristic dimer fluorescence. The forces binding the dimer have been ascribed by Forster[5] to resonance dipole interaction. The criterion has been given for excimer formation that the molecule should possess a weak ^1L_b level lying beneath a strong ^1L_a level. Most of the excimer-forming molecules obey this criterion, a notable exception being anthanthrene.

It has been alternatively suggested[6] that the binding of the dimer may arise from charge transfer interaction in which one molecule donates charge to its partner or shares charge with its partner. In this picture the dimers behave like charge-transfer complexes and the excimer emission band is a charge-transfer band. It has been well established[7–9] that the frequency ν_{CT} of the charge transfer band is given to a first approximation by the relation:

$$h\nu_{CT} = I - E_A - \Delta \quad (1)$$

when I is the ionization potential of the electron donor, E_A is the electron affinity of the electron acceptor and Δ represents the various other interaction terms, including resonance dipole interaction, which are assumed small. If the excimer emission is to be explained in terms of charge transfer one would expect a similar relationship