

OPTICAL OBSERVATIONS OF SOLAR DISTURBANCES CAUSING TYPE II RADIO BURSTS

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During 1956-57, 15 type II radio bursts have been recorded on the Dapto radio spectrograph during times of observation with the Sydney H α flare patrol camera. We believe that we have established identifications of the optical disturbances responsible for 13 of these bursts, and alternative identifications for the remaining two. As Table I shows, some of these were

TABLE I

SUMMARY OF TYPE II BURSTS AND IDENTIFICATIONS

| Date | Harmonics Observed ¹ | Optical Event | Radial Distance ² | Velocity (km/sec) | Apparent Flare Area ³ |
|-------------|---------------------------------|---|------------------------------|-------------------|----------------------------------|
| 1957 Mar 1 | — | Ejected prominence | 1.00+ | 350,280 | — |
| Mar 26 | — | Ejected prominence | 1.00+ | 490 | — |
| Sep 24 | — | Flare-surge | 1.00 | ≥ 200 | 10 |
| Sep 24 | — | Surge | 1.00 | 670 | — |
| Jan 31 | 1, 2 | Disappearing filament followed by two parallel flares | 0.50 | — | 1050 |
| Nov 29 | — | Disappearing filament followed by two parallel flares | 0.95 | — | 600 |
| Aug 6 | 1, 2 | Diffusely expanding flare | 0.43 | — | 70 |
| 1956 Jan 19 | 1, 2 | Flare | 0.56 | — | 450 |
| Nov 13 | inadequate record | Flare | 0.77 | — | 385 |
| 1957 Nov 13 | 1, 2 | Flare | 0.59 | — | 170 |
| Nov 22 | 1, 2 | Flare | 0.61 | — | 385 |
| Dec 6 | 1, 2 | Flare | 0.75 | — | 350 |
| Dec 20 | 1, 2 | Flare | 0.34 | — | 175 |
| Jul 17 | 1, 2 | Flare or disappearing filament | 0.48 0.80 | — — | 220 — |
| Nov 6 | — | Ejected prominence or Flare-surge | 1.00+ 0.90 | 240 — | — 30 |

¹ Absence of a comment indicates that there was no evidence of harmonic structure.

² 1.00+ indicates that the base of the optical event lay behind the limb.

³ In millionths of hemisphere, uncorrected for any foreshortening.

prominences ejected at the limb. Some were disappearing filaments that ejected matter and were accompanied by the development of two parallel lines of flares, one on either side of the position of the former filament. Others were flares, almost all being particularly bright and showing some evidence of dark-hydrogen activity.

The limb ejections were of high velocity, exceeding the velocity of sound, 170 km/second, in ionized hydrogen at 10^6 °K. Two of them (1957 September 24) occurred in an active region, which, during the same day, ejected a number of other surges having velocities of 160 km/second or less. This evidence suggests that type II bursts accompany only supersonic ejections.

Heights may be obtained from the optical limb observations by assuming the ejection to lie in a diametric plane. Similarly, burst heights can be obtained by assuming the emission to be at the coronal plasma frequency or in its second harmonic, and by combining the electron density so obtained with the Allen-Baumbach electron-density distribution. In comparing the two sets of heights, it should be noted that there was no clear harmonic structure in any of the type II bursts associated with the limb events. In some cases, evidence from the height-time plots suggested that the emission was in the second harmonic; in others it favored the fundamental.

The theory of a spherically symmetrical corona, however, indicates that the fundamental plasma frequency should not be received from events originating very far from the center of the disk, though the second harmonic should be observable to the limb [1]. On comparing the position of the source with the presence or absence of definite harmonic structure, we find that both harmonics are usually present to about $0.8 R_{\odot}$ from the center of the disk, beyond which there is usually no evidence of harmonic structure. We think that in these latter cases it is the fundamental frequency that is missing.

In any case, the presence of the fundamental well away from the center of the disk indicates that the corona is by no means spherically symmetrical for the purposes of radio frequency propagation. This, and departures from the Allen-Baumbach model, may explain why some of the limb events give unsatisfactory height-time plots for the second harmonic. Perhaps also the optical observations may not have revealed the highest, faintest and fastest parts of the ejection.

REFERENCE

- [1] Wild, J. P., Murray, J. D., and Rowe, W. C. *Aust. J. Phys.* **7**, 439, 1954.