UNUSUAL ABSORPTION OF A SOLAR TYPE II BURST BY 'SHADOW' TYPE III BURSTS

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Abstract (*Proc. Astron. Soc. Australia*). The Hα-flare on 1968 August $23^d23^h45^m$ was followed by a short-lived type II burst. The radio spectrograph record obtained at Culgoora is shown in Figure 1. The type II burst was of split-band structure with unusual spectral features in each component of the split band. The most remarkable one is an absorption feature between $23^h52^m02^s$ and $23^h52^m10^s$: suppression of the bright type II emission along an 'inverted *U*' (between 120 and 85 MHz).

The present event was recorded also with the 80 MHz radioheliograph at Cul-

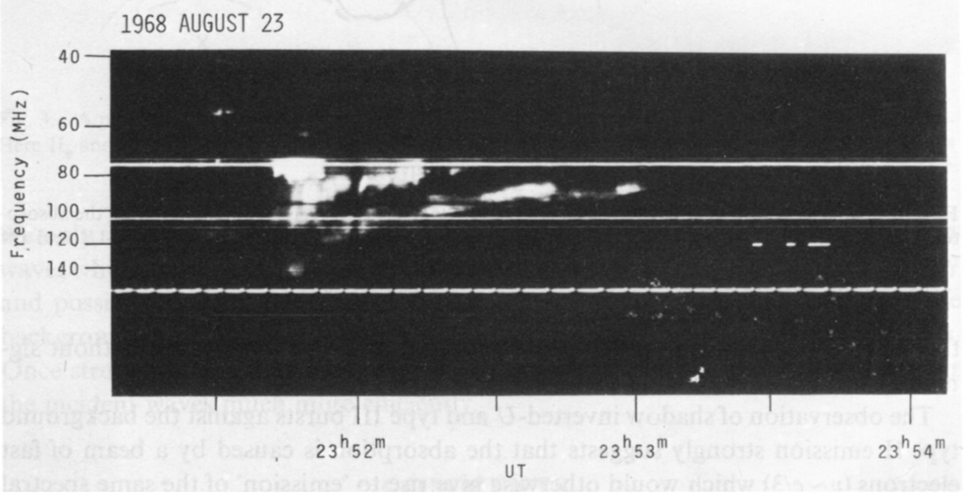

Fig. 1. Radio spectrograph record of the split-band type II burst on 1968 August 23. Note the unusual absorption features in the spectrum of the type II burst (particularly around 23^h52^m); which appear as 'shadow' bursts superimposed on the type II emissions.

goora. The lower-frequency band of the type II burst crossed 80 MHz between $23^h51^m50^s$ and $23^h52^m20^s$, the upper-frequency band later, at about $23^h52^m46^s$. The observed size (to half the peak brightness) is $\sim 12' \times 7'$ for each split-band source. The separation between the upper and lower band sources is $\sim 4'$. The most dramatic absorption at 80 MHz occurred between $23^h52^m02^s$ and $23^h52^m04^s$. The lower band of the type II emission was cut along a sharp dark lane which drifted from high to low frequencies with a drift rate (~ -10 MHz s^{-1}) similar to that of a typical type III

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burst. It is not clear, however, whether the dark lane is a shadow burst of type III or of the ascending branch of an inverted-U burst. Contour plots of the 80 MHz type II source are shown in Figure 2 for two successive seconds, just before and during the absorption. The observed maximum brightness temperature was $\sim 10^9$ K before the absorption; it then dropped by a factor of 5 to 1.8×10^8 K. It should be noted that

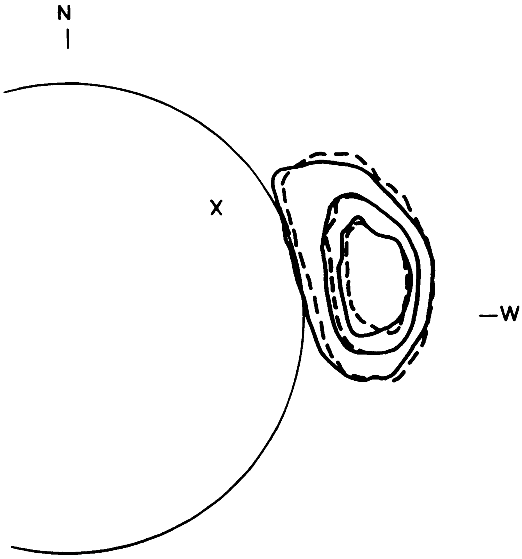

Fig. 2. Two contour plots of the 80 MHz type II burst taken successively, before and during the absorption (full line for $23^h52^m01^s$ and dashed line for $23^h52^m02^s$). The contours represent $1/\sqrt{2}$, 1/2 and 1/4 the maximum brightness.

this marked depression in brightness occurred during one second and without significant change of the source structure.

The observation of shadow inverted-U and type III bursts against the background type II emission strongly suggests that the absorption is caused by a beam of fast electrons ($v \sim c/3$) which would otherwise give rise to 'emission' of the same spectral type. Then, irrespective of the detailed mechanism, we have the following requirements for absorption. (1) The absorbing region must be on the observer's side of the type II emitting regions and of sufficient angular extent to cover the latter (both for the upper-frequency and lower-frequency band emissions, whose observed sources are separated by 4′). (2) The region must act as an absorber only when the fast electrons pass through the region. At such times its optical depth must increase to values of the order of 1. (3) The brightness temperature of the U and III bursts which are generated by the fast electrons in the absorbing region must be at least one order of magnitude lower than that of the type II burst.

A possible geometrical relation between the source regions of the type II and of the shadow bursts is schematically illustrated in Figure 3. The sources of the shadow bursts are in front of the type II sources along the line of sight: for the U-bursts the

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form is a large-scale magnetic loop. The heavy absorption of the type II emissions depends critically on the above, or other similarly stringent, relative positions and sizes of the emitting and absorbing regions. However, we have to recall that such events have rarely been observed.

We can offer no detailed model which would explain the absorption phenomenon.

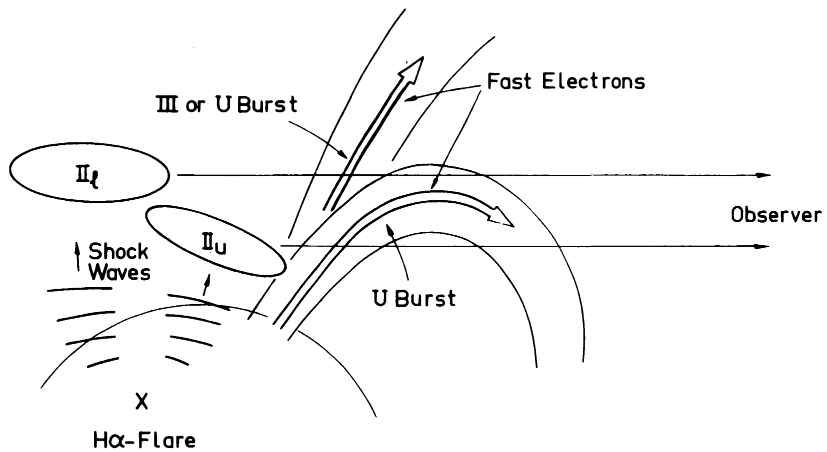

Fig. 3. A possible geometrical relation between the source regions of the type II and the shadow bursts. Here II_u and II_l indicate respectively the regions where the upper-frequency and lower-frequency bands of the type II burst are emitted.

We only suggest that the absorption or scattering takes place resonantly on plasma waves which are excited by a beam of fast electrons close to the local plasma frequency and possibly its second harmonic. In the absence of the beam, fluctuations of the background electrons scatter incident transverse waves only by negligible amounts. Once strong longitudinal waves are set up by the electron beam, they could scatter the incident waves much more efficiently.

COMMENTS

Uchida: Was there any indication or even a trace of brightening at the second harmonic on your dynamic spectrum at the moment of absorption by shadow type III probably through the interaction of plasma waves with frequency ω in the type III region caused by the particle stream and radio wave of frequency ω from the type II source.

Kai: There is no evidence of second harmonic emission. As computed by D. Melrose their intensity would be too small to be detected.

Rosenberg: How are you sure that you are dealing with a true absorption? I can show slides of the Utrecht spectrograph records where there is an awful lot of structure including 'black' type III's which could be taken as absorbing features.

Kai: I am afraid you could not see clearly the absorption along an 'inverted *U*' shape on my slide. If you looked at a better print of the spectrum, you would be convinced that we are dealing with a genuine absorbing feature.

Melrose: The theories of mine to which Dr Kai referred are as follows: The first theory is based on the assumption that the absorption is due to the inverse of the familiar plasma emission processes. Absorption at both the fundamental and the second harmonic are possible, but the latter occurs only under un-

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acceptably extreme conditions. Absorption at the fundamental requires that the two sources overlap, i.e., fill the same volume, in order to explain the observed bandwidth. The other theory is based on the assumption that the type III stream generates ion sound waves. This theory can explain all the details of Kai's observations, but the assumption that ion sound waves are so generated is not considered likely from the viewpoint of existing theories of the propagation of electron streams.

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