ABSORPTION OF 10.7-CENTIMETRE SOLAR RADIATION DURING FLARE OF MAY 19, 1951

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Sudden increases in the emission of radio waves from the sun occur frequently and many of these can be associated with the occurrence of solar flares. As yet no temporary diminution of radio waves has been reported and any evidence relating to this type of phenomenon will be of exceptional interest. Such a diminution of solar radio noise at a wavelength of 10.7 centimetres was recorded on May 19, 1951 at the Solar Radio Astronomy Observatory of the National Research Council in Ottawa, and occurred a few minutes after a typical burst of radiation had been observed at 19^h52^m U.T. (see figure 1). The uniqueness of the event was recognized just after it had occurred and resulted in a special check of the operation of the equipment by A. E. Covington, and the making of an additional calibration of the daily level. This check and calibration indicated that the instrument was working satisfactorily. However, the significance of this unusual feature was not fully appreciated until it was re-discovered in the record files by Helen W. Dodson and E. Ruth Hedeman during a recent visit to the Radio Observatory.

During the morning of May 19, 1951 the steady radio emission from the sun was measured at 13^h35^m U.T. and produced an equivalent temperature of the radiation resistance of the antenna of 500°K. This is equal to 2.15 flux units where one flux unit is 10^{-20} watts/m.^{2} cycle/sec. bandwidth. The flux as measured in the afternoon at 22^h50^m U.T. was 2.17 units. The difference in these two values is only slightly more than the scatter to be expected in making independent calibrations, and has little significance. The emissive part of the burst of radio noise shows typical variations that have been observed frequently in similar bursts recorded in the past[1]; both the intensity of the burst, 2.3 flux units, and the duration, 16 minutes, are average. The absorption of radio waves might be considered to start at 20^h12^m U.T., to reach a maximum depression of 0.17 flux units at 20^h30^m U.T., and to be over by 21^h15^m U.T.

The depression is only a small fraction of the steady daily level, 0.8 per cent., and may be interpreted as representing the temporary removal of an emissive region. The daily level of the radio noise at 10.7 centimetres consists of two parts; one component originating from the inactive solar disk which has a constant intensity for long periods of time, and a second

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component from the vicinity of sun-spots and *plage* areas which has an intensity related to the sun-spot area (correlative coefficient: 0.95). For this particular day and year, the quiet sun emission was 34 per cent. of the daily level. The 8 per cent. observed diminution in flux can therefore be considered to constitute a reduction of 12 per cent. in the radiation associated with the sun-spot regions.

Intercomparison of radio and photographic observations of the sun for May 19, 1951 indicates that this unusual decrease of radio emission took place during the post-maximum phase of an equally unusual solar flare which was observed and studied at the McMath-Hulbert Observa-

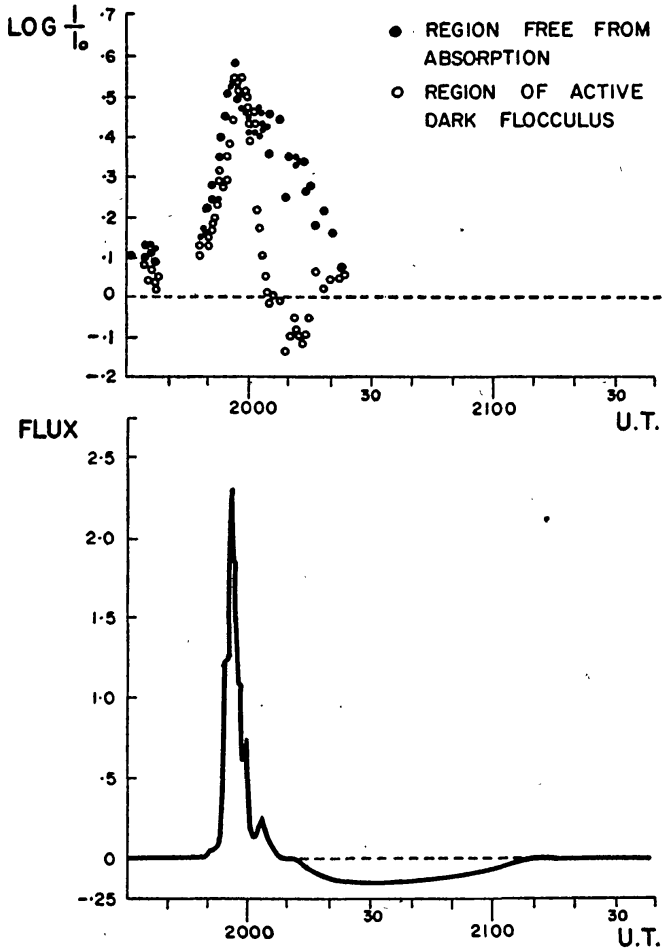

FIG. 1–May 19, 1951. *Upper diagram*: Photometric light curves, Hα flare. *Lower diagram:* 10.7-cm. radio emission.

tory.[2] The flare was judged to be of importance 3–, covered 1350 millionths of the solar hemisphere, and was 3.5 times as bright as the undisturbed Hα disk (1.25 times as bright as the neighbouring continuous

spectrum). All flares of importance are in a sense unusual solar events, but this flare on May 19 was exceptional because of the extent and location of the active dark flocculus that developed just after Hα maximum had been attained. The dark flocculus (prominence material observed in projection against the disk) was at least 125,000 km. in extent and part of it lay directly over the flare. Figure 1 shows the photometric light curve for a part of the flare apparently free from absorption and a second curve for a region in the flare where the intensity was greatly modified by the overlying material. This latter region faded rapidly from flare maximum and for a short time was darker than the undisturbed Hα disk. The Hα absorption became apparent as early as 20^h02^m U.T. Photographic observations were stopped at 20^h25^m, but the dark flocculus was still visible at that time. The flare and active dark flocculus here described are shown in figures 2 and 3.

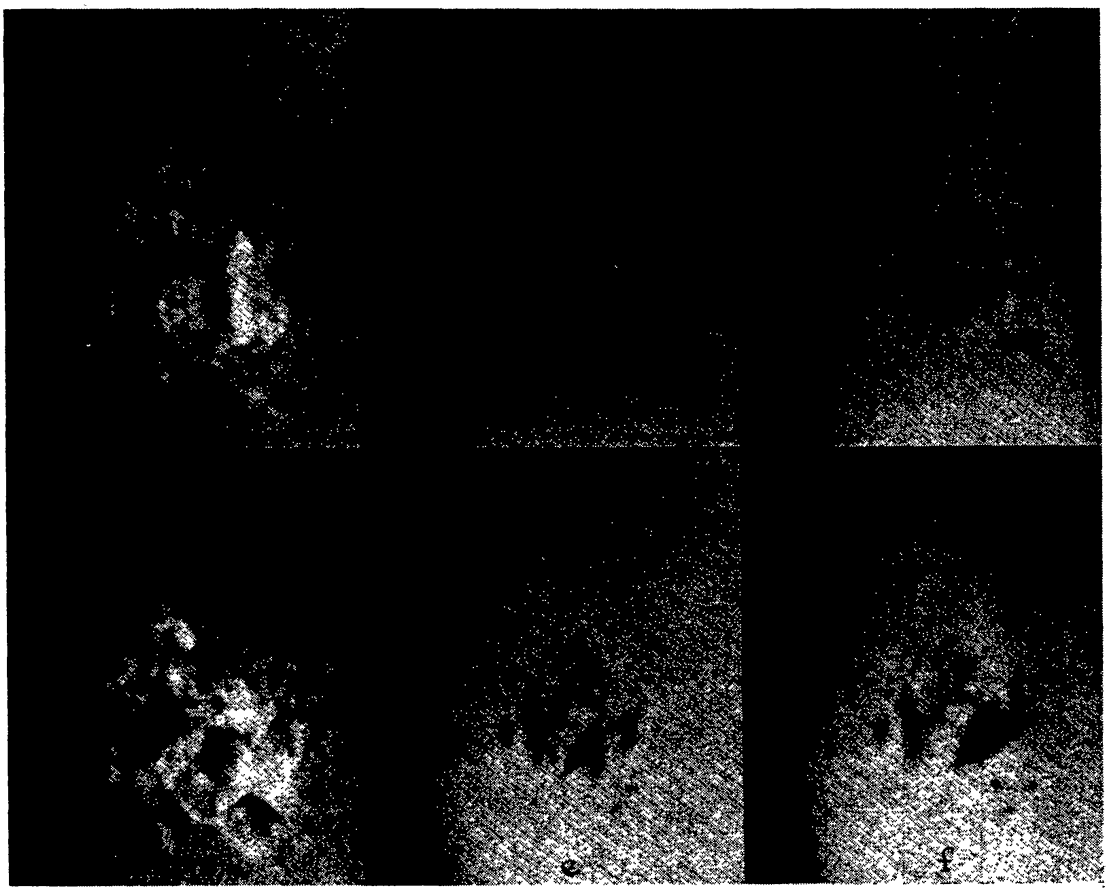

FIG. 2–May 19, 1951. Spectroheliograms showing flare and associated dark flocculus. (a) 19^h56^m; centre of Hα; (b) 20^h08^m; 2A. to violet of Hα; (c) 20^h08^m; 2A. to red of Hα; (d) 20^h06^m; centre of Hα; (e) 20^h19^m; 2A. to violet of Hα; (f) 20^h19^m; 2A. to red of Hα.

(Courtesy, *The Astrophysical Journal*, vol. 115, p. 320, 1952.)

It was during the course of this flare and active dark flocculus that Mohler[3] found the unprecedented twenty-fold increase in the equivalent width of the infra-red helium absorption line, 10830A. The unusual helium absorption was recorded at 20^h06^m and 20^h09^m U.T.

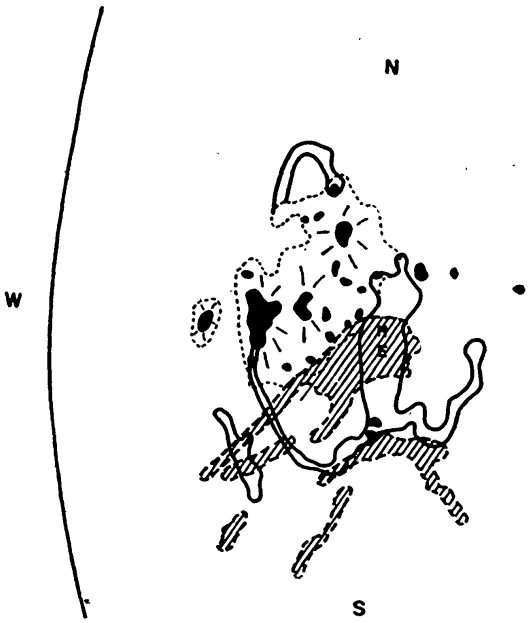

FIG. 3—May 19, 1951. Composite diagram showing spot group, flare *(full outline)*, active dark flocculus *(shaded)*. *E* indicates apparent region from which material was ejected; *H* indicates position of spectrograph slit for helium observations by Mohler. (Courtesy, *The Astrophysical Journal*, vol. 115, p. 320, 1952.)

The occurrence of active dark flocculi in the post-maximum phase of Hα flares is a well established and usual phenomenon. The mere existence of the flocculus is evidently not sufficient to introduce a distinct diminution of flux in the 10.7-centimetre solar radiation.

For example, a flare of importance 2+ occurred on May 18, 1951 near the same spot group as the flare of May 19 just described. This earlier flare was also accompanied during the post-maximum period by a large active dark flocculus at least 120,000 km. in length. The 10.7-centimetre solar radiation for this period shows a burst with the typical post-burst increase but no evidence of absorption. (See figure 4.)

Detailed comparison of the photographic records of the temporary, active dark flocculi accompanying these two flares brings out the following similarities and differences:

1. The dark flocculi on the two dates were comparable in extent.
2. The velocities were of the order of ± 100 km./sec. on May 18, and ± 180 km./sec. on May 19.

3. On May 18 the dark flocculus was not superposed on any part of the flare and lay principally outside the large, stable bright *plage* region that surrounded the spots. On May 19 the dark flocculus covered part of the flare and lay principally over the bright *plage*.

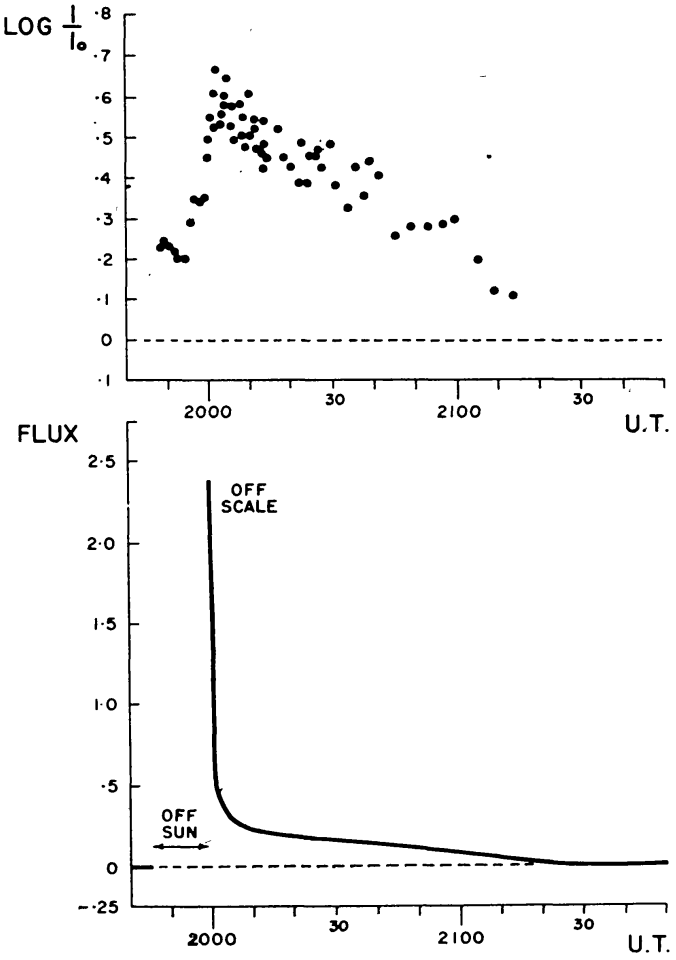

FIG. 4–May 18, 1951. *Upper diagram:* Photometric light curve, Hα flare. *Lower diagram:* 10.7-cm. radio emission.

4. In neither case did the dark flocculus appear superposed over the spots themselves.

The possibility of a reduction or modification in the flux of 10.7-centimetre solar radiation by overlying prominence material, as here suggested, must be borne in mind in further studies of 10.7-centimetre data.

REFERENCES

1. *Jour. Roy. Astro. Soc. Can.*, vol. 45, p. 15, 1951.
2. *Astrophysical Journal*, vol. 115, p. 320, 1952.
3. *Astrophysical Journal*, vol. 115, p. 323, 1952.