SOLAR HYDROGEN "BOMBS"[1]

By FERDINAND ELLERMAN

Visual and photographic observations of a solar phenomenon which had previously escaped our attention have been carried on at this observatory during the past two years.

On September 21, 1915, while the writer was observing the Hα line for reversals and distortions in an active spot-group, there suddenly appeared a very brilliant and very narrow band extending four or five angstroms on either side of the line, but not crossing it. In a couple of minutes it faded away and was not seen again. A month later, on October 21, more observations were recorded and a spectrogram was secured.

On the first occasion the appearance was so extraordinary that it seemed hardly real; after the second observation, however, the existence of such phenomena as part of the solar activity seemed established, and a search has been made for them whenever conditions of seeing and other work have permitted.

There are two conditions essential for observation—good seeing and a large solar image—as the area of the phenomenon, even with the 16-inch image of the sun at the 150-foot tower telescope, is so small that only with difficulty is the point of disturbance kept on the slit.

The appearance of the phenomenon indicates something in the nature of an explosion, in which hydrogen seems to be the only element playing a part. The duration is only a few minutes—from one to three on the average, and from five to ten minutes rarely. This sudden performance suggested the name of hydrogen "bomb," which we have adopted to designate it.

In the *Astrophysical Journal*, **30**, 78, 1909, Dr. Walter M. Mitchell gives an account of solar observations made at Haverford College Observatory, together with a drawing which illustrates the appearance of Hα in the spectrum of a "bomb," and from his

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description there seems to be no doubt of its being such. This is the only recorded observation of the kind that has come to our notice, and it must have been an unusually large one to have been seen with the instrument used by Dr. Mitchell. Furthermore, he mentions D_3 as showing the band, while our observations have failed to detect it.

While the average width of the Hα band is about 8 A, in an exceptional and probably an extreme case it was as wide as 30 A. In general the band appears symmetrical on each side of the line, but in a few measured cases the extension was greater on the violet side than on the red. In none have we found greater extension on the red side.

The regions where the "bombs" are likely to appear are around and among active spot-groups, especially groups which are developing and composed of many members. In such groups they appear at the outer edge of the penumbra, or at points between the spots, and also at small distances to one side. When a "bomb" appears and fades away, the point of disturbance should be kept under observation, as it is very probable that others will appear in the same place. At times they seem to follow one another like the balls of a Roman candle at intervals varying from ten to twenty minutes or more.

They frequently appear in the faculae so that their spectra are superposed on those of the faculae, thus giving the appearance of great extension to the bright "bomb" band. On rarer occasions they are superposed on bright reversals of Hα over eruptive regions, but this is an uncommon occurrence, and the distinction is easily made between the two phenomena by the flickering of the "bomb" band compared to the Hα reversal, due to the effect of seeing.

The observations have been confined mainly to Hα, although D_1, D_2, D_3; b_1, b_2, b_4; Hβ and Hγ have been examined. None but the hydrogen lines have shown the band. Hβ has been photographed and shows the band fairly well, but not as well as Hα nor of as great width. Hγ also shows the band, but less clearly than Hβ.

The level at which the "bombs" occur must lie well below the reversing layer, as the hydrogen absorption line is not affected by them, nor do they seem to affect the other Fraunhofer lines.

In Plate XVI, *a* and *b*, are shown spectra of "bombs" which appeared in regions where the Hα line shows considerable distortion due to radial velocities of the hydrogen flocculi. It will be noted that the "bomb" bands do not extend as far on each side of Hα as mentioned above, but this is to be expected, as it is impossible to guide and keep the image of the "bomb" on the slit perfectly during the entire exposure, and the fainter extensions which are easily observed visually are lost in the photograph. Plate XVI, *c*, shows the "bomb" band superposed on the spectrum of a facula, and in *d* are shown two bright reversals of Hα near a small spot, to illustrate the difference in appearance between ordinary eruptive reversals of Hα and the bright band due to "bombs."

MOUNT WILSON SOLAR OBSERVATORY
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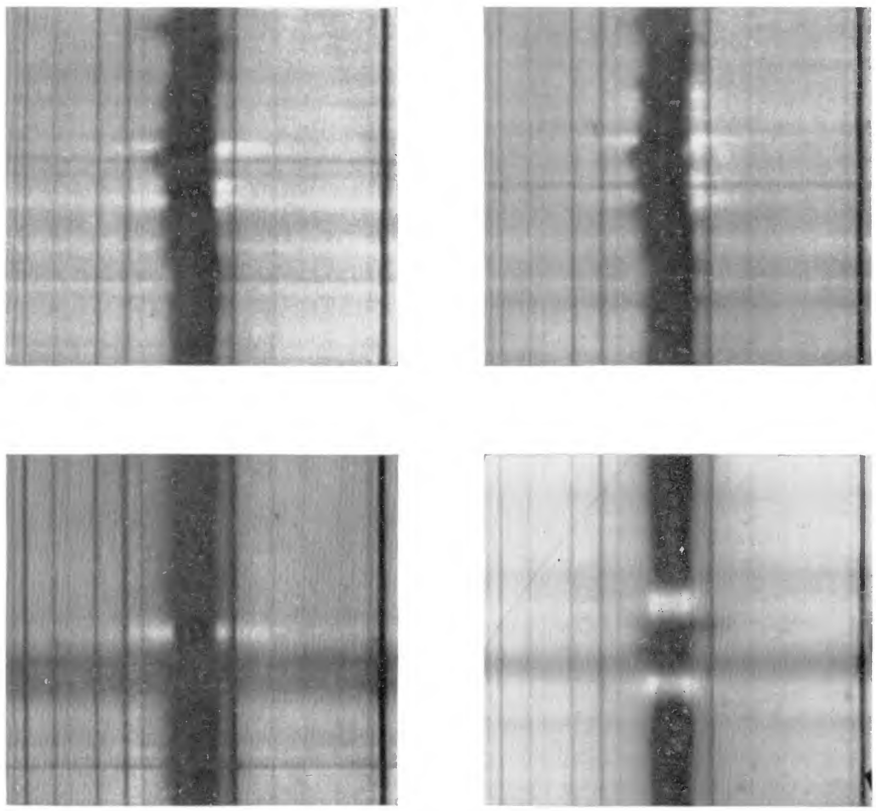
PLATE XVI



a and *b*. Appearance of the Hα line in an active sun-spot region, showing the bands of "bombs" and the distortions of the line.

c. Spectrum of a "bomb" (close to the dark Hα line) superposed on the spectrum of a facula.

d. Appearance of reversals in an active region.