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SUNSPOT EVOLUTION IN THE VICINITY OF A LARGE SOLAR FLARE IN AR 6891

Y. M. ALMLEAKY, A. A. MALAWI, AND H. M. BASURAH
Astronomy Dept., P O Box 9028, Fac. of Science, KAAU, Jeddah 21413, KSA

ABSTRACT

Utilizing a Calcium filter, a large two ribbon flare of an importance 2.5X/3b was recorded at King Abdul-Aziz University Solar Observatory (KAAUSO) at the 30 th of October 1991. This chromospheric flare observation, which is of special importance since it is rarely reported, was for a flare that occurred near the south west of the equator at the vicinity of a large sunspot group on an active region known as AR 6891 . The observed foot points of this flare had a strange behavior in which the separating motion of the ribbons were not typical of most flares, rather were nearly orthogonal. In this article we present the characteristics of the main sunspot group of this active region, and try to investigate its evolution and fragmentation with time. Information regarding magnetic fields and velocity fields are necessary to understand the restructuring of the magnetic field pattern and plasma motion, and hence the changes that could lead to the occurrence of such an interesting flare.

I. INTRODUCTION

It is well known that flares are closely associated with the rapid release of magnetic energy. This energy is stored in the stressing of magnetic field configurations in active regions, e.g. the vicinity of sunspots. Although shearing or rotating of magnetic field tubes and their effect on existing flux tubes are usually considered in investigating energy release, however, new emergence of magnetic flux is known to play a very important role in this process (Zirin 1983, Schmieder 1994). These chromospheric observations are considered to be important in investigating solar flares, since they are closely related to the magnetic field of the chromosphere rather than that of the photosphere. In this article we will provide some images taken for a large two ribbon flare, as well as some drawings for the active region in which the flare took place. Our prime goal is to investigate the sunspot changes in relation to the observed ribbons. In addition, we also try to discuss the relationship between this flare and the behavior of velocity and magnetic field of the region, which might lead to an understanding of the unusual spreading motion of the flare ribbons. Solar physicists have been extensively studying inorede to answer some of the questions regarding the spatial correlation between flares and both velocity and magnetic configuration (e.g. Sweet 1958, Parker 1957, Rust 1976, Chen et al 1994, and Schiemder 1994).

II. INSTRUMENTATION AND DATA COLLECTION

The event was observed on October the 30 th, 1991 at 6:15 UT in the solar laboratory of KAAUSO using a lynexx 2 CCD camera with a singly ionized calcium filter (Ca II K; 3933 A). The onset time of the flare , the maximum and the end were at 6:11, 6:34 and 9:35 UT respectively, and at a position (S08 W25). Observations of this activity lasted for more than three hours (6:15 - 9:35 UT) , during which more than 90 images have been taken at the different phases of the event. The flare began as an irregular bright point near a large F sunspot, which occurred at highly active region known as NOAA 6891. In fig. 1, three images have been provided, indicating the development and the apparent motion of the flare ribbons (Fa and Fb), as well as the active region in question. Figure 1(a), with a field of view of 11x18 arc minute, (b) and (c) were taken at 6:22, 6:35 and at 7:27 respectively. It is clear from these figures that both ribbons have developed near the north-west of the main sunspot group, and that the ribbon Fa has a longer life time than Fb. In addition these figures show the umbrae of the main sunspot group, which could be clearly seen in figure 2. The sunspot observations were collected at KAAUSO, by using a 6 inch Code telescope. Moreover, sunspot drawings and images for three days, 28-30, have been collected from different observatories; Meudon observatory, Sayan observatory, and UCCL, as could be seen in figures 2.

III. SUNSPOT EVOLUTION IN AR 6891

This active region consisted of a large sunspot group, and could be seen clearly in figure 2; figure 2a shows the sunspot group drawings taken at Sayan observatory on the 28 th of October 1991, at 12:12 Ut. Figure 2b is a drawing for this sunspot group on the 29 th, taken from Meudon observatory at 12:4. Meanwhile, the sunspot group at the day of the event (30 October 1991) as shown in figure 2c have been collected from KAAUSO , Sayan observatory and compared with that taken from Meudon observatory. the fragmentation of the sunspots as well as the rapid change in their shape and sizes could be seen by following figure 2. The active region became visible as three large sunspots (designated A, B, and C) very close to each other, and appeared on 28. Three medium ones can be seen at the north west of spot A, three others at the south east of B, and two at the south east of spot C. In addition, many smaller ones scattered around A, B, and C. On

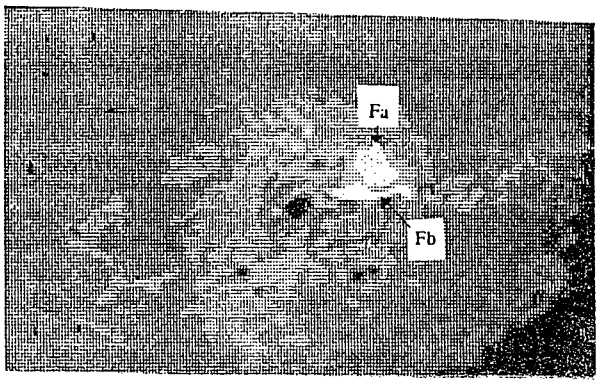

Fig. 1a.— A CCD image showing the AR and the flare evolution at 6:22 UT. The two ribbons designated Fa and Fb, and the field of view is 11"x18".

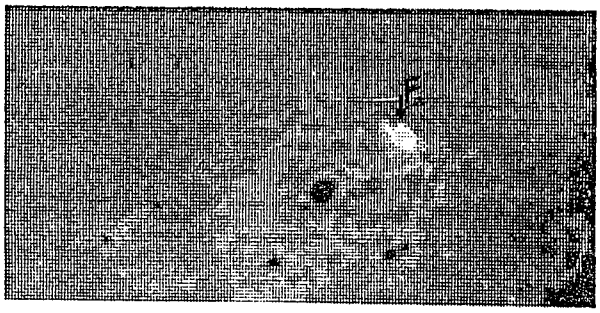

Fig. 1b.— A CCD image showing the AR and the flare evolution at 6:53 UT.

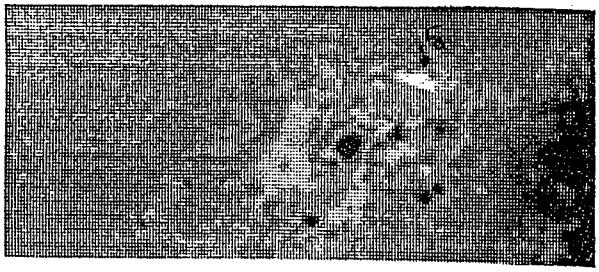

Fig. 1c.— A CCD image showing the AR and the flare evolution at 7:27 UT.

Fig. 2a.— The sunspot group in the active region, taken at Sayan observatory on the 28 th of October 1991, at 12:12 UT.

Fig. 2b.— The sunspot group in the active region, taken at Meudon observatory on the 29 th of October 1991, at 12:45 UT.

Fig. 2c.— The sunspot group in the active region, taken at KAAUSO, Sayan observatory, and Meudon observatory on the 30 th of October 1991.

the next day, spot A has split into two large ones(A1, A2), where A2 has more rounded shape than the other. Meanwhile, the medium size spots at the south of A1 have split into four rather than three as in the previous day, and one of the three north of A2 has been fragmented into smaller ones. On the day of the event totally different changes have occurred to the active region, in which spot A1 and B changed in structure as if they were engulfing spot A2 (which has a more circular shape than the preceding days). the umbrae of spot C, on the other hand, has been fragmented into many smaller ones, this was also the case for spot B, indicating magnetic field restructuring which could lead to shearing of field lines, Schiemder et al 1994. Between both spots B and C a group of smaller ones have appeared which may indicate the emergence of a new flux, which could lead to the trigger of the flare . It is at the north of spot B that the flare has taken place In a work by Chen et a1 (1994) they presented for this active region (AR 6891) the magnetograms and Dopplergrams in both the photosphere and the chromosphere, figure 4a of their paper could be compared with figure 1a and 2c of this paper. They discussed the relation between flare ribbons, which has been designated as K and L at figure 4e, to the magnetic and Velocity field patterns . From the Dopplergrams of this region they showed that the two flare ribbons Fa and Fb where associated with very complex structures of velocity fields and covered both red-and blue-shift areas. By comparing Dopplergeam and magnetogram for this region, c.f. fig. 4c of Chen et al and fig 1a of this paper, it is shown that the velocity field of the flare ribbon Fa is very complex and positioned in the blue-shift side of the velocity inversion line . By investigating the spreading motion of flare ribbons with time, c.f. fig. 3 in Basurah et al 1995, it is noticed that the motions are not typical of most flares, where they were orthogonal rather than the usual oppositely directed spreading motion. Flare ribbon Fa, for example, has spread out with time at the north west direction, meanwhile Fb elongated in both east and west directions. This strange behavior made those observations unique and interesting.

IV. SUMMARY

an unusual spreading motion of a two ribbon flare have been observed at KAAUSO at an active region which is known for its high productivity of flares. The evolution of the sunspot group under consideration has been discussed and investigated. Photographs, drawing and important data have been collected from many different observatories to help in studying and analyzing this unique event. It is shown, that both magnetic and velocity fields are important for flare production and formation, and that more observations and studies are necessary to understand such event.

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REFERENCES

Basurah, H. M., Malawi, A. A., Almleaky, Y. M., and Kamal, F. 1995, Solar Phys. 158, 383

Chen, J., Huang, Y., and Liu, Z. 1994, Solar Phys. 150, 179

Cugnon, P. 1994, Privat communication

Rust, D. M. 1976, Phil. Trans. R. Soc. Lond. 281, 427

Schmieder, B., Hagyard, M. J., Zhang, H., Ai G., Gyori L., Rompolt, B., Demoulin, P. Machado, M. E. 1994, Solar Phys. 150 199

Zirin, H. 1983, ApJ, 274, 900