AN ACTIVITY PATTERN OF AR NOAA 9026 DURING THE LAST HALF OF ITS EVOLUTION

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***Abstract**:*

We have studied the evolution of active region NOAA 9026 by processing and analysis of white-light images and H_α filtergrams obtained in Astronomical Institute in Wroclaw (Poland). For determination of the full picture of activity events during the active region evolution the data from BBSO, GOES and Palma Reports were used. The sunspot evolution, filament and flare activities were summarized. The analysis of LASCO and EIT (SoHO) data suggests possible interrelations between associated with active region coronal mass ejections and filament eruption, as well as some X-flares in this region.

Introduction

The active region (AR) NOAA 9026 was observed on the solar disk from 02 to 12 June 2000. For the first time during this solar cycle, the Sun display a spectacular fireworks of many flares going off in close succession from one and the same active region.

The AR 9026 was observed in Wroclaw Astronomical Institute (Poland) from June 7, 2000 when it was located near the central meridian, to June 11, 2000. The registrations in white light and H-alpha were made. The observational data was processed with the Joyce Loeble microdencitometer in NAO Rozhen (Bulgaria).

For more detailed study of the active region evolution from its first appearance to its decay the BBSO Solar Activity Reports, GOES event list, and Palma Reports data were used.

Our aim was obtain a full picture of activity events, as well as some possible interrelations between them during the evolution of AR NOAA 9026.

Sunspot evolution:

The AR 9026 was observed for the first time at the E-limb on June 2, 2000. Its location was near N19E75. At the moment of its appearance the AR was observed as two well shaped sunspots with distinct penumbra. The

Maunt Wilson magnetic configuration was beta-gamma with possible delta configuration located on the southern edge of the leading spot.

There is a slight increase of magnetic complexity on June 5, 2000, which was change to large beta-gamma-delta region and strong delta configuration in leading spot. The leading part of the region was much larger and developed than the following one. The middle part contains a great number of sunspots with a common penumbra. The large sunspot in the eastern part of the AR has clearly expressed, regular shaped penumbra, with a magnetic polarity coincident with polarity of the polar magnetic field. This spot remains near constant in shape and dimensions over the time of observation.

On June 7, 2000 the AR 9026 was located near the central meridian at N20W02. On this date the sunspot group in AR has a complex beta-gamma-delta configuration. There is not a significant change in sunspot area and count.

A slight decrease of sunspot group dimensions is remarked on June 8. This variation is accompanied of the decaying of the leading part of the sunspot group and the breaking of the penumbra in the middle.

Rapidly decaying sunspot group shows little or no activity on June 9. The breaking of the penumbra in the middle part continues and the distance between sunspots increase. The leading part was already break up. Maunt Wilson classification has changed from β-γ-δ to β-γ.

On June 10 the sunspot group is rather simplified, containing some sunspots with penumbras.

Filament activity

Figure 1 shows the H-alpha filtergrams, made in Wroclaw Astronomical Institute. There are some quiescent filaments in the close proximity of the active region. Two of them exhibit a partial DB (disappearance brusque or sudden disappearance) and DB, respectively, on June 6, according to the Synoptic Maps of Solar Activity of the Meudon Observatory. During this day the imaging telescope EIT on board of SoHO observed the flare and filament eruption beginning at about 15:12 UT. There was also an earlier X1.1 flare and filament eruption from the same region at about 13:36 UT. Some of these quiescent filaments could be used to trace the area of solar rigid rotation near the active region in our future work.

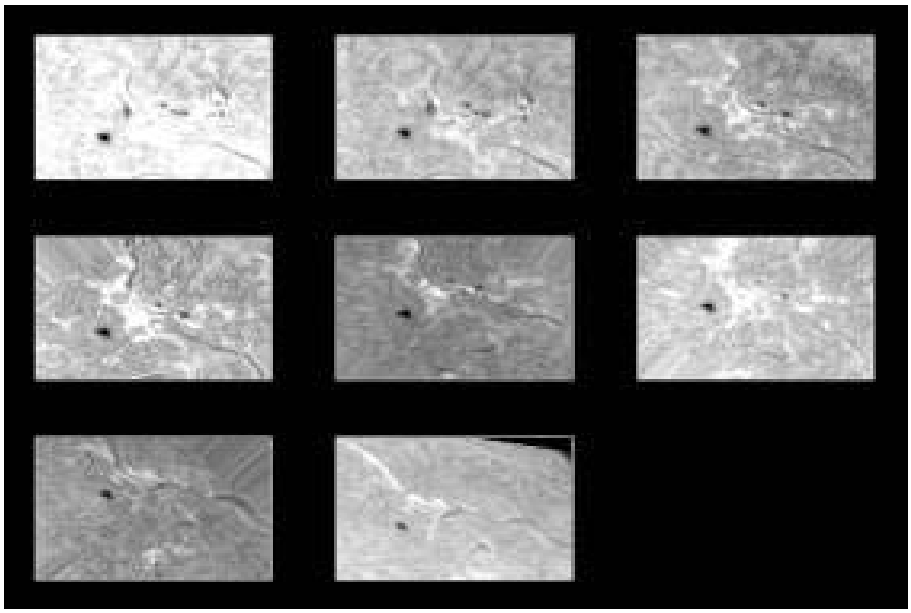

Fig 1. Filament evolution between June 7, 2000 and June 11,2000.

Flare activity:

The Table 1 shows chronologically the flares, associated with AR 9026. There are given the X-ray class of the events and the corresponding optical flares. A count of radio burst is presented too. We are used the GOAES event listing and the Palma reports.

A great series of flares was registered on June 6, 2000. The X-ray flare at 15:12 UT and this one at 13:36 UT were registered by EIT. There are another X-ray flares observed by EIT on June 7. The flare morphology was different than both X flares on June 6. It is not so much compact as the X2.3 flare and extends over a different region that the X1.1 one.

The C-class activity continues on June 8. There are not registered X-ray flares on June 9, 2000.

Fig. 2 represents H-alpha filtergram with the relative positions of the flare sites on the June 7.

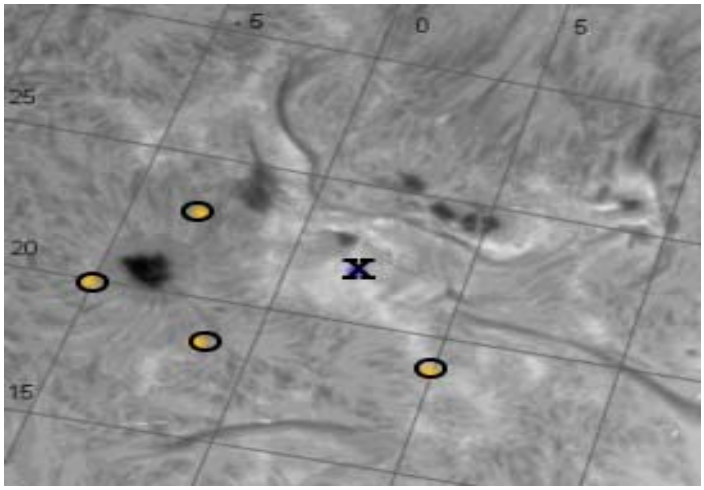

Fig. 2: Relative positions of the flare sites on the June 7, 2000. The circles marks optical flares and the cross mark X-ray flare.

Table 1.

Date	Peak time (UT)	X-ray class	Optical flare	Location	Count of Radio burst
1-JUN-00					5
2-JUN-00	19:38	M7.6			20
3-JUN-00	01:49	C7.0	SF	N20E57	11
	06:47	C4.6	SF	N20E54	
	14:24	C7.6	SF	N18E51	
	17:00	C3:0	SF	N17E49	
	19:24	M6.1	2B	N20E49	
4-JUN-00	04:32	C8.4	SF	N23E49	2
	20:18	C1.8	SF	N21E37	
5_JUN-00	11:30	C2			
	14:00	M1.5			
	18:35	C3.8	1F	N19E22	
6-JUN-00	08:36	C2.8	SF	N21E16	26
	08:51	C2.4	SF	N19E14	
	13:19	M2.7			
	13:39	M7.1			
	13:36	X1.1			
	15:25	X2.3			
7-JUN-00	15:53	X1.2	3B	N23E03	11
	15:53	X1.1			
8-JUN-00	04:36	C2.0	SF	N21W06	9
	05:28	C2.2	SF	N20W10	
	15:56	C1.7	SF	N20W11	
10-JUN-00	17:02	M5.2	3B	N22W38	13

Related activity:

Some enormous Coronal Mass Ejections (CME) were associated with active region passage on the solar disk – on 6 June, 7 June and 10 June.

On June 6, 2000 LASCO and EIT (both on board of SoHO) observed a full halo CME. The event was first visible at all position angles in C2 LASCO chronograph field of view at 15:54 UT. It appears as a bright front, particularly over the N pole, with trailing filamentary material. The plane-of-sky speed of the leading edge of the halo is about 908 km/s. It was supposed that the event was associated with an X2.3 flare and filament eruption in AR 9026 during this day.

LASCO and EIT registered another halo CME on June 7. The event was first visible as a faint diffuse front in C2-chronograph field of view at 16:30 UT. The CME was probably associated with an X1.2 flare in AR 9026, located near central meridian at about N20 E02. The plane-of-sky speed was about 411 km/s.

Conclusions

This study of AR NOAA9026 brings out the full picture of its evolution at different heights in the solar atmosphere. We follow the sunspot, filament and flare evolution in the region, as well as the coronal response.

The next step of this study will be to determine the Doppler shifts and to precise the pre-flare conditions. We will search for area of rigid rotation (pivot-point) near the region using the quiescent filaments as tracers. Because of the very high flare activity, related to this active region, the availability of pivot-point is very likely.

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