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Possible II Type EP by Its Kinematic Characteristics

K. Koleva, M. Dechev, P. Duchlev

Institute of Astronomy, Bulgarian Academy of Sciences, Sofia 1784, Bulgaria

Abstract. The morphology evolution of a prominence during its eruption on August 14, 2001 observed in the Astronomical Institute of Wroclaw University was analyzed. The basic parameters of the eruption process were determined. The prominence evolution during the eruption, as well as the kinematic pattern of the eruption compared with the morphology and kinematics of the eruptive prominences of type I and II suggests that the studied prominence belongs to II type of eruptive prominences.

1 Introduction

According to B. Rompolt [1] the eruption of quiescent prominences (QP) is forced by the eruption of huge magnetic systems (HMSs). Cool and dense plasma of QP in most cases is frozen only into a part of such a HMS – before as well as during the eruption. During the HMS eruption the frozen-in prominence material is also lifted up.

Two different types of prominence eruption can be distinguished according to Rompolt 's classification: [1], [2]

Type I: EPs seen in the shape of a large arch during the eruption. This large arch is formed by a number of fine filaments often twisted or intertwined. The EP of this type is located just in the lower part of the associated CME big bubble.

Type II: EPs which erupt in one arm of the associated HMS. They change the inclination of their main body from being roughly parallel to the limb at the beginning of eruption, up to being perpendicular in the late phase. The EP of this type is located in one leg of the associated CME big bubble somewhere near its internal boundary.

In this work we describe results from investigation of kinematic character of the EP of 14 August, 2001. Relations between the EP and another activity events are considered.

2 Data and EP Description

2.1 Observational data-processing and analysis

The prominence eruption was registered on August 14, 2001 in the H_α hydrogen line with the Small Chronograph (130/3450) at the Astronomical Institute of Wroclaw University. The erupting prominence was observed at the Eastern limb (N22-E, CR 1979). Figure 1 shows the morphological evolution of the prominence during the eruption.

The H_α filtegrams were digitized with the automatic Joyce-Loeble MDM6 microdensitometer at NAO Rozhen, Bulgaria. The two-dimensional scans were taken with pixel size of 20 microns and step of 20 microns between the pixels in both directions.

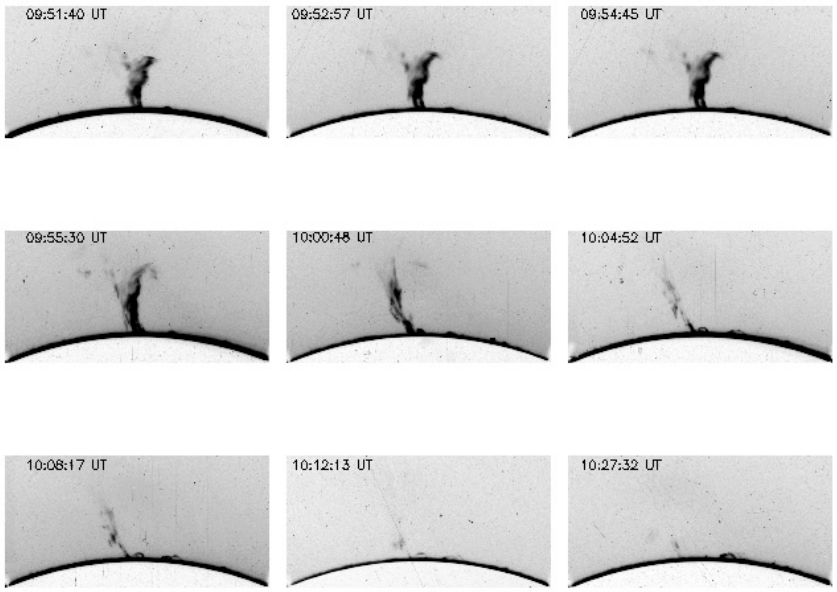

Figure 1. The evolution of the EP of 14 August 2001, between 09:51UT and 10:28 UT

2.2 EP location and identification with a filament

The prominence was registered on August 14, 2001 between 09:52UT and 10:28 UT at the eastern limb (N22-E). Figure 2 shows a fragment of Meudon synoptic map for Carrington rotation 1979 with eastern limb position on 14 August 2001

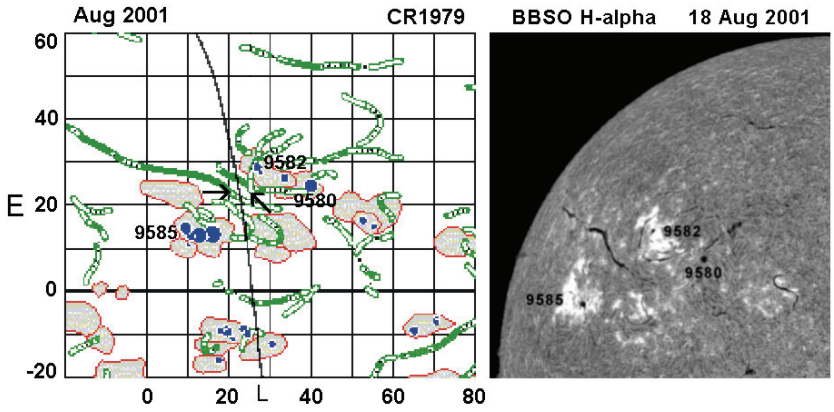

Figure 2. Active region NOAA 9580, 9582 and 9585 and the EP on August 14, 2001: **Left** – a part of Meudon synoptic map for Carrington rotation 1979 with indicated Eastern limb on August 14, 2001 and active regions with NOAA numbers; **Right**– BBSO H_α image on August 18, 2001. The arrows on the synoptic map indicate the two filaments seen on the limb on August 14, 2001, one situated between NOAA 9582 and 9585, and the second one in NOAA 9582. One of them is possibly the EP registered on August 14

and the BBSO H_α specrtoheliogram for 18 August 2001, representing the filaments and active regions (ARs) around the EP position at the solar limb. The EP can be associated either with a southern end of active region filament located in AR 9582 ($\approx 3^\circ$ before the EP limb position) or with a part of a long filament located between ARs 9582 and 9585 ($\approx 3^\circ$ behind the EP limb position). These parts of the filaments are indicated with arrows on the Meudon synoptic map. The choice is very difficult because the parts of the filaments are located before and behind the limb plane at the same distance.

3 EP Kinematics

The qualitative analysis of the prominence eruption evolution, as well as its initial big height suggests a later registration of the EP before the eruption onset. For determination of the height-time dependence of the EP, measurements of two points, the most upper diffuse and the most upper bright ones were made.

Figure 3 shows the height of the diffuse and bright points of EP as a function of time. The behavior of the diffuse point height is additional argument that the EP was observed in the late stage of the eruption when the EP raises from 120 000 km to 235 000 km. As another argument of this opinion is the constant velocity of the EP raising estimated by the linear last square fit of ≈ 100 km/s. The bright point height shows opposite behavior. The brighter and therefore denser prominence plasma fall back to the chromosphere with constant velocity estimated by the linear last-square fit of ≈ 70 km/s.

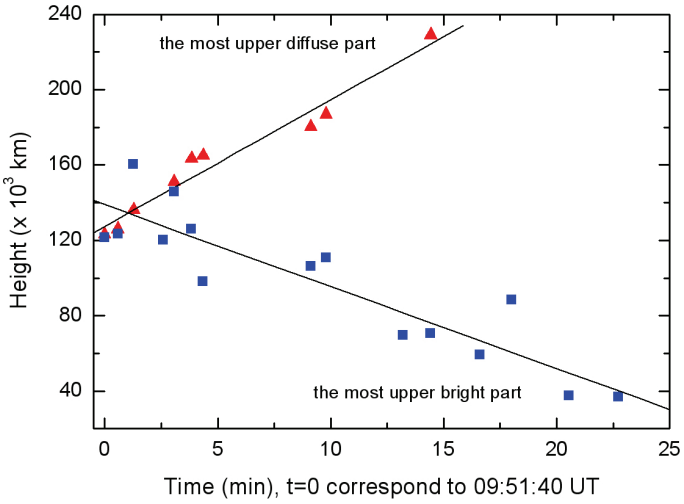

Figure 3. Height-time diagram, showing the change of the height of the most upper bright and the most upper diffuse part of the prominence during the eruption. The zero at the time scale corresponds to 09:52:40 UT

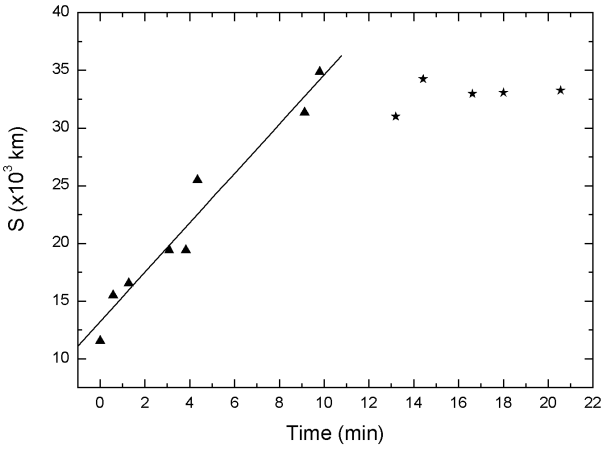

Figure 4. The distance between the magnetic tube feet of the prominence legs as a function of time

The shape of the EP suggests that the EP body was formed in the southern legs of magnetic arcade at the bottom of a huge magnetic system. The bright part of the EP body that is almost vertically to the solar surface consists of two helically twisted magnetic tube filled with prominence plasma. During the observed eruption the magnetic tubes in EP leg untwist. To estimate the displacement of magnetic tube feet during the eruption the distance S between them was measured. The result is shown on Figure 4. The behavior of the distance S between tube feet shows two different phases. During the first one the tube feet undergo obvious horizontal expansion with constant velocity estimated by linear last-square fit of 36 km/s. The phase of horizontal expansion continues up to the time when the EP almost riches a maximal height. Most probably the process of horizontal expansion is a result of the untwisting of the magnetic tubes composing a vertical leg of the EP. During the second phase the magnetic tubes are fully untwisted and the distance between their feet remain constant.

4 Relation to Solar Activity Events in the EP Vicinity

A few days later, several active regions and filaments in the vicinity of the EP were seen on the BBSO spectroheliogram (Figure 5). That were ARs NOAA 9580, located at N25E38 on August 17, 2001, NOAA 9582, located at N32E49 and NOAA 9885 (N15E64). According to BBSO Solar Activity Report NOAA 9580 and NOAA 9582 were beta regions, with increasing magnetic complexity, sunspot number and area, and extended plages.

There was a full halo CME on August 14, 2001, registered by SOHO instruments LASCO and EIT, that was probably associated with the prominence eruption. The event was first observed in C3 field of view at 16:08 UT. The speed projection of the front on the sky plane was estimated, according to LASCO CME list, as 415 km/s without significant acceleration. The BBSO Ha spectroheliogram of 17 August 2001; SOHO/EIT solar image in EUV (Fe XII, 195 Å) and LASCO registration of CME are shown in Figure 5.

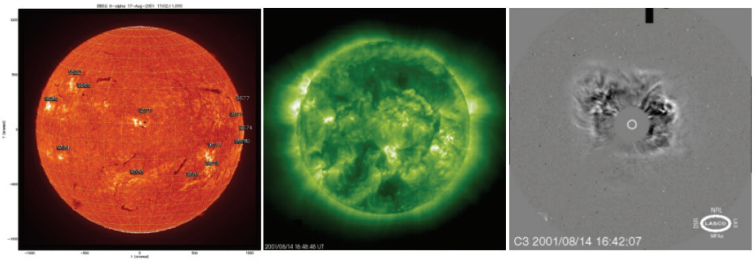

Figure 5. Activity events on 14 August 2001: **Left** – BBSO H_α spectroheliogram of 17 August 2001; **Center** – SOHO/EIT Fe XII 195 Å; **Right** – full halo CME registered by SOHO/LASCO C3

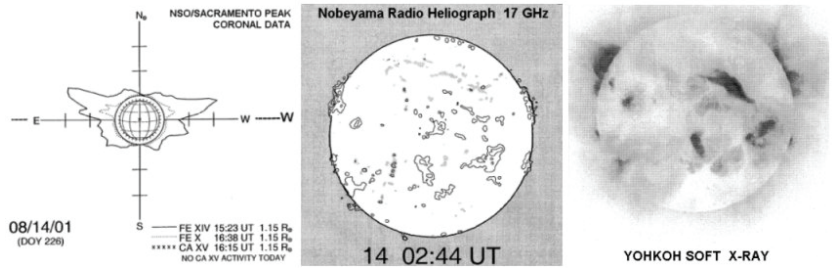

Figure 6. Solar activity events on 14 August 2001: **Left** – intensity map in the green (Fe XIV, 5303 Å) and red (Fe X, 6374 Å) corona from NSO/Sacramento Peak; **Center** – solar radio map (17 GHz) from Nobeyama Radio Heliograph; **Right** – a reversed color X-ray Yohkoh image

Figure 6 shows solar images on 14 August 2001 as obtained from Solar Geophysical Data Center. Above the prominence one can observe the enhanced emission of green corona (Fe XIV, 5303 Å) and red one (Fe X, 6374 Å), as well as an increasing in soft X-ray emission. A local radio emission was registered around the EP position at the solar limb.

5 Conclusions

The EP of 14 August, 2001 was located in solar region with complicated solar activity and it was associated with different activity events.

The shape of the prominence and its change during the observed eruption suggest that the EP is most probably of type II. Such conclusion is confirmed by its basic kinematics characteristics, the eruption height and horizontal expansion, which are typical for the last eruption stage of the type II EPs.

Acknowledgments

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References

[1] B. Rompolt (1984) *Adv. Space Res.* **4** 357. R1-R22.

[2] B. Rompolt (1990) *Hvar Obs. Bull.* **14** 37.