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# Evolution and Dynamics of an Eruptive Prominence on September 20, 1980

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**Abstract.** A long series of $H_\alpha$ filtergrams of the eruptive prominence of 20 September 1980 obtained in the Astronomical Institute of Wroclaw University was analyzed. The dynamic characteristics of the prominence eruption were determined. An analysis of the evolution and the untwisting of the internal structure during the prominence eruption (II type) was performed

## 1 Eruptive Prominence on 20 September 1980

The spectacular prominences eruption arose on the south-west solar limb (S40-W) on 20 September 1980. The eruptive prominence (EP) was observed in $H_\alpha$ line between 08:07 UT and 11:31 UT with Small Coronagraph of Astronomical Institute of Wroclaw University.

Until 09:21 UT it was typical quiescent prominence. The activation of the prominence (pre-eruptive phase) started at around 09:21 UT and at around 09:11 UT it erupted. The EP reached its maximum height of 380 000 km at 09:59 UT where upon the prominence faded and most part of its material fell back to the chromosphere (post-eruptive phase) (Figure 1) up to the prominence disappearance in $H_\alpha$ line at 11:31 UT.

The sample of EP images in Figure 1 traces the basic phases in the prominence evolution. The eruption process was accompanied of an untwisting process. The EP body had very complicated helical twisted structure. It was composed from two main helical twisted bundles whose untwisting was clearly visible after 10:01 UT. At 10:23 UT, two main bundles were fully untwisted and to the end of the post-eruptive phase, each one of them untwists of more small magnetic tubes filled with prominence plasma.

The shape of the EP and its evolution during the eruption, as well as the increasing of the inclination of the EP body (Figure 1) about the solar limb are typical indications that the EP of 20 September 1980 is of an classical example type II EP, according to Rompolt's classification [1, 2]. Such indications suggest that the EP was frozen into one leg of the huge magnetic system, before and during its eruption.

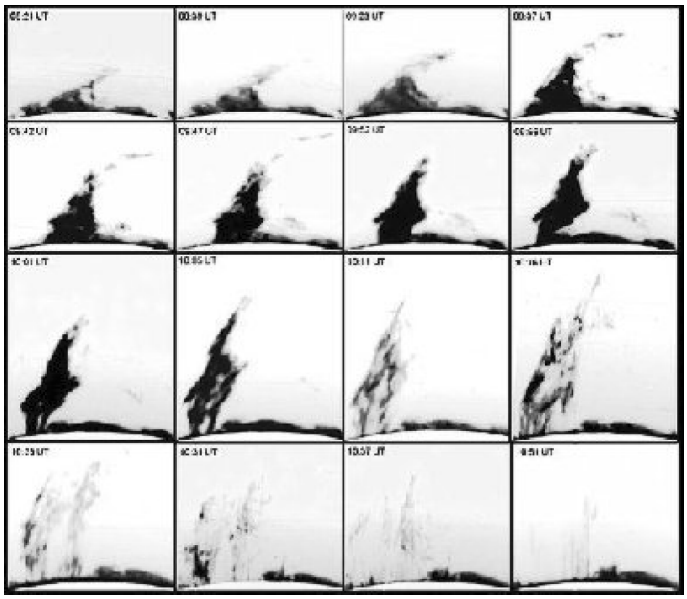

Figure 1. A sample of selected images of EP on 20 September 1980, observed between 08:07 UT and 11:31 UT.

Beside the eruption in the vertical direction, a number of EPs exhibit expansion in the horizontal direction [1, 2]. The EP of 20 September 1980 showed considerable horizontal expansion as was mentioned earlier papers by Rudawy *et al.* [3, 4].

The EP of 20 September 1980 is associated with the southern end of the long short-lived quiescent filament in the southern hemisphere of the Sun (Figure 2

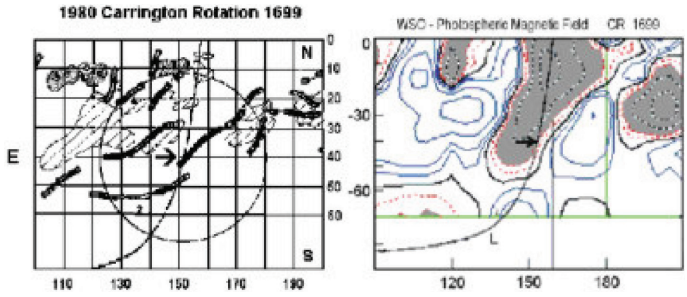


Figure 2. Fragments of Meudon synoptic map (left) and photospheric magnetic field map of Wicox Solar Observatory (right) for Carrington rotation 1699. The position of the solar limb for the EP observation time, as well as the limb location of the EP of 20 September 1980, is indicated.

left) with the coordinates $30°$S – $166°$L, according to Meudon Catalogue of filaments. The photospheric magnetic map (Figure 2 right) shows that the filaments is located along the polarity reversal line of the photospheric magnetic field separating extensive solar regions with opposite magnetic polarity. Most probably the EP was manifestation of the final stage of the filament existing.

## 2 Observational Data

A long series of $H_\alpha$ filtergrams of the EP of 20 September 1980 registered with Small Coronagraph (130/3450 mm) of Astronomical Institute of Wroclaw University were processed and analyzed. All filtergrams were digitized with the automatic Joyse-Loebl MDM6 microdensitometer at the National Astronomical Observatory – 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. The long series of EP images is especially suitable for a detail analysis of the dynamics of the EP because the series covers the whole process from prominences activation to it disappearing in $H_\alpha$ line: pre-eruptive, eruptive and post-eruptive phases. In this work are presented some basic characteristics from evolution and dynamics of the pre-eruptive and eruptive phases of the EP obtained during first stage of the EP investigation.

## 3 Kinematic Characteristics of EP

The "Height-Time" diagram for the EP of 20 September 1980 is shown in Figure 3. In this figure are presented the results from detailed analysis of the dynamics of the pre-eruptive and eruptive phases.

During the pre-eruptive phase, between 08:21 UT and 09:05 UT, the EP slow rose from 74 000 km to 105 000 km with constant velocity. The raising velocity estimated by linear last-square fit with 98% confidential probability is 11 km/s.

The eruption of the prominence started around 09:11 UT. The detailed analysis of the eruption phase shown that it consists of two stages: acceleration and constant velocity. After the eruption start, during acceleration stage between 09:11 UT and 09:49 UT, the velocity of the prominence raising increases from 11 km/s to about 250 km/s. The mean acceleration estimated with exponential fit with 98% confidential probability is 1.1 km/s$^2$. After 09:50 UT the EP entered in its second, last eruption stage of constant velocity. During this stage, the EP rose with constant velocity estimated by linear last-square fit with 98% confidential probability of 256 km/s. The EP reached maximum height of 380 000 km that is a half solar radius above the solar surface (09:59 UT).

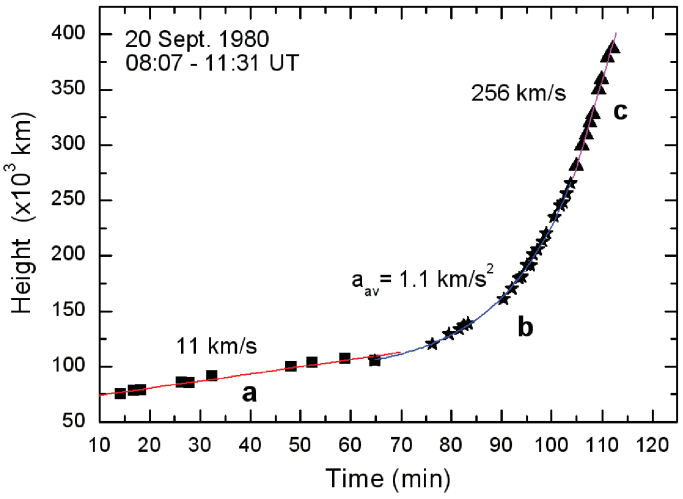


Figure 3. Height of the EP of 20 September as a function of the time. The zero-point by X-axes corresponds to 08:07 UT. The pre-eruptive phase (**a**), as well as two stages of eruptive phase, acceleration (**b**) and constant velocity (**c**), are indicated

## 4 Evolution of EP Internal Structure

The EP of 20 September 1980 is very interesting case of EP from point of view of the evolution of its helical-like internal structure. In view of long series of the EP images only qualitative analysis of the internal structure evolution was performed. A general tracing of this evolution was made above in Section 1. The observations of helical-like structures in the pre-eruptive phase and the evolution during the eruption is close connected with the condition for the onset of eruptive instability [6]. Unfortunately, helical twisted structure of the EP of 20 September 1980 was so much compact during pre-eruptive and eruptive phases that only after the reaching the maximum EP height (10:01 UT) the untwisting process, *i.e.* the simplification of the internal structure may trace. The two main bundles of the EP were fully untwisted of smaller helical twisted bundles during the post-eruptive phase at 10:23 UT. After this time, the smaller bundles of magnetic tubes began to untwist. The process of untwisting was observed up to the fully disappearing of the EP in $H_\alpha$ line. The entire untwisting process was accompanied with considerable horizontal expansion of the feet of the bundles and separate magnetic tubes.

## 5 Conclusions

This paper presents the results from the first stage of the study of EP of 20 September 1980. The analysis results of the EP images during the first study stage are summarized as follow:

**1.** The EP of 20 September 1980 was associated with short-lived quiescent filament and most probably it represents the final stage of the filament existing.

**2.** The morphological evolution of the EP body and increasing of the body inclination to the limb typical for type II EPs outline changes in the southern leg of the associated huge magnetic system expanding up high in the corona during the eruption.

**3.** The dynamic evolution of the EP was consisted of three phases – pre-eruptive, eruptive and post eruptive phases. The fine structure of the eruption phase shown that it was composed from two stages – acceleration and constant velocity. In this relation, this EP belongs to class A EPs according to Vršnak's dynamic classification [5].

**4.** One of the interesting aspects of EP is the untwisting motions of the magnetic bundles and thin magnetic tubes of its complex body distinct visible especially during post-eruptive phase. In the second stage of the EP analysis, we will concentrate our investigations on the dynamics of the internal structure of the EP especially during last post-eruptive phase, as well as the horizontal expansion between feet of bundles and treads building the prominence body.

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