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An Interesting Case of Eruptive Prominence on 8 June 1980

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Abstract.
An interesting case of the eruption of a quiescent prominence observed on 8 June 1980 at the Astronomical Institute of Wroclaw University was studied. The kinematic pattern of the prominence eruption connected with magnetic field reconnection and morphological changes during the that process were analyzed.

1 Introduction

The quiescent prominences (QPs) are cooler and denser formations in the low solar corona in comparison with the plasma of the corona itself. They form extended emission structures over the solar limb in chromospheric spectral lines (H-alpha for example) and when viewed in similar lines on the disk, these structures form absorption features, known as filaments. During its lifetime QPs can undergo eruptions. This process usually lifts hight into the corona a large part of the prominence material. In some cases part of the erupted matter may fall back to the solar chromosphere [1]. The time scale of the eruption is several hours and the erupted matter reaches a height of several 10^5 km up to ten solar radii [2]. A review of the prominence eruptions is given by [3].

The magnetic fields that thread prominences can sustain their masses against gravity [4, 5]. Magnetic fields permit prominences to exist for days or weeks, much longer than the minutes-long coronal free fall time of their constituent density enhancements, while changing only slowly. Magnetic fields also keep the cool, dense prominence material thermally isolated from the surrounding hot, tenuous corona. In the same time changes in magnetic fields lie into the base of prominence evolution and possible eruptions [6].

In this paper we trace the evolution and kinematics of an eruptive prominence observed on 8 June 1980 considered by Rompolt [7] of an example of eruption driven by magnetic reconnection.

2 Observational Material

The eruptive prominence (EP) (CR 1696) was observed in H-alpha on 8 June 1980, with a small coronagraph at the Astronomical Observatory of Wroclaw University, Poland. All H-alpha plates were digitalized with the automatic Joyce-Loebl MDM6 microdensitometer at the National Astronomical Observatory Rozhen, Institute of Astronomy, Bulgaria.

The two-dimensional scans have resolution of 20 μm per pixel and an step of 20 μm in both directions (Figure 1).

The EP (8 June 1980, CR 1696) appeared at eastern limb at a mean latitude of $S18°$. The prominence was observed between 07:06:30 UT and 09:02:55 UT. The QP in which a reconnection of magnetic field occurred consisted of two arches [7]. At 08:03:00 UT the central leg of the prominence strongly brightened up. Ten minutes later a loopy structure has been ejected from this leg. At 08:28:05 UT the leg had no more contact with the chromosphere. Some minutes later the leg between two arches has been rebuilt by the material flowing down from the top part of both arches [7]. The EP is identified with the western end of plage filament on Meudon synoptic map for Carrington rotation 1696 (Figure 2). The western filament end cross the solar limb under an angle of about of $45°$.

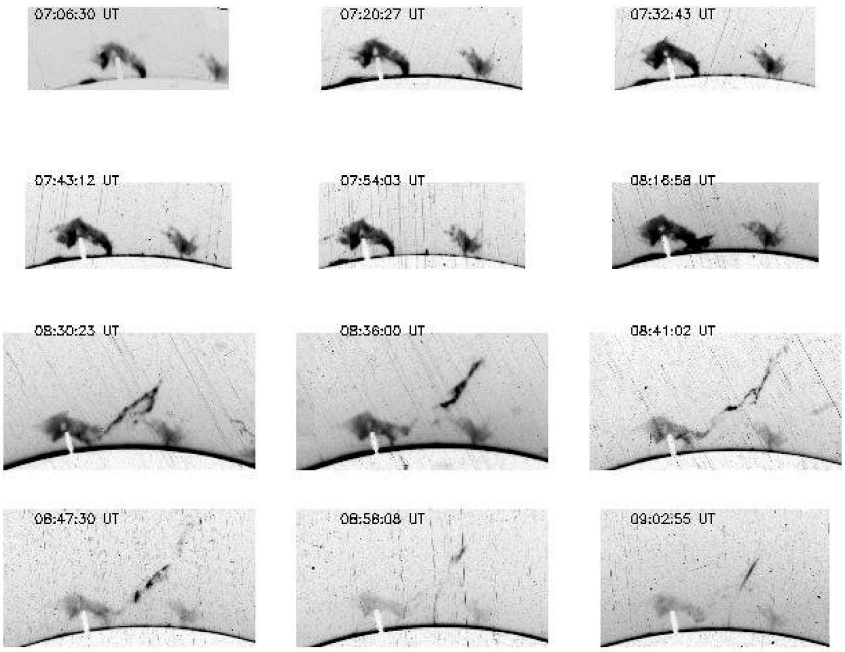

Figure 1. H-alpha filtergrams of EP on 8 June 1980.

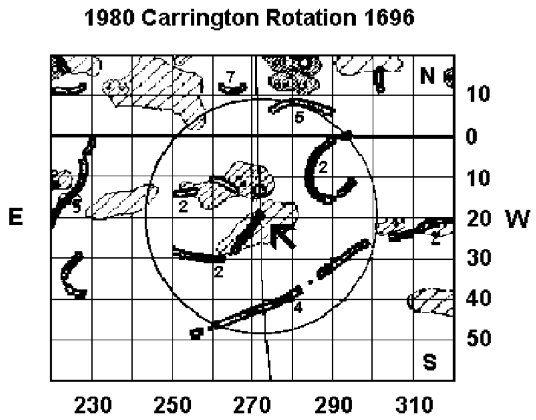

Figure 2. Meudon synoptic map for Carrington rotation 1696.

The eruption processes was registered during second rotation of the filament lifetime.

Figure 3 represents a sketch of the prominence arch. On the sketch are marked points of measurements. These points are used to trace kinematics and development of prominence eruption.

3 Results and Discussion

For the aims of our study we concentrated on the points 1, 5, 6, shown on Figure 3. The methods used to obtain kinematic parameters of the observed prominence were described in Koleva *et al.* [8]. Figure 4 represents height variations

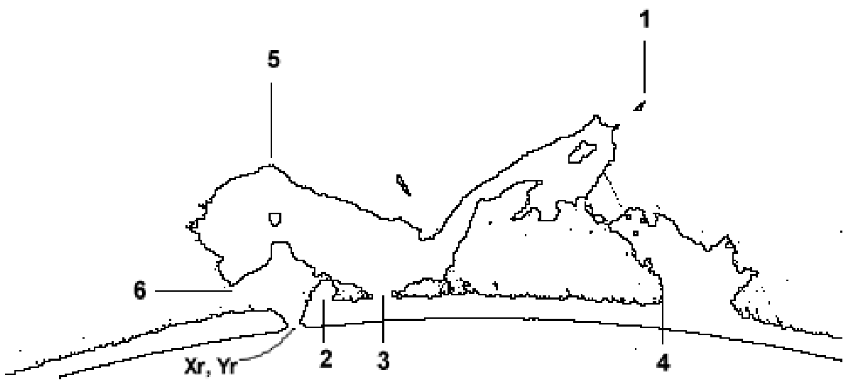

Figure 3. Sketch of the prominence arch.

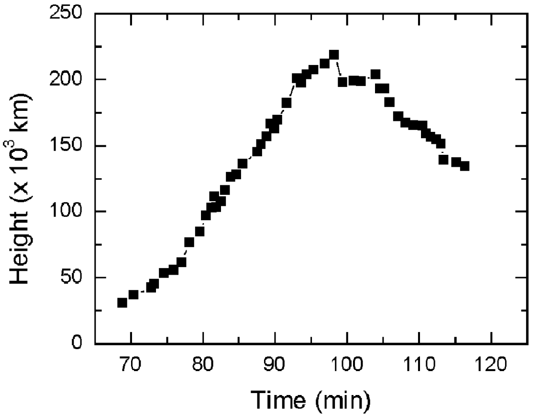

Figure 4. Height variation of Point 1. Zero is at 07:06:30 UT.

of point 1 (Figure 2) with the time. Time scale on Figure 4 is minutes after 08:03:00 UT. 70 min after beginning of observation Point 1 began to rise and about 30 min after that it reached maximal height of 2.18×10^5 km above the limb. The measured velocities during eruption are $\approx$ 120 km/s for accession and $\approx$ 75 km/s for falling back (derived from a linear fit with a 97% confidence level). On Figure 5 and 6 are traced height-time dependencies of Point 5 (P5) and 6 (P6) (Figure 2). It is obvious that the behavior of these point was more complex.

To investigate the behavior of the left part of the prominence structure we checked the correlation between height-time functions of Point 5 and Point 6. The correlation coefficient was 0.64, which suggested for a strong correlation. Such a value of the correlation coefficient supports the hypothesis, that Point 5 and Point 6 were parts of one prominence structure and not random features on the line of sight. Tests for randomness have been run to determine whether or not P5 and P6 height-time sequences are random sequences of numbers. The results of these test are presented at Table 1.

The test counts the number of times the sequence was above or below the median. The number of such runs for P5 equals 31, as compared to an expected value of 36.0 if the sequence was random. Since the P-value for this test is greater than or equal to 0.10, we cannot reject the hypothesis that the series is random at the 90% or higher confidence level. The expected number of runs for

Table 1. Test of randomness results

Point	Median	Above and below median	Expected numbers	P-value
P5	75.7	31	36.0	0.2785
P6	23.1	26	35.493	0.0291

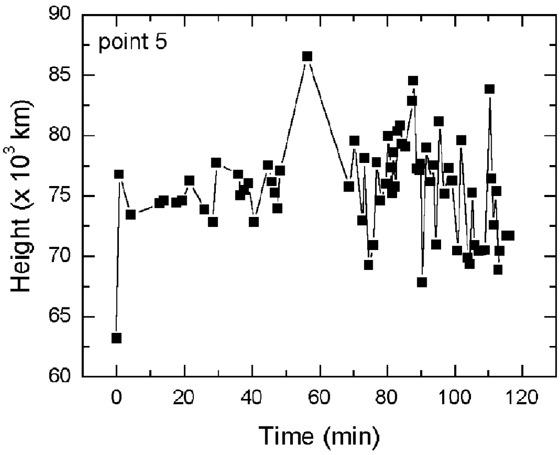

Figure 5. Height variation of Point 5. Zero is at 07:06:30 UT.

P6 if the sequence was random is 35.4928. The obtained one is 26. Since the P-value for this test is less than 0.1, we can reject the hypothesis that the series is random at the 99% confidence level. The strong correlation between P5 and P6 and probable random motion in P5 supposes fine structure internal motions in that point superimposed on a global shaking of the structure.

The estimated autocorrelation for P6 are shown on Figure 7. As one can see only autocorrelation with lag 2 is statistically significant. This lag correspond to a period of 20 min.

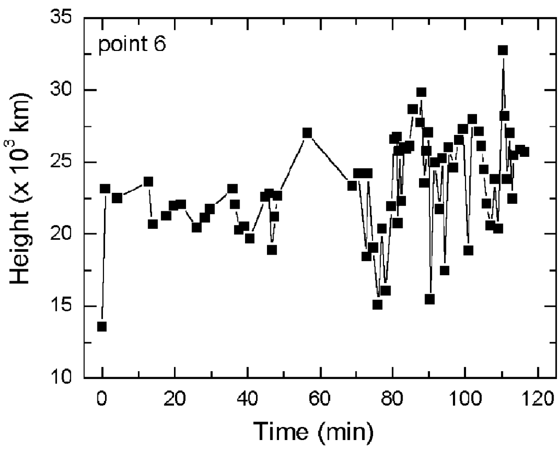

Figure 6. Height variation of Point 6. Zero is at 07:06:30 UT.

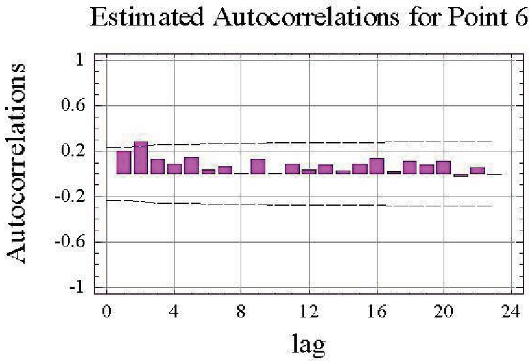

Figure 7. Estimated autocorrelations for Point 6.

4 Conclusion

The eruptions of QPs are caused by local changes in the magnetic filed supporting the prominence body. There are two main ways for the that changes – magnetic reconnection due to newly emerging magnetic flux or shear motions near the legs of the prominence and a blast from distant solar flare. The behavior of the observed eruption – eruption in the right leg and periodic movements in the left part suggest for the second possibility – changes in the magnetic field as result of propagation of oscillations along the prominence structure and reaching a critical value for eruption as described in [9].

Acknowledgments

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