PULSATIONAL COURSE OF THE FLARE IN 19TH OF JULY 1999

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ABSTRACT

A series of quasi-periodic pulsations have been detected in the flare of 19th July 1999. The total area occupied by the flare ribbons exhibited temporary increases in the declining phase of the flare at certain moments, the period of the pulses was about 20-30 minutes. The phenomenon has been recognized in the center, as well as at 0.5 and 1.0 Ångstroms on both sides of the H-alpha line. The pulses can be regarded as temporary recoveries in the source of the flare. The results can be interpreted in terms of a mechanism in which part of the energy released by the flare could be recycled to temporarily rebuild the current layer by positive feedback.

1. INTRODUCTION

In spite of the remarkable development in flare theory the interpretation of several features in flare events remains a challenge. It is widely accepted that the energy release is resulted by magnetic reconnection [1] but this process can be different in the different events. The reconnection is certainly not a steady process but it may have dynamical features in different timescales. A usual way of empirical approach is to observe with high resolution in order to find the locations of the energy release, this usually needs a detailed construction of the magnetic structure. The 19 July 1999 event, however, was so complex and rich in H-alpha features that a different approach was also possible: a global treatment of its temporal behaviour.

2. OBSERVATIONS

The observations have been gathered in the Helio-physical Observatory, Debrecen, with the large coronograph and the attached tunable Lyot-filter. The FWHM of the filter is 0.4 Ångström. During flares the observer makes serii of observations at four positions five wavelength: line centre, +0.5 Å, -0.5 Å and at a special passband ±1 Å with an as high cadence as possible. A total of 19 such serii have been collected starting at 07:46:53 UT, the first series recorded the state immediately before event. The observations were recorded on KODAK H-alpha patrol film and the involved frames were digitized later. With this strategy one can easily follow the intensity of the flare, because the H-alpha faculae are visible only up to about ±0.5Å.

The event was a classic impulsive flare with classification 2N/M5,8, it had two well developed, complex and receding systems of ribbons. A spectacular CME was also ejected in connection with the flare without any geophysical consequences because the active region (NOAA 8636) was close to the Eastern limb.

We wanted to determine the total area of all flare ribbons on each frame in order to follow its temporal behaviour. This means different strategies at the different wavelengths. In the center and at ±0.5 Å one has to distinguish between the patches of faculae as well as the flare. Since the exposures are automatic and absolute photometric calibration cannot be done therefore two other procedures have been carried out, one of them was based on constrast data, the other exploited the distriubtion of intensities, both methods gave fairly similar results. In the contrast method we have selected those pixels which had higher contrast with respect to the background undisturbed chromosphere than the most intense facular points, these points were regarded as parts of the flare ribbons and their number is the area of the ribbon. This can be done on the frames of the line center and ±0,5 Å, whereas on the frames taken at ±1 Å the case is more simple, because the faculae are not observable but the undisturbed chromosphere is more homogeneous so the bright flare points can easily be found.

The other method is based on the distribution of the intensities in the three main components of the chromospheric images: the flare, facular and background points. Each component has a normal distribution of intensities, so the total distribution can be synthetised from three gaussians. The area of the gaussian representing the flare intensites is considered as a measure of the flare ribbon size. Figure 2 shows the histogram of a frame and the three fitted gaussians, the curve belonging to the flare points can readily be recognized.

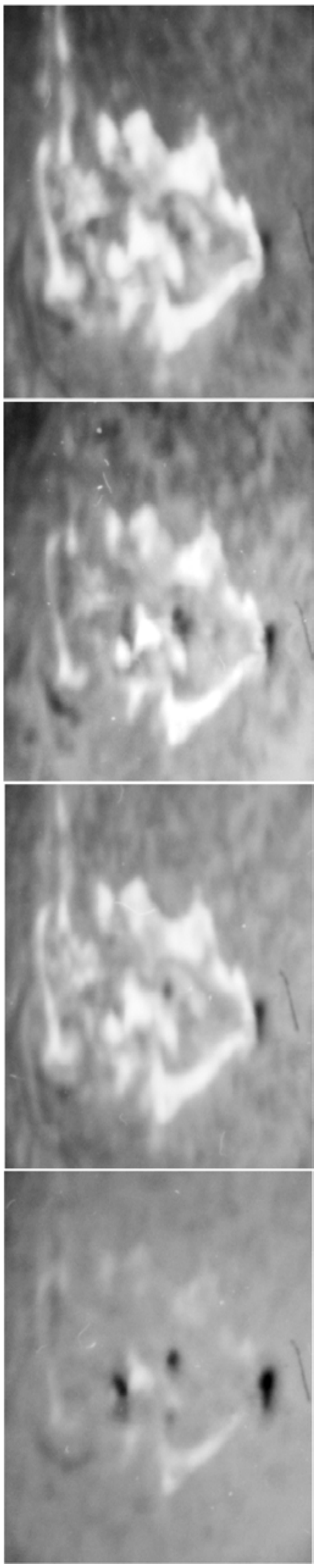

Fig. 1. Image of the flare in the line center, at –0,5 Å, +0,5 Å and ±1 Å.

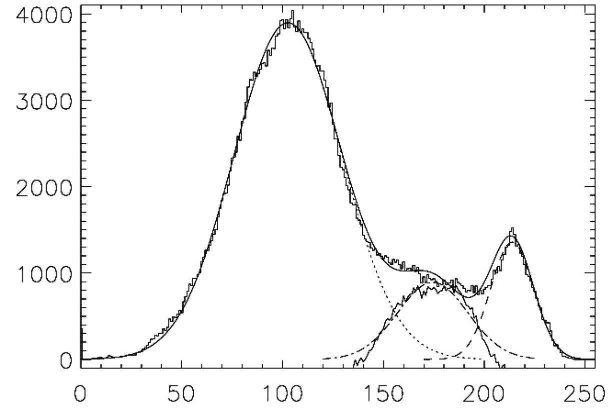

Fig. 2. Distributions of intensities in the undisturbed chromosphere, faculae and flare in the uppermost frame of Fig. 1

3. TEMPORAL BEHAVIOUR

Figure 3. shows the temporal distribution of the flare area decrease. The continuous line with crosses indicates the area at line center, dotted line with triangles: +0,5 Å, dashed line with diamonds: -0,5 Å dot-dashed line with squares: ±1 Å. All of these distributions exhibit certain fluctuations which cannot be regarded as random. The curves have local minima and maxima close to each other which cannot happen incidentally because the measurements and the selection criteria are made differently and independently at the different wavelengths. The curves should be regarded as independent, so their local strengthenings and weakenings corroborate each other.

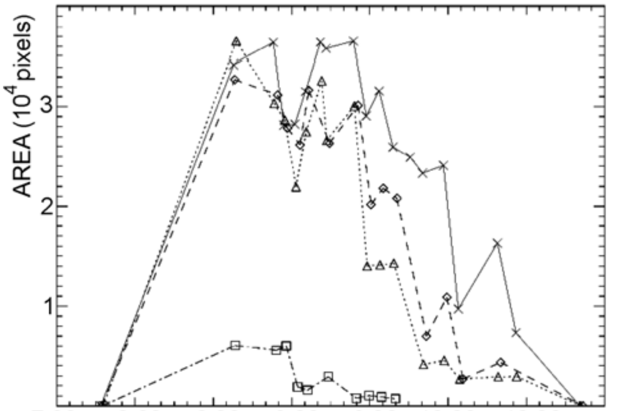

Fig 3. Temporal distribution of the flare area decrease at different wavelengths.

The most important piece of information to be deduced from the curves is the distance of the peaks. After the first maximum and decrease a temporary recovery follows at about 9:10 UT, then another decrease and increase at 9:40 and two later recoveries (in ±1 Å frames already not visible) at about 10:00 and 10:20 UT. The areas are depicted in the number of pixels, the area of a pixel is 0,13as^2, no foreshortening has been taken into account because we are here only interested in the temporal behaviour and not in the absolut size of the flare. One can see that the period of consecutive local maxima is between 20 and 30 minutes.

4. A POSSIBLE BACKGROUND OF THE FLUCTUATIONS

Fluctuations of flaring can take place in different timescales having different causes. Recurrences at the longest timescale mean homologous flares [2], [3], the time interval between them may extend from a few hours to a few days. In the case of homologous flaring the processes leading to the preflare state are continuing also after the flare and they are able to build up a similar preflare state for a next flare. This cannot be the case in this event because the temporary enhancements cannot be considered to be new flares. Another possibility is a regime of fluctuating reconnection, this is the case of short timescale fluctuation, however, its typical period is about a few seconds, it can be observed in X-ray [1] or radio [4], but not in H-alpha. In this case plasmoids escape from the current layer in a periodically interrupted way, but it can only be detected high in the corona.

In our case a mechanism presented by Litvinenko and Somov [5] could perhaps be relevant. They describe a scenario in which an additional electric field can be built up during the flare by the velocity of inflow into the current layer and the magnetic field, and this electric field could accelerate the particles to high velocities. This secondary accelerating mechanism can take place in the later phase of the flare, with about 1000 seconds later than the impulsive phase, which is close to the above indicated period in order.

The Litvinenko-Somov mechanism, however, predicts only a single secondary phase whereas the above presented event has produced several recoveries. We think therefore that either a cyclic version of the Litvinenko-Somov scenario or any such mechanism could be responsible for this feature in which some part of the escaped energy can be recycled to the current layer.

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