# Quasi-periodic behaviour of a flare ribbon system

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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 Å wings on both sides of the H-alpha line.
Keywords: *flare, oscillations*

## 1. Introduction

Oscillatory and wave phenomena in the solar corona attract continuously growing attention of observers and theorists in the context of MHD coronal seismology and coronal heating. Often, the oscillations are associated with flaring loops. Svestka (1994) described repetitive X-ray brightenings with mean periods close to 20 min. A typical example was studied by Harrison (1987): the Hard X-ray Imaging Spectrometer on SMM detected soft X-ray (3.5 to 5.5) keV pulsations with the period of 24 min. Very recently, 10-20 min periodicities have been found in the Doppler shift of the EUV emission lines observed by SOHO/SUMER (Kliem et al. 2002) and interpreted as slow magnetoacoustic modes by Ofman and Wang (2002). To our knowledge, there have not been reports of long-time periodicities associated with coronal events observed in the white light and in this contribution they are discussed for the first time.

## 2. Observational material and procedure

The event of July 19, 1999 was a classic impulsive flare with classification 2N/M5.8, it had two well developed, complex and receding systems of ribbons (Kulinová and Karlický, 2001). The observations have been gathered in the

Heliophysical Observatory, Debrecen, with the large coronograph and the attached tunable Lyot-filter. The FWHM of the filter is 0.4 Å. During flares the observer makes serii of observations at four wavelengths: line centre, +0.5 Å, -0.5 Å, and at a special passband ± 1 Å. A total of 19 such serii (76 frames) have been gathered between 07:46:53 and 11:03:08 UT, the first series recorded the state immediately before event. Figure 1 shows the first series about the flare. 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 ±0.5 Å.

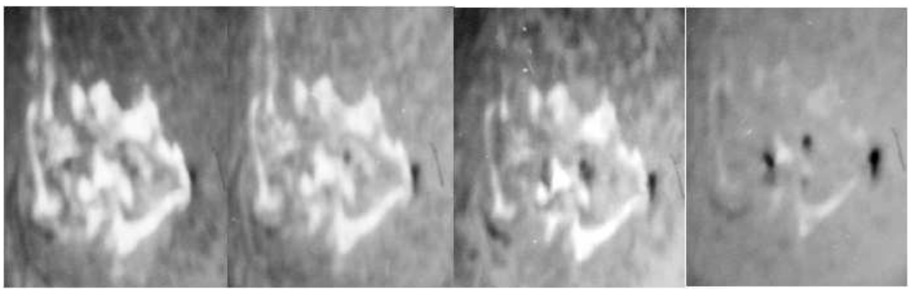

Figure 1: Images of the flare at the H$\alpha$ line center, +0.5Å, -0.5Å, and ± 1 Å.

The aim of observing this series was to determine the time profile of the total flare ribbon area. Since the images were made by automatic exposures and an absolute photometric calibration was not possible, an indirect method was applied. This method was based on the analysis of the intensity histogram of each frame. The histograms of the intensities contain the three main components of the chromospheric pattern: the flare, facular and background points. Each component has a normal intensity distribution, so the total distribution is a superposition of three gaussians. The area of the gaussian representing the flare intensities is considered as a measure of the flare ribbon size. Figure 2.a. shows the histogram of a frame and the three fitted gaussians, the curve belonging to the flare points can readily be recognized.

## 3. Observational results

The time profiles at the four wavelengths are depicted together in Figure 2.b. The continuous line with crosses indicates the area at line center, dotted line

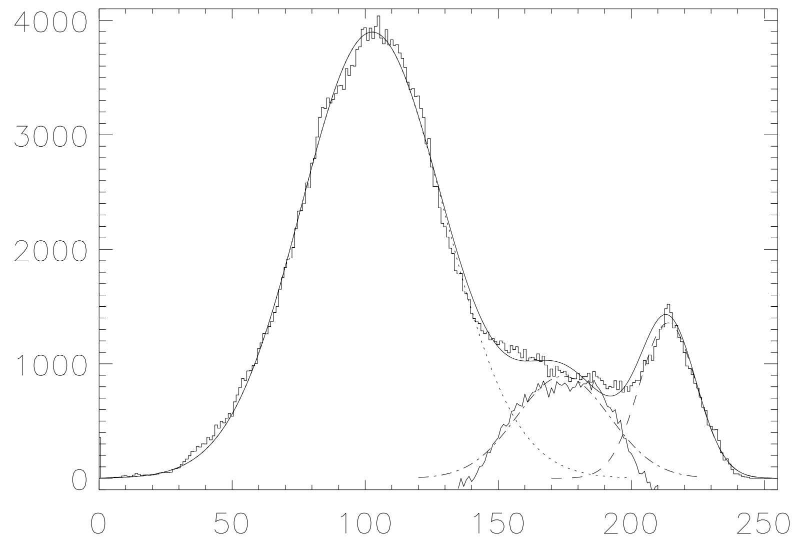


Figure 2: (a) Intensity histogram of a frame at the line center, horizontal axis: intensity level given by the 8-bit camera, vertical axis: number of pixels.

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 maxima and minima corroborate each other.

The most important piece of information to be deduced from the curves is the duration 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 $0,13$ $arcsec^2$ (0.3549 *as* x 0.3643 *as*), no foreshortening has been taken into account because we are here only interested in the temporal behaviour and not

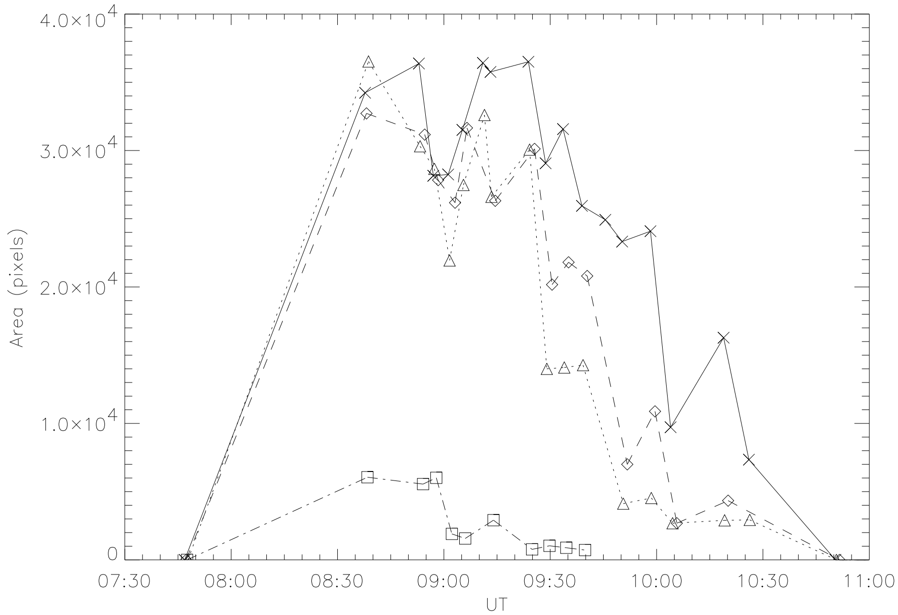


Figure 2: (b) Time profiles of the flare at the four wavelengths studied.

in the absolute size of the flare. One can see that the period of consecutive local maxima is between 20 and 30 minutes.

## 4. Discussion

The observed quasi-periodic variations of the white light emission intensity generated by a solar flare may be associated with slow magnetoacoustic oscillations of the flaring arcade, similar to that reported by Kliem et al. (2002). In this scenario, the slow waves are trapped between the loop footpoints and cause longitudinal field-aligned changes in the plasma density. The density fluctuations modulate the emission intensity observed. More detailed study of this scenario will be presented elsewhere.

## Acknowledgments

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