MULTIDIRECTIONAL SCANNING OF ACTIVE REGIONS WITH A SLIT-JAW SPECTROGRAPH AND A SOLAR CHROMATOGRAPH

I: Description of the Method and some Preliminary Results for the Flare Event of August 4th 1972

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Abstract. At the Swedish Solar Observatory in Anacapri we have simultaneously used the following combination of instruments in our investigation of active regions:

1. A spectrograph with an image rotator placed in front of the slit.
2. A subtractive double dispersive spectrograph (solar chromatograph).
3. A Hα ± 0.5 Å patrol instrument. Scans over the 3b flare of August 4th 1972 are used to illustrate the method. The illustrations clearly show downflowing matter connected with bright knots and filaments in the emitting area, possibly in accordance with Hyder’s infall-impact mechanism.

1. Introduction

It is well known that one has to be very careful in the interpretation of spectral features indicating mass motions. In some cases the type of motions involved is obvious. Already in 1947, Ellison clearly demonstrated a rising arch-type prominence with rotating legs. Öhman et al. (1968) discussed rotational motion also on the disc. In other cases however the spectral interpretation of differential velocities can be rather hazardous. The aim of our work has been to study mass motions in active phenomena. In order to improve the interpretation of spectral velocity features we have in our investigation always recorded:

1. The exact position of the slit.
2. A systematic scanning with fine spacing of the phenomena with small time lapse and with the slit orientated in different directions.
3. Simultaneous solar chromatograms and filtergrams at the center and in the wings of Hα.

The purpose of the present paper is to describe and illustrate the method used.

2. Instrumentation

A 20-cm f/100 horizontal telescope was used. The spectrograph has a Babcock grating
ruled with 610 lines mm$^{-1}$. The spectra were observed in the 4th order, giving a linear dispersion on the film of approximately 1.4 Å mm$^{-1}$ at Hz. The exposure times vary from 1/15–1/2 s on Kodak E4 (Kodak SO-392 was sometimes used). A reflecting mirror with a 0.08 mm wide slit was used. The length of the slit is 20 mm corresponding to 206°. The slit position relative to the chromosphere was viewed and photographed through a 0.7 Å Lyot-Öhman filter centered at Hz. A motor driven Nikon camera took the slit-jaw pictures simultaneously with the spectra. In front of the slit an image rotator (Peschan prism) is placed. With this device one can choose any slit direction relative to the chromosphere. The solar image is guided so that series of spectra with closely-spaced slit positions can be taken.

The solar chromatograph is a subtractive double dispersive spectrograph that produces two-dimensional images of solar regions, which are monochromatic in every point of the image, although the wavelength changes slowly across the image (see Figure 2). The instrument has been described by Stenflo (1973). The monochromatic bandwidth can be changed to practically any value, and the transmission band can easily be shifted to any part of the visible spectrum. We have used a bandwidth of 0.12 Å and a 4 Å transmission band around Hz. The solar image of the Capri chromatograph is automatically guided using the principle of thermal expansion of electrically heated wires described by Pålsgård and Stenflo (1970).

The continuous Hz patrol instrument is an 8-cm $f/19$ telescope mounted with a 0.7 Å filter. During scans with the spectrograph filtergrams were continuously taken in Hz as well as at Hz $±$ 0.5 Å.

3. Observations

During the periods August–October 1971 and June–August 1972 more than 2000 spectra in Hz were collected. During these periods we made continuous spectrographic patrol covering active regions and prominences. The developments of Emergent Flux Regions were in several cases followed. Series of spectra were taken when the seeing was good and when we saw interesting features. Some outstanding events were photographed though the seeing was poor. Each series was taken in $\frac{1}{2}$–2 min, immediately after which a new series of spectra with another slit direction was obtained. Each such procedure was repeated with convenient intervals depending on the type of phenomenon. A series of such scans covering the medium phase of the 3b flare of August 4th 1972 situated near the center of the disc is shown in Figure 1. (Two similar scans in the initial phase and three scans in the final phase of the flare were also taken). The picture is taken at UT 0729$^{h}$50$^m$ after the optical maximum phase. The drawing on the filtergram shows the areas covered by the scans. In the photometric analysis special care has been taken when comparing the line profiles in the places in the spectra where slits intersect and the profile is asymmetric.

Figure 2 shows four photos out of a series of chromatographic pictures taken at UT 0730. The solar region is fixed and the transmission band, 4 Å wide, is moved so that the flaring region appears at the center and in the wings of Hz. From the figures one can see that the complex spot group is partly covered with absorbing matter.