Hα IMPULSIVE PHASE FLARE OBSERVATIONS WITH HIGH TEMPORAL RESOLUTION

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Hα observations with high temporal resolution allow a detailed analysis of the chromospheric response to the primary energy release. The timing relationship between Hα and hard X-rays gives information about the energy transport mechanism. Sites of massive injection of nonthermal electrons are identified by characteristic features in the Hα line profile (Canfield et al. 1984; Canfield and Gayley 1987).

We have built a specialized post-focus instrumentation for Hα flare observations with high temporal resolution (Figure 1). It consists of two digital CCD imaging systems which can be operated simultaneously. One system takes images at Hα line center at a rate of 3 images every second. The other CCD is coupled to an imaging spectrograph. It takes images simultaneously in 25 spectral channels along the Hα line profile at a rate of 1 set of images every 2.3 seconds. Both systems are installed at the 15 cm Telescope of the Specola Solare Ticinese at Locarno-Monti (Switzerland). For the calibration, display, and analysis of the large amount of multispectral data, special software has been developed.

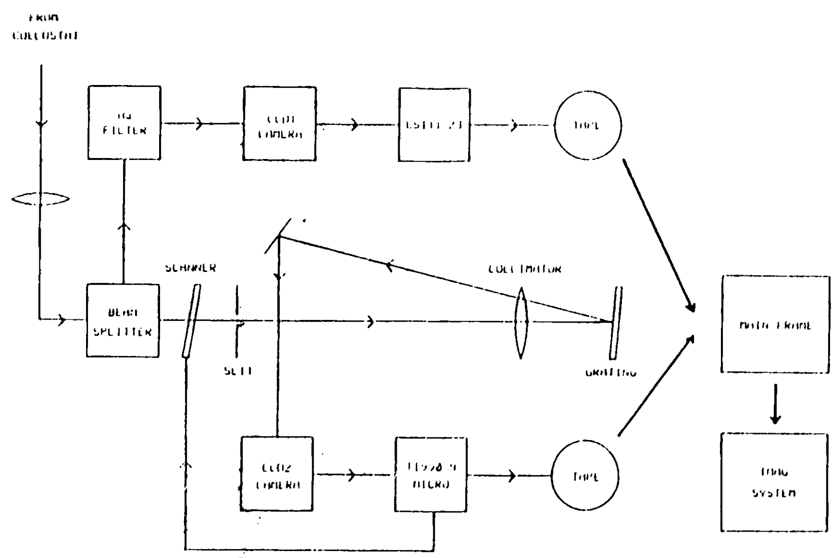

Figure 1. Two digital CCD camera systems are simultaneously used for the acquisition of the Hα line center intensity (upper part) and the Hα line profile. The data is calibrated on a main frame computer before detailed analysis is done. The dedicated IMAG system is used for the display and detailed investigation of pictures in different spectral channels.

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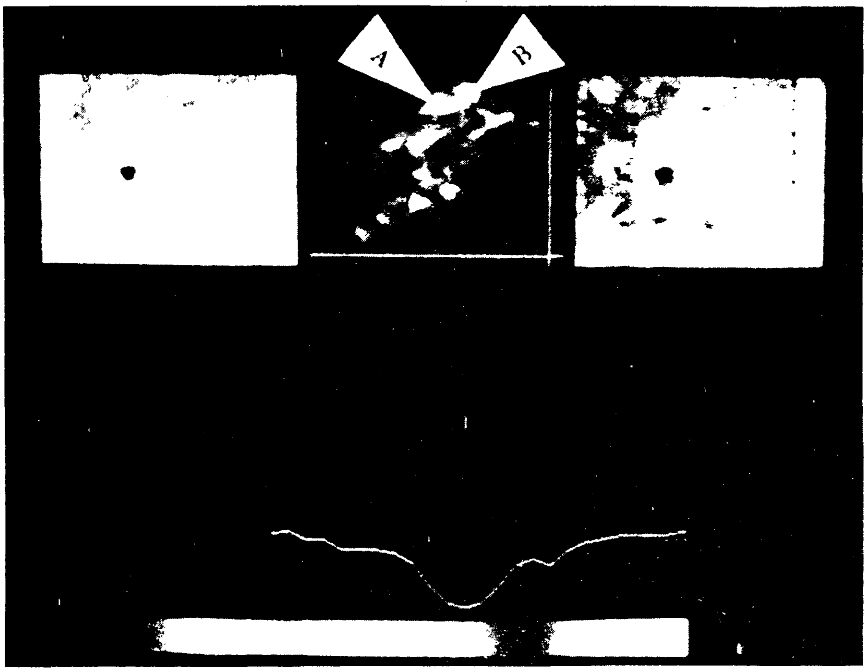

Figure 2. Display screen of the IMAG system showing the flare on May 24, 1987. See text for explanations.

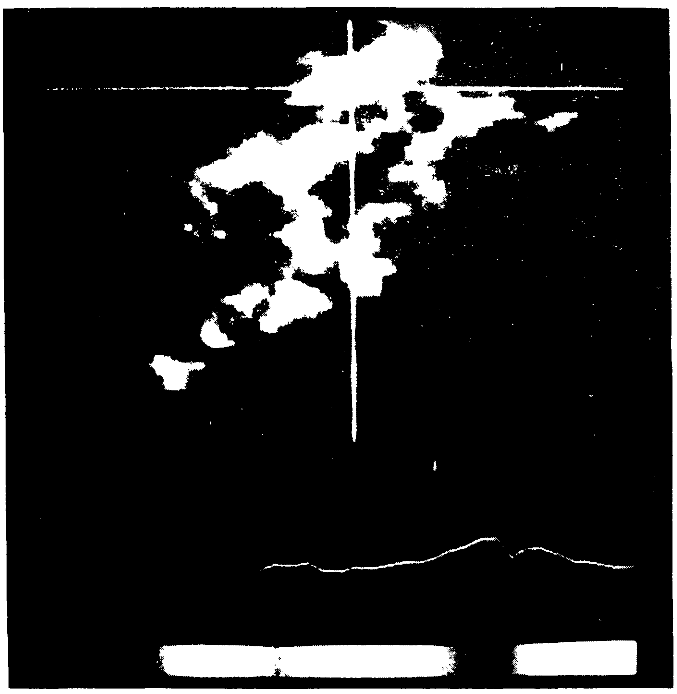

Figure 3. Hα line center image at 15:25:28 UT on May 24, 1987. Below the image, the line profile of the pixel at the cross-hair location is displayed.

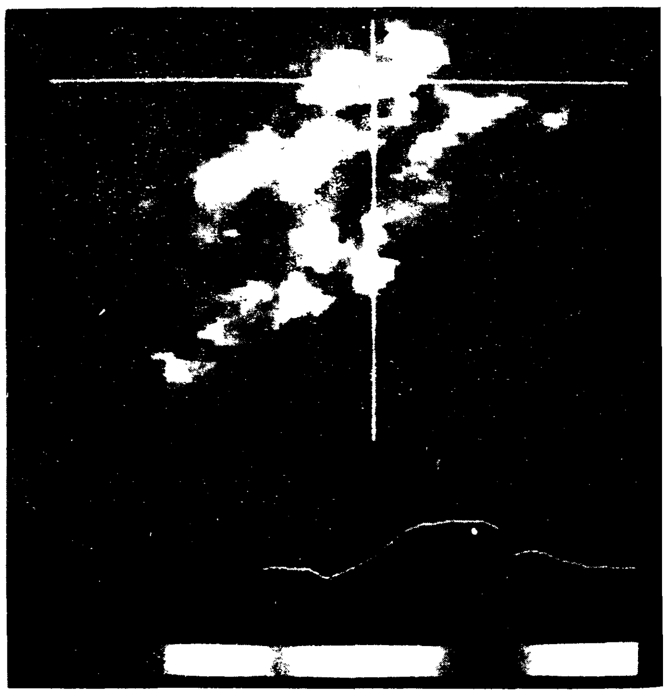

Figure 4. Hα line center image, and one line profile at 15:26:38.

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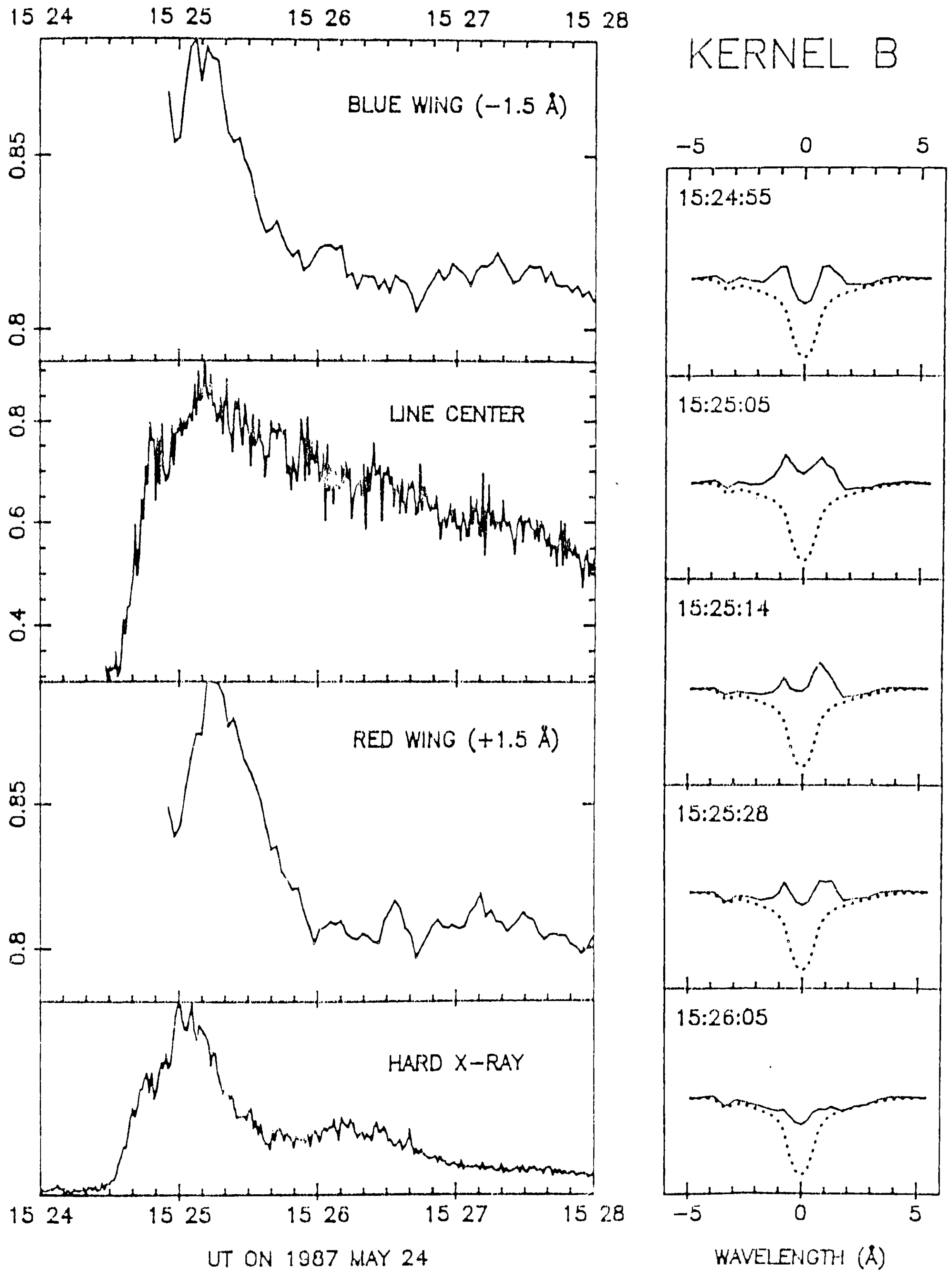

Figure 5. Temporal of kernel B at different wavelengths within Hα. The hard X-ray flux above 25 keV (from HXRBS) is shown for reference.

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First successful observations with both systems operating simultaneously have been carried out on a 1b flare on May 24, 1987. This unique set of observations gives a good picture of the impulsive phase in Hα. The flare is analyzed in more detail in Wülser and Marti (1988). Here we want to illustrate the capabilities of the instruments, and some aspects of the first observations.

Figure 2 shows the flare region at 3 different spectral channels of the imaging spectrograph: at Hα − 0.5 Å, line center, and Hα + 0.5 Å. The flare is visible at all three channels. The two main kernels are denoted by the letters A and B. At the bottom of the Figure, the grey level coding of the intensity is shown. The transformation of the original color representation into a black and white print resulted in a somewhat arbitrary relationship between the intensity and the print grey-level. The graph shows the line profile of the quiet sun at the location of the crosshair. The short vertical tick above the profile indicates Hα line center.

The line profile varies greatly in space as well as in time. Figures 3 and 4 show the flare at two different times (15:25:28 UT, and 15:26:38 UT, respectively). The crosshair is moved to the pixels of strongest emission. At 15:25:28 the left part of kernel A shows strong red shifted emission which is believed to be the signature of a downward moving chromospheric condensation produced by massive heating (e.g. Fisher et al. 1985). At 15:26:38 the right part of kernel A shows strong line center emission, but much less red-asymmetry.

The temporal evolution at different spectral positions within the Hα line profile gives valuable information on the flare heating mechanism. Figure 5 shows the temporal evolution of kernel B and some selected line profiles. The temporal evolution at line center was observed by the line center imaging system, whereas the line wing data, and the line profiles are from the imaging spectrograph. The data of the imaging spectrograph start about 20 s after flare onset because of a tape rewind occuring at this time. The hard X-ray data are from HXRBS aboard the Solar Maximum Mission satellite (Dennis 1988, private communication). At hard X-ray maximum the count rate was $\sim$ 550 counts/s above 25 keV. Note the close correspondence of the hard X-rays and the Hα line wings, suggesting heating by a beam of non-thermal electrons at this kernel.

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