The Development of Imaging Spectrograph in the Solar Tower of Nanjing University

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Abstract

This paper describes the design and the features of a imaging spectrograph which was established in the Solar Tower of Nanjing University. Some observational results obtained by the system were given.

1 Introduction

A traditional spectrograph can only obtain one dimensional spectrum of object covered by the slit of spectrograph. In order to study the physics of solar events in three-dimension space of solar atmosphere, it is needed to observe line profiles in two-dimensional field and in many wavelengths simultaneously. There are basically two kinds of way to approach this goal: one is based on using spectrograph, another is wavelength scanning with a narrow-band filter. Comparing to the filter, a spectrograph gives a high spectral resolution and a low scattering light level. Nevertheless,in the case of spectroheliograph the scanning and recording by film are too slow to observe the fast evolution of solar events. The application of CCD data acquisition gives the possibility to solve this problem. Since October 1992, by use of CCD cameras we have developed a imaging spectrograph , which can obtain the real time data of digital bidimensional spectra in the Hα and CaII K wavebands automatically and simultaneously. The foregoing description gives the details of this system.

2 Construction of the CCD system

Fig. 1 shows the scheme of the solar telescope and the imaging spectrograph system. The system includes a multichannel spectrograph, CCD cameras, an image processor, a computer, and an advanced mechanical scanning device.

The spectral resolution of the spectrograph is 130000. An image reducer is used to reduce the spectral image by a factor of 3. The CCD cameras are PULNIX TM-765 with 756(H)$\times$581(V)

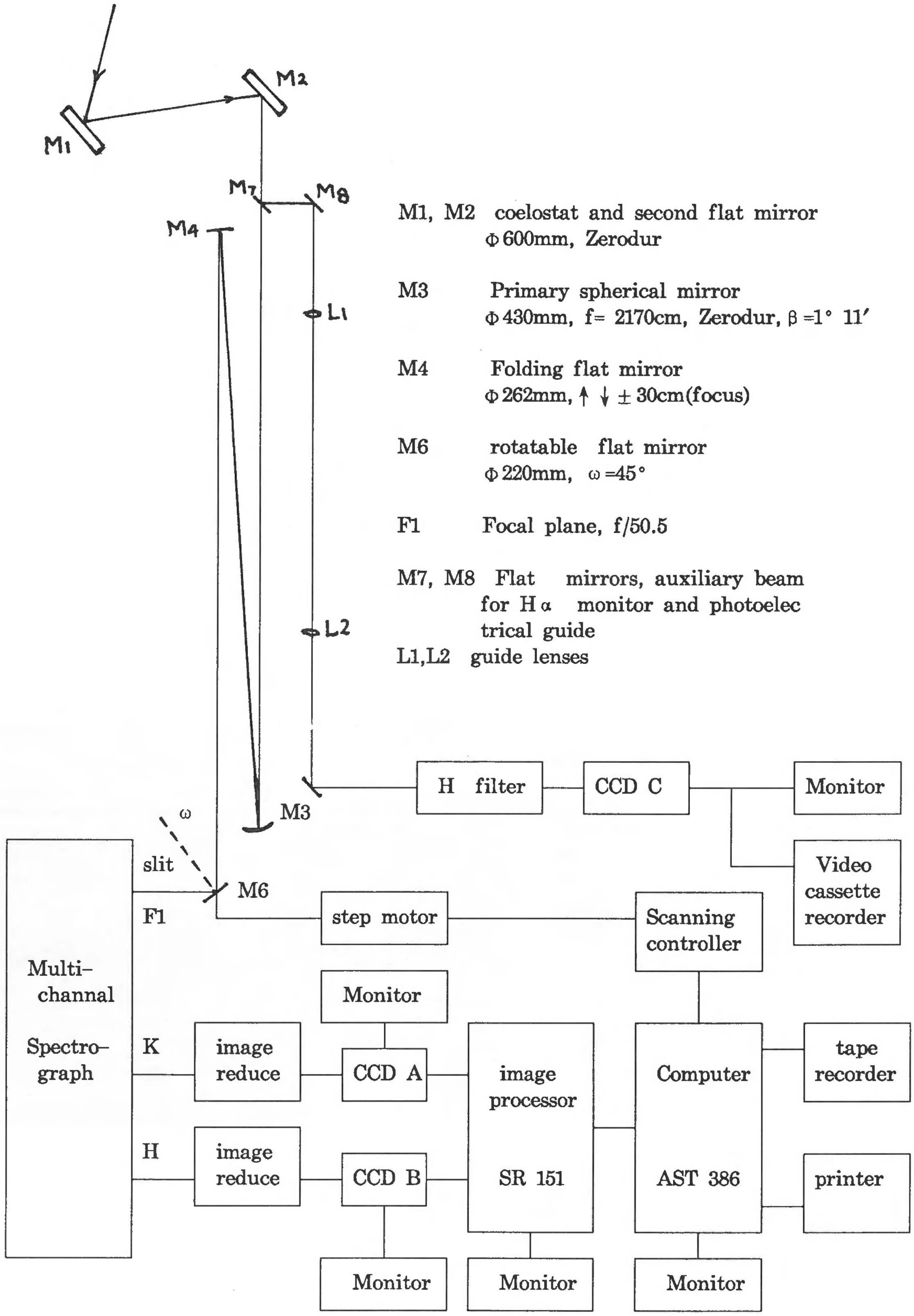

Fig. 1. Scheme of the solar tower of Nanjing University
and the imaging spectrograph

pixels The size of each pixel is $11\mu \times 11\mu$. The image scale on the CCD is 0".732 per pixel along the direction of slit of the spectrograph. The dispersion is 0.0422 Å/pixel for Hα and 0.0541 A/pixel for CaII K respectively.

The automatic scan system makes the solar image move perpendicularly over the slit while the observation is doing. Signals from CCD cameras are amplified and digitized to 8 bit data by the image processor. A microcomputer AST386 is used for data store and scan controlling. A software package, which gives various automatic observing program, has been developed. Only 10 seconds is needed to obtain a bidimensional spectra in 10 Å wavelength region for an 1'× 2' area on the solar disk.

3 Application Examples

Using the system many bidimensinal spectra of solar events , such as flares, prominences and filaments have been recorded.

Fig. 2 shows the time variations of a flare on December 16, 1992, which were reduced from the bidimentional spectra obtained. The red-asymmetry can be seen easily from this figure.

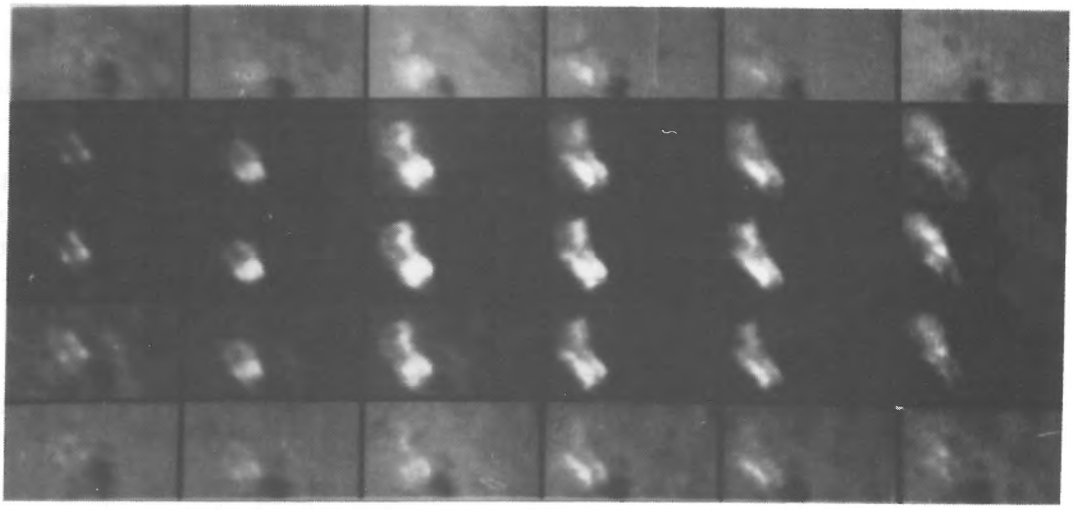

Fig. 2. Time variation of a Hα flare on December 16, 1992. Figures on the left side indicate offband raletive to the center of Hα line

Fig. 3 is the line of sight velocity field contours of the flare of Dec.,16 1992 at 03:16:23 UT, which was also reduced from the bidimensional spectra. The contours from outside to inside correspond to line of sight velocity as follows: 11.5km s^{-1}, 23.0 km s^{-1}, 32.6 km s^{-1}, 40.3 km s^{-1}. Fig. 4 is the intensity contours of the same flare at 03:16:23 UT

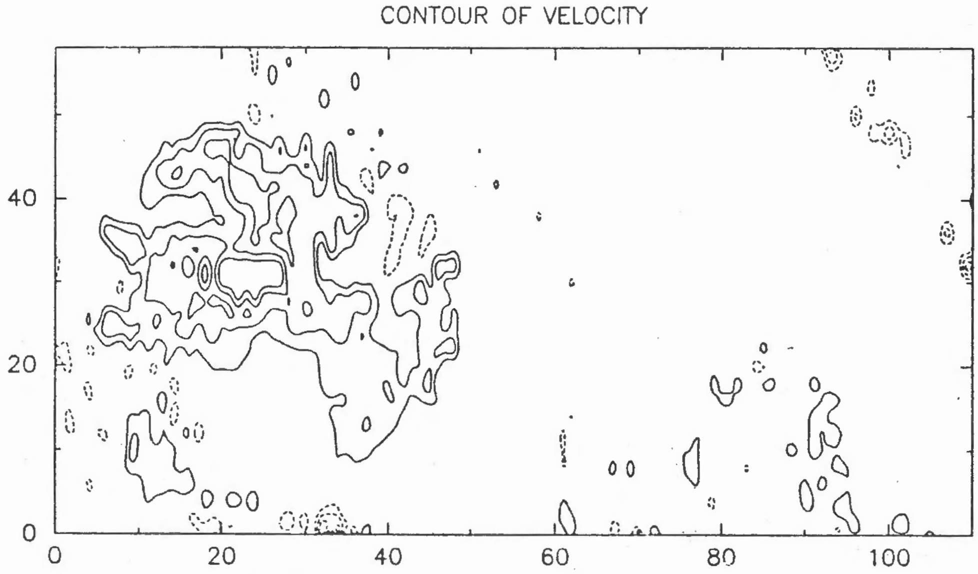

Fig. 3. Line of sight velocity contours of the flare of Dec.,16, 1992 at 03:16:23 UT, dashed lines -- blue shift, solid line -- red shift

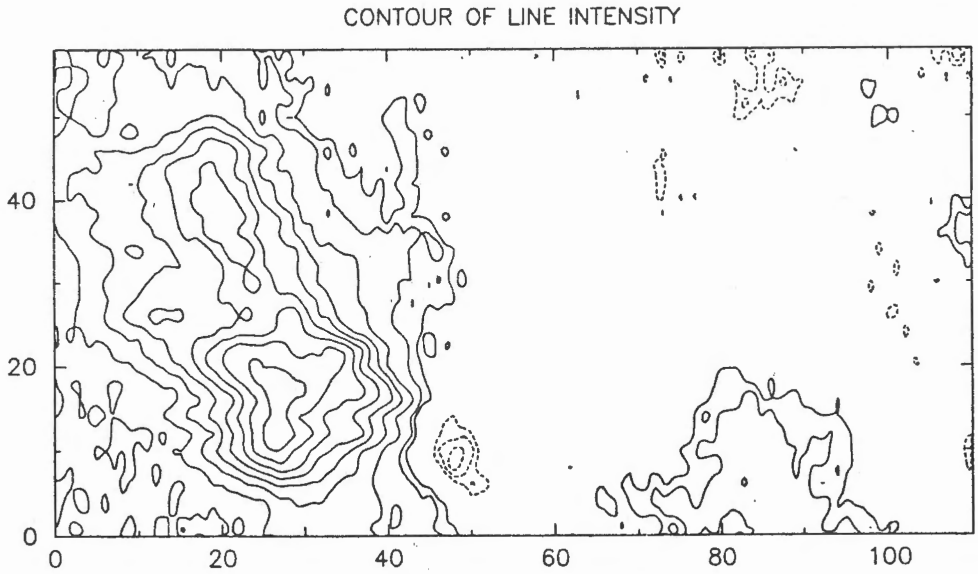

Fig. 4. Intensity contours of the same flare as shown in Fig. 3.