

Digitization of Kodaikanal Data

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Abstract. In this report we describe a digitizer developed in the laboratories of the Indian Institute of Astrophysics (IIA) to digitize the large amount of solar synoptic data obtained since 1904 at Kodaikanal. We show a sample spectrum, an $H\alpha$ spectroheliogram, and a Ca^+K spectroheliogram digitized using this equipment. The digitized data will be used to study the temporal variations in photospheric and chromospheric rotation rates, the solar differential rotation, the evolution of sunspots & $H\alpha$ filaments, and in the evaluation of Ca^+K plage and network indices. The digitized data will be made available to the scientific community as a part of IIA's astronomical data archive.

1. Introduction

About 100 years of solar data are available on photographic films and plates at the Kodaikanal Observatory. The various telescopes and instruments used to procure the data have been described by Bappu (1967). Further, a large quantity of spectroscopic data obtained at the Main spectrograph of the Solar Tower Telescope, mainly comprising of integrated Ca^+K line profiles, are also available, for the past about 20 years, on photographic films. The photographic emulsion is prone to damage even if preserved carefully, as is being done at Kodaikanal. The valuable data have been, and continues to be used for a variety of scientific studies. In particular, the temporal variations of the Sun continues to be carried out by many groups using the Kodaikanal data (Singh & Bappu 1981; Singh & Prabhu 1985; Singh & Livingston 1987; Muneer & Singh 2002) and data from other observatories (Foukal 1996; Worden, White & Woods 1998; Caccin et al. 1998; Brandt & Steinegger 1998; Johannesson, Marquette & Zirin 1998; Howard 1991; Howard 1996). So the digitization of Ca^+K spectroheliograms was taken up using a PDS machine in the beginning of 1990s. The PDS machine took about 25 minutes to digitize a single

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plate. Obviously, this process was very slow and hence the complete digitization of the data remained incomplete. Moreover the PDS machine developed some defects and the manufacturer was not in a position to rectify this because of non-availability of spare parts. Under these circumstances, we have developed a digitizer using a CCD camera and installed it at the Kodaikanal Observatory. The rate of digitization is sufficiently fast for the large volumes of data to be digitized, and a commonly used format is used for the data storage. The purpose of this report is to bring to the knowledge of the scientific community, the availability of this facility and the data archival.

2. Details of the Digitizer

We have used an available contact printer to provide a uniform light table. A stabilized power supply is used to avoid the intensity fluctuations of the source. A Nikon 28–105 mm lens with Micro facility is used to image the photographic plate emulsion on to the CCD camera. There is provision to add a 2X lens to obtain higher spatial resolution while digitizing small sized images. The *Andor* CCD camera has a 2048 × 2048-format scientific grade chip with pixel size of 13.5 micron. The Peltier cooled CCD camera can be cooled to -60°C using air circulation and to -70°C with water circulation. The digitized image can be read with a 4-speed range between 31.25 kHz and 1 MHz.

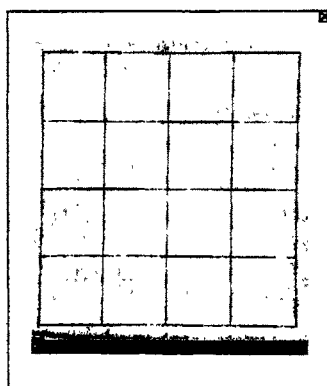


Figure 1. The digitized image of a grid of 20 cm × 20 cm size. Each small square has sides 5 cm wide on the plate. The 2X tele-converter and a zoom lens were used at 50 mm focus. Initial measurements on the image show no significant vignetting in the central 10 cm region.

In order to digitize an image area of up to 200 mm in size, and to minimize the vignetting effects, we have chosen a distance of about 60 cm between the scanning plate and the imaging lens. By adjusting the focal length of the lens, one can vary the magnification. The present set up provides a range of 0.04 to 0.12 mm on the photographic plate per pixel on the CCD. The digitized data can be stored on hard disc in any of the formats such as fits, jpeg, bmp, tiff, and ASCII. In addition, the software of the CCD creates a

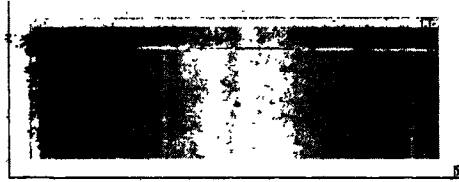


Figure 2. The digitized image of Ca^+K line region between about 3932 and 3937 Å. The emission reversals are readily seen. The 2X tele-converter and the zoom lens at 105 mm focus provided an image scale of 44.1 micron of the spectrum per pixel.

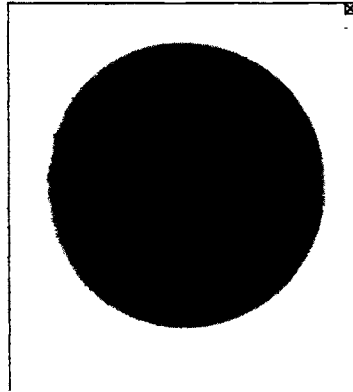


Figure 3. The digitized image of a photoheliogram of about 20 cm diameter using 2X tele-converter and zoom lens at 50 mm focus. The image scale is 73.3 microns per pixel.

sif format file. The software also allows the dark and flat field corrections to be carried out on the scanned images.

3. Results

Figure 1 shows the digitized image of a 20×20 cm grid using the 2X tele-converter and zoom lens at 35 mm focus. The initial measurement of pixels between various distances indicates no measurable vignetting in the central area of upto 10×10 cm on the plates. Regions beyond this show a marginal vignetting. Therefore the Kodaikanal spectroheliograms and the spectra of comparable dimensions may be conveniently digitized. Figure 2 shows the digitized spectrum of about 5 Å width centered around the Ca^+K line obtained using the Main spectrograph. The 2X tele-converter and zoom lens at 105 mm focus were used on the scanner. This arrangement provides an image scale of 0.044 mm of the spectrum per pixel of the CCD. Figure 3, 4 and 5 illustrate respectively the digitized versions of sample broadband image of the Sun, Ca^+K and $\text{H}\alpha$ spectroheliograms obtained at the Kodaikanal Observatory. The details of the setup used for these are given in the figure captions.

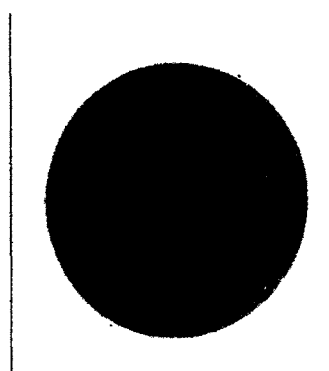


Figure 4. The digitized image of a Ca^+K spectroheliogram of about 60 mm diameter. The 2X tele-converter and the zoom lens at 78 mm focus were used. The image scale is 52.8 microns per pixel.

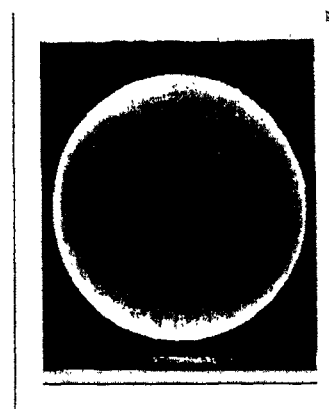


Figure 5. The digitized image of an $\text{H}\alpha$ spectroheliogram. The settings are same as those described in Figure 4.

We have so far digitized only a sample set of data. We shall shortly start digitizing the spectroheliograms and the program specific spectra obtained at the Main spectrograph. Efforts are on to reduce the marginal vignetting which is presently occurring for areas beyond the central region of about 10 cm square on the photographic emulsion.

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