SYNOPTIC Hα FULL DISK OBSERVATIONS OF THE SUN FROM BIG BEAR SOLAR OBSERVATORY

I. Instrumentation, Image Processing, Data Products, and First Results

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Abstract. The Big Bear Solar Observatory (BBSO) has a long tradition of synoptic full disk observations. Synoptic observations of contrast enhanced full disk images in the Ca II K-line have been used with great success to reproduce the H I Lyα irradiance variability observed with the Upper Atmosphere Research Satellite (UARS). Recent improvements in data calibration procedures and image processing techniques enable us now to provide contrast enhanced Hα full disk images with a spatial resolution of approximately $2''$ and a temporal resolution of up to 3 frames min^{-1}.

In this first paper in a series, we describe the instruments, the data calibration procedures, and the image processing techniques used to obtain our daily Hα full disk observations. We also present the final data products such as low and high contrast images, and Carrington rotation charts. A time series of an erupting mini-filament further illustrates the quality of our Hα full disk observations and motivate one of the future research projects. This lays a solid foundation for our subsequent studies of solar activity and chromospheric fine structures. The high quality and the sunrise-to-sunset operation of the Hα full disk observations presented in this paper make them an ideal choice to study statistical properties of mini-filament eruptions, chromospheric differential rotation, and meridional flows within the chromosphere, as well as the evolution of active regions, filaments, flares, and prominences.

1. Introduction

Synoptic Hα full disk images are provided by many observatories around the world, e.g., Holloman Air Force Base in New Mexico, Kiepenheuer Institut für Sonnenphysik at the Observatorio del Teide/Tenerife in Spain, Learmonth Solar Observatory in Australia, National Solar Observatory at Sacramento Peak in New Mexico, Sonnenobservatorium Kanzelhöhe in Austria, and Hα spectroheliograms from Observatoire de Paris Meudon in France. In the past, high-resolution Hα imaging could only be carried out on limited areas of the Sun. Modern, large format CCD cameras enable us to obtain detailed images of the whole Sun. To the best of our knowledge, the only other large format CCD camera used for Hα full disk observations is operated at the Hiraiso Solar Terrestrial Research Center in Japan (Akioka, 1996). In this paper, we report on new image processing techniques enhancing the contrast of all chromospheric features and make limb prominences visible, as well. Hα full disk observations were usually used to survey solar activity, to find interesting objects, and to monitor flares. However, there are only a few research projects based on Hα full disk observations alone, but we argue that large format CCD cameras and advanced image processing techniques provide a unique opportunity for studies with full disk data.

Full disk data from BBSO have been mainly analyzed in the context of irradiance variations with the solar cycle, e.g., high-contrast, full disk images observed in the Ca II K-line were successfully used in previous studies (Johannesson, Marquette, and Zirin, 1995, 1997) to reproduce the H I Lyα irradiance variability observed with the Upper Atmosphere Research Satellite (UARS) and to model the extreme ultraviolet irradiance variability of the Sun (Warren *et al.*, 1996). Lean *et al.* (1998) utilized BBSO's contrast enhanced Ca K filtergrams to assess the component of solar irradiance variability that can be attributed to bright magnetic features. We refined the data acquisition and image processing techniques and applied them to white-light and Hα full disk images in October 1997. Currently, we are investigating the potential of supplementary observations in the G-band at 430.6 nm and in the violet wavelength region from 382.8 nm to 384.6 nm where many absorption lines are formed by Mg I, Fe I, and CN molecules (Chapman, 1970).

With the Yohkoh satellite, the Solar and Heliospheric Observatory (SOHO is currently defunct, but may return to operational status and near-term alternatives are beeing considered as well.), and the Transition Region and Coronal Explorer (TRACE) in space probing the solar atmosphere from the photosphere to the corona, Hα full disk observations with high temporal and spatial resolution should prove to be one of the key diagnostic tools for determining the magnetic field topology between the photosphere, transition region, and corona. Domingo, Fleck, and Poland (1995) present an overview of the SOHO mission, and first results from SOHO have been published in a special issue of *Solar Physics* (Fleck, 1997). The TRACE mission was outlined in Strong *et al.* (1994).

We first show a typical contrast enhanced Hα full disk image which was observed on 29 October 1997. In the following sections, we will focus on this particular data set to demonstrate and examine its potential to study solar activity and the evolution of chromospheric fine structures. Figure 1 shows an Hα full disk image superimposed on a Stonyhurst grid. Several dark filaments and two active regions (NOAA 8099 and NOAA 8100) with bright Hα plages are visible in this contrast enhanced image. The image calibration and image processing procedures described in this paper allow the simultaneous display of disk features, as well as prominences above the solar limb. The richness in detail of these limb features is at least comparable or even better than observations made with complex instru-