NEW Hα INSTRUMENTATION AT THE KANZELHÖHE SOLAR OBSERVATORY

A. Hanslmeier¹, W. Otruba², and W. Poetzi²

¹Institut für Geophysik, Astrophysik und Meteorologie, Univ.-Platz 5, 8010 Graz, Austria
²Sonnenobservatorium Kanzelhöhe, A-9021 Treffen, Austria

ABSTRACT

We present a short overview over new instrumentation developed at the Kanzelhöhe Solar Observatory. The main advantages of this observatory is a permanent staff which permits continuous solar monitoring. Due to the high quality of data (especially Hα) and the incorporation of the observatory into several international solar observing campaigns new developments are done continuously. Observing in the wings of Hα provides the possibility to study different phenomena such as waves and oscillation propagation.

Key words: Sun, Instrumentation, Hα, waves.

1. INTRODUCTION

The solar observatory Kanzelhöhe belongs to the institute for Geophysics, Astrophysics and Meteorology of the University of Graz, Austria. It was founded in 1943 in order to serve as an observatory for predicting solar activity that influences the communication systems on Earth which was of great interest during the second world war. The location is: N 46°40.7 and E 13°54.4 and the elevation is 1526 m. It is mostly but not entirely dedicated to solar observations because also monitoring of parameters that are important for the environment is performed. Comparing to large solar observatories such as the Observatorio del Teide the main advantage is that a permanent staff is working there during the whole year.

Typically we observe on 300 days per year with about 2000 hours of observations. The main instrumentation for solar observations consists of:

- Patrol instrument: this consists of a multi purpose instrument which observes the full disk at different wavelengths: Hα, Na-D, white light.
- Hα instrument: consists of a refractor d/f=100/2000. The filter is a 0.7 Å FWHM Zeiss Lyot Filter. The data are stored in two modi:

1. 1kx1k 10 Bit CCD Pulnix TM-1010 10 frames/sec with frame selection.
2. 2k×2k 14 Bit CCD Apogee KX4 camera (NSF funded, together with the Big Bear Solar Observatory) 1 frame/ 5 sec.

This system is part of the Global Hα Network.

- A recent development is to use the filter as a tunable filter for observations in the line wings of Hα.

2. IMAGE REDUCTION PROCEDURES

To select the "best" one of a number of consecutive frames we are looking for the frame with the maximum variance in a subsection of the frame near disk center. The variance is directly correlated to the average contrast of the image and can be calculated using a fast internal routine of the frame grabber’s on-board DSP.

Also a kind of flat fielding and limb darkening correction is done. The read-out noise of the system
Figure 2. Filter properties, $6563\AA$, $0^\circ$, $60^\circ$, $120^\circ$, $180^\circ$, $240^\circ$, $300^\circ$.

Figure 3. GOES data are used for triggering.
is very low. Only two pixels are different from zero in dark images, although one pixel column is corrupt and shows an arbitrary shift in intensity. But investigation of correlation to the neighboring columns and autocorrelation of the column showed the column to be consistent itself. So one can determine the shift for each image and correct it by subtraction. Further a large scale asymmetry can be observed. It can be removed by using a flat fielding method developed by K. Burlow-Vasilev at KIS Freiburg, Germany. This method, which uses a single frame, splits the solar disk into concentric rings and fits polynomials into these. As the disk is supposed to be radial symmetric in large scales the polynomials give the image distortion similar to a Fourier decomposition. Combining the polynomials of the rings this method gives also the center-to-limb variation of the sun.

The images are centered and oriented. Image center coordinates \((x_0, y_0)\) are determined by looking for the middle between the maximum gradient positions along several pixel rows (for \(x_0\)) and columns (for \(y_0\)) and averaging the row and column data. The image is shifted near to center by an integer amount of pixels to avoid data distortions due to pixel averaging.

Because of the equatorial mounting of the telescope we don't have a systematic image rotation during the day. Therefore the correction angle \(\Delta \phi\) which denotes the inclination of the E-W-direction with respect to the frame axes is constant beside some small variations (less than \(\pm 0.2\) deg) due to small imperfections of the telescope and the mounting. It can be determined and checked from time to time by recording a set of images with turned-off tracking system and computing the track of the disk centers. Heliographical positions can be given better than \(\pm 0.5\) deg.

3. OBSERVING PROGRAMS IN \(\text{H}\alpha\)

The filter properties were already described in the previous section. We now give some new developments in hard and software to adjust the observations and frame rates for different specific problems. In order to define the observing modes the following guidelines were taken into account:

- frame selection for better image quality (seeing)
- observe as much as you can,
- browse observations and dismiss useless data later
- archive at least a standard time-series

Of course such a system also has its natural limitations:

- image acquisition rate (frame grabber)

Figure 4. Flare observed according to triggering by GOES.

- frame selection
- time to write selected frame to HDD
- total HDD space

We therefore define two modes:

High-Speed Mode: 1 Image per 2-3 sec only in line center.

Script Mode: depending on the solar activity level the following modes are available: for quiet periods 1 Image per 5-8 sec in line center and for active periods 1 Image per 5-8 sec in line center plus 1 Image per min, line wings set. The active periods are determined in real-time by using the GOES X-ray flux. The image selection can be done automatically and manually. On a RAID system 240GB for temporal archiving of full resolution images are available.

Low cadence data - extracted from the basic data - are processed to meet the standards of the SOHO Ground Based Synoptic Observations. These images are available online from the Kanzelhöhe WWW server (http://www.solobskh.ac.at) and are mirrored by the SOHO-WWW site. The routine service started in Feb 2000.

4. SCIENTIFIC ARGUMENTS FOR OBSERVING IN H-ALPHA LINE WINGS

Kneer and V. Uexküll (1984) performed a fourier analysis of time sequences of observations in the \(\text{H}\alpha\) line core and \(\pm 0.5\) Å (in total 128 min) to observe acoustic waves.

The problem of forecasting flares on the basis of preflare activity in the \(\text{H}\alpha\) line wings is discussed by Shilova (1985).

Kawaguchi et al. (1982) observed brightening in \(\text{H}\alpha\) +1.2Å. The phenomena have been interpreted as small flares or subflares, and seem to be the optical counterpart of the multiple loop activation detected on the EUV observations of Skylab.

Ding et al (2001) made numerical tests to study the wing fluctuations observed. Fine temporal structures
in hard X-ray and microwave emissions of solar flares have been known for many years. Recent observations with high time and spatial resolution revealed that emissions in the wings of Hα could also exhibit fast (subsecond) fluctuations. They found that the background Hα wing emission is mainly formed in the photosphere, the fast fluctuations are probably produced in the chromosphere.

REFERENCES


Shilova, N.S., Abastumanskaia Astrofizicheskaia Obseratoriia, Biuleten' (ISSN 0375-6644), no. 60, 1985, p. 253


Figure 5. Full disk Sun observed at different filter-tunings: $\phi$, $60\phi$ ($-0.3\AA$), $150\phi$ ($+1.7\AA$)