PHOTOMETRIC OBSERVATIONS OF THE
SOLAR ATMOSPHERE IN SEVERAL WAVELENGTHS
AT KANZELHÖHE SOLAR OBSERVATORY

M. STEINEGGER and A. HANSLMEIER
Institut für Astronomie, Universitätsplatz 5, A–8010 Graz, Austria

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Abstract. A small full-disk telescope for photometric observations of the Sun is currently under construction at the Institute of Astronomy in Graz, Austria. After completion this instrument should be installed during 1998 at Kanzelhöhe Solar Observatory. It will provide long-term solar observations of the photosphere and chromosphere in various wavelengths with high time cadence. The photometric data obtained will be made accessible to the public by means of an on-line archive, which will also be incorporated into the international network of ground-based supporting stations for the SOHO mission. Among the scientific objectives to be pursued with these photometric data are the interpretation and modelling of solar irradiance variations as observed e.g. by the VIRGO experiment onboard the SOHO satellite.

Key words: full-disc solar telescope, photometry, solar irradiance

1. Introduction

Kanzelhöhe Solar Observatory was founded in 1943 and is situated in the southern part of Austria in the province Carinthia. It is the only professional solar observatory in Austria and is operated by the Institute of Astronomy in Graz. The observing conditions at an elevation of 1530 m are quite excellent for solar observations of moderate spatial resolution. The average duration of sunshine is approximately 2000 hours on more than 300 days per year. These favourable climatic conditions in combination with the good infrastructure present at the mountain predestine Kanzelhöhe So-
lar Observatory for many kinds of long-term solar observations which do not require high spatial resolution.

Currently the main routine observations performed at Kanzelhöhe are the following: (a) Daily drawings of sunspots and spot groups are produced from a projected solar image of 25 cm diameter. From these drawings a continuous time series of more than 50 years exists. Sunspot numbers are derived from these data and are reported regularly to the corresponding data centers. (b) Daily full-disk images of the photosphere at 546 nm (bandwidth 10 nm) are obtained with the Kanzelhöhe photoheliograph (Pettauer, 1990). These white light images are recorded on photographic film to achieve very high contrast for the precise determination of sunspot positions and areas (Pettauer, 1994; Pettauer and Brandt, 1997). With a diameter of 87 mm these images are among the best full-disk images available regarding spatial resolution. (c) Daily Hα images at 656 nm (bandwidth 0.07 nm) are observed with a 8 bit 1 K × 1 K pixels CCD camera. These data are available on-line and are part of the archives for the ground-based support of the SOHO (Solar and Heliospheric Observatory) mission (e.g. Domingo, Fleck, and Poland, 1995). (d) Nowadays also full-disk magnetograms are recorded on a daily basis with the new installed magneto-optical filter, which is a co-operation with the Trieste Astronomical Observatory and the Department of Physics at the University of Rome.

Recently, ground-based photometric full-disk observations of the Sun have become of increasing importance in solar physics. These observations are especially valuable and necessary in trying to understand, to model, and to predict solar irradiance variations on various time scales. See e.g. Steinegger et al. (1996) for details about using high resolution observations of active regions for the modelling of solar constant variations during a period of maximum solar activity.

The VIRGO (Variability of Solar Irradiance and Gravity Oscillations) instrument onboard the SOHO satellite provides continuous observations of the total solar irradiance as well as of the spectral irradiance at three different wavelengths (Fröhlich et al., 1995). In order to understand the physical origins of the observed variations of the solar energy output many efforts on international level are undertaken or being planned. One example
is the RISE/PSPT (Radiative Input from the Sun to Earth/Precision Solar Photometric Telescope) project (e.g. Coulter, Kuhn, and Lin 1996; Ermolli et al., 1997). This is a small network of photometric telescopes for long-term observations of the Sun with high time cadence.

A small observatory like Kanzelhöhe Solar Observatory is very well suited for this type of long-term observations on a routine basis with high temporal resolution. Such kind of special and dedicated programs using small instruments enable also small observatories to make important and valuable contributions to solar physics. Therefore, a project was initiated to construct and operate a small full-disk telescope for photometric observations of the Sun in several different wavelengths. The details of this telescope and the planned observations are outlined in the following sections.

2. The Instrument

The new photometric telescope will be an enlarged and improved version of an already existing prototype, the so-called ”Telescopio Symbiotic” constructed by the solar group of the Instituto de Astrofísica de Canarias (IAC) at Tenerife, Spain. This Spanish telescope is mounted to the Vacuum Newton Telescope, hence the name symbiotic telescope, at the Observatorio del Teide and provides photometric full-disk data since April 1996 (Bonet et al., 1996). However, our telescope will have a larger aperture, a longer focal length, and it will be equipped with a larger CCD camera. Additionally, our instrument will be operated during the whole year, which is not possible with the prototype because the Observatorio del Teide is usually closed during winter.

The main components of our improved instrument, which should be installed at Kanzelhöhe Solar Observatory in 1998, are the following (see Figure 1): (a) A commercially available refractor of 12 cm aperture and 114 cm focal length, both approximately twice that of the prototype and therefore yielding a much better spatial resolution. A filter in front of the objective lens will transmit only about 10% of the incoming light in order to avoid problems with heating inside the tube. (b) A filter wheel
constructed to hold a maximum number of eight interference filters of 2 inch diameter. It is controlled by a small stepping motor. (c) A pair of crossed polarizers which enable us to adjust the intensity of the incoming light beam and therefore the level of counts detected by the camera by simultaneously keeping the exposure time constant. Of course, the exposure time can also be controlled by the software of the camera. The polarizers are also moved by a small stepping motor. (d) A 1 K × 1 K pixel CCD camera with 8 bit dynamic range. The pixel size of 12 μm in combination with the given optical system corresponds to 2.17 arcsec or an effective spatial resolution of 4.3 arcsec.

Fig. 1. The optical layout of the photometric full–disk telescope; adopted from Bonet et al. (1996).
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3. Observing Wavelengths and Modes of Operation

The first three filters to be installed are one for chromospheric observations at Ca K (393.3 nm, bandwidth 1.50 nm), and two for observations of the photosphere in a blue (409.4 nm, bandwidth 0.25 nm) and a red (607.2 nm, bandwidth 0.50 nm) continuum window. The Ca K filter is the same as the one used at the IAC and the latter two are intentionally compatible with the wavelengths used by RISE/PSPT in order to enable data exchange, to fill observation gaps and to stimulate collaborations.

Additionally, there are plans for the future to install three more filters, i.e. a small-band Ca K filter, one for observations in the G-band, in which the photospheric faculae show high contrast even near the solar disk center, and one for a continuum window in the green wavelength region.

The minimum of intended daily routine observations will be one image per filter per day. However, the aim is to obtain one image of the solar disk per filter per hour. In addition to this routine observing mode there will be the possibility to use the telescope also for special dedicated observing campaigns, e.g. for parallel observations with other instruments, for which the frequency of observations can be increased even more.

All observations obtained with this instrument will be made available to the public through a World Wide Web server. This data archive will be quite helpful for stimulating collaborations and data exchange with other institutions. It is also planned to provide the data as a ground-based support for the SOHO mission and to incorporate them into other solar data bases.

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References


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FOTOMETRIJSKA OPAŽANJA SUNČEVE ATMOSFERE NA NEKOLIKO VALNIH DULJINA NA SUNČEVOM OPSEVATORIJI KANZELHÖHE

M. STEINEGGER and A. HANSLMEIER
Institut für Astronomie, Universitätsplatz 5, A–8010 Graz, Austria

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Ključne riječi: teleskop za opažanje Sunca, fotometrija, Sunčeva iradijancija

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