Photosphere and chromosphere telescope at Hvar Observatory

Jaša Čalogović, Mateja Dumbović, Bojan Vršnak, Roman Brajša
Hvar Observatory, Faculty of Geodesy, Kačićeva 26, HR-10000 Zagreb

P-O-KRet
HUMAN RESOURCES DEVELOPMENT
STRUKTURNI I INVESTICIJSKI FONDOVI
Europska Unija
Ulaganje u budućnost
Projekt je sufinancirala Europska Unija iz Europskog socijalnog fonda
SOLSTEL
hrzz Hrvatska zaklada za znanost

Abstract

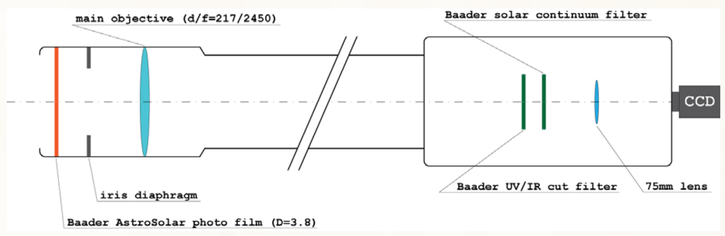
The double solar telescope at the Hvar Observatory consists of two Carl Zeiss refractors, attached as one unit on a German parallax mounting. The photosphere telescope has an objective diameter of 217 mm and the chromosphere telescope has a diameter of 130 mm. It provides a valuable instrument to study rapid changes of chromospheric and photospheric features. Using a field of view of about 11 and 7 arcmin, it aims to produce high-resolution and high-cadence imaging of active regions on the Sun. Modern Pulnix TM-4200GE 12-bit 4 megapixel CCD cameras allow to obtain time series with a cadence up to 30 images per minute. High-cadence chromosphere ground-based observations are an important tool to identify and study solar flares, filaments and other solar phenomena that are associated with coronal mass ejections and their propagation to the Earth. Hence these observations can be also used to improve space weather forecasts.

Introduction

The double solar telescope at Hvar Observatory was built in 1972 based on an agreement between the Faculty of Geodesy of the University of Zagreb and the Astronomical Institute of the Czechoslovak Academy of Sciences. Since that time, continuous development on the telescope and its acquisition system followed the rapid evolution of the electronics and computers. In 1997 the original photographic material acquisition system was replaced by a video-recording system, and then again in 2004 with 1MPix 10-bit CCD camera. In 2010, the fourth generation of acquisition hardware and software was installed, together with some improvements on the optical telescope design. As a result of tight collaboration between the Faculty of Geodesy and the Institute of Physics (IGAM) of the University of Graz, Hvar Observatory implemented identical acquisition system as the Kanzelhöhe Solar Observatory. The aim is to complement Kanzelhöhe full-disc images by Hvar active-region high-resolution images.

The Photosphere Telescope

The main objective of the Hvar photosphere telescope is achromatic doublet with diameter of 217 mm and the focal length of 2450 mm. The optical system consists of Baader AstroSolar photo film, iris diaphragm, Baader solar continuum and UV/IR cut filter, 75mm lens and CCD camera. The adjustable iris diaphragm controls the amount of light in the telescope together with AstroSolar photo film which reduces sunlight intensity to about 0.001%. The Solar Continuum Filter is designed to enhance the visibility of solar granulation and sunspot details by transmitting a specific spectral region around 540 nm, free of emission and absorption lines thus boosting the contrast and reducing the effects of atmospheric turbulence. The field of view of the corresponding system is about 11.28 arcmin, yielding the resolution of 0.33 arcsec/pix with 2048x2048 pixels CCD camera.



Statistics (6.5.2011 - 11.9.2015)

Chromosphere observations (15s cadence)

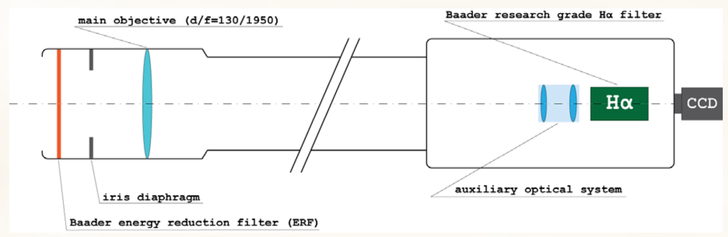
- Number of days observing: 385
- Number of images: 399 400
- Total duration: 1664h (69 days)
- Size in archive: 3.2 Tb

Photosphere observations (60s cadence)

- Number of days observing: 367
- Number of images: 94 100
- Total duration: 1568h (65 days)
- Size in archive: 760 Gb

The Chromosphere Telescope

The optical system of the chromosphere telescope consists of an energy reduction filter, iris diaphragm, main objective, auxiliary lens, H-alpha filter and CCD camera. The main objective is an achromatic doublet with a diameter of 130 mm and focal length of 1950 mm. The energy reduction filter blocks most of the sunlight, thus decreasing the heating and turbulence inside the telescope. A Baader research grade filter with 0.2 Å passband is used. The field of view with corresponding system is about 7.15 arcmin what gives 0.21 arcsec/pix with 2048x2048 pixels CCD camera.



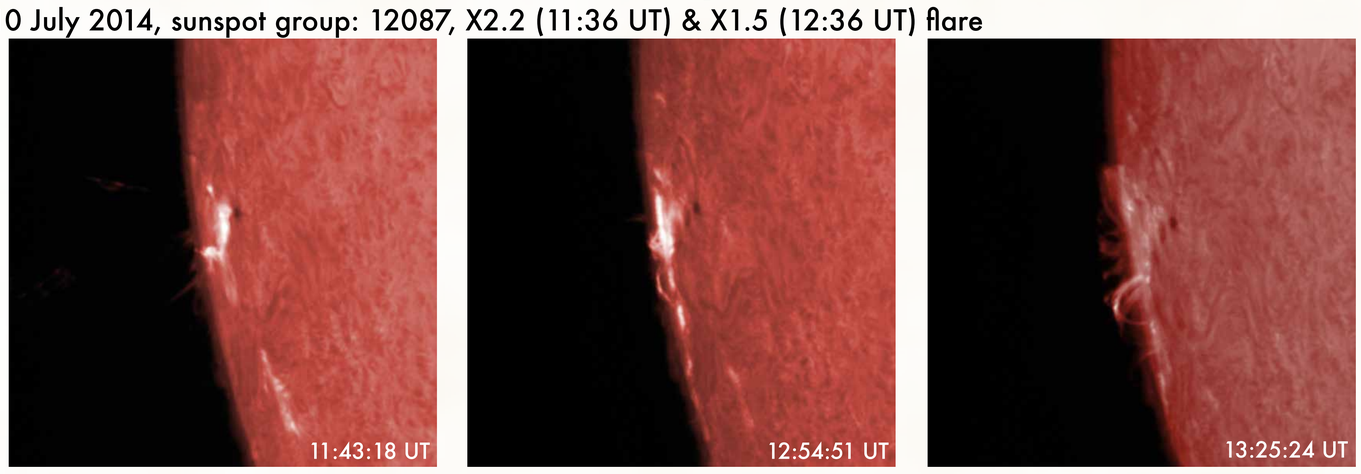
Acquisition system and data

Both telescopes are equipped with Pulnix TM-4200GE 12-bit CCD cameras, connected to 2 windows PCs in the control room below the dome. The acquisition software displays the real-time images, and saves the data time-series in the FITS and JPEG format with corresponding information headers. It also regulates the exposure time automatically and performs the frame selection (cameras are recording 7 frames per second), which is employed to select moments of good seeing. A standard time series uses the image cadence of four images per minute for the chromosphere and one image per minute for the photosphere. However, a cadence up to 30 images per minute is available for specific purposes. All obtained data are stored in central archive on the server located iz Zagreb and are available to public upon request. Daily movies with photosphere and chromosphere observations can be accessed on **http://oh.geof.unizg.hr** website.

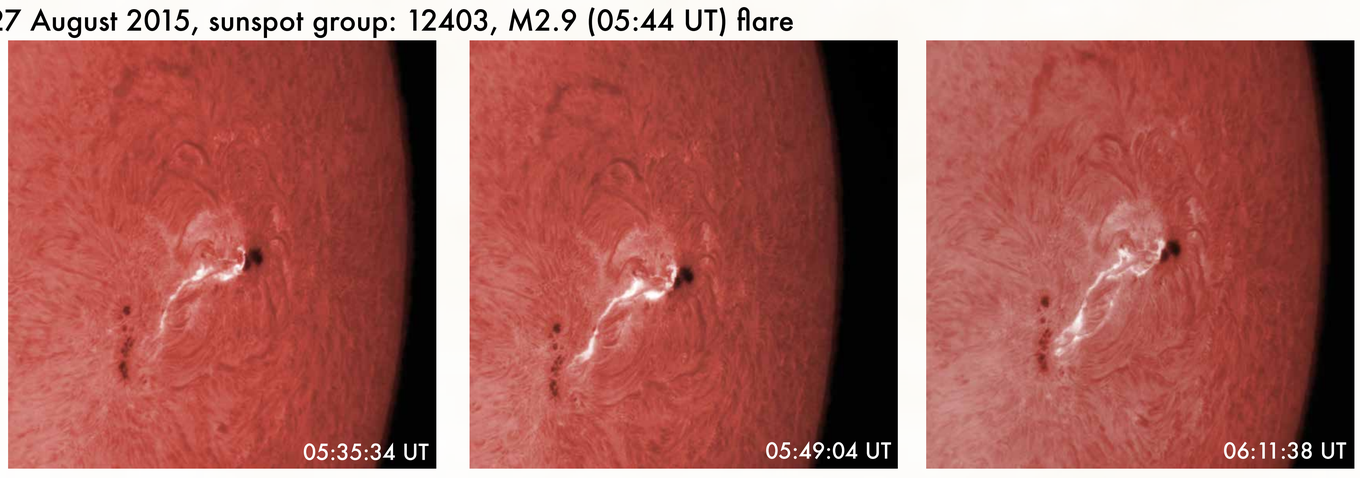
Observations

Chromosphere

10 July 2014, sunspot group: 12087, X2.2 (11:36 UT) & X1.5 (12:36 UT) flare

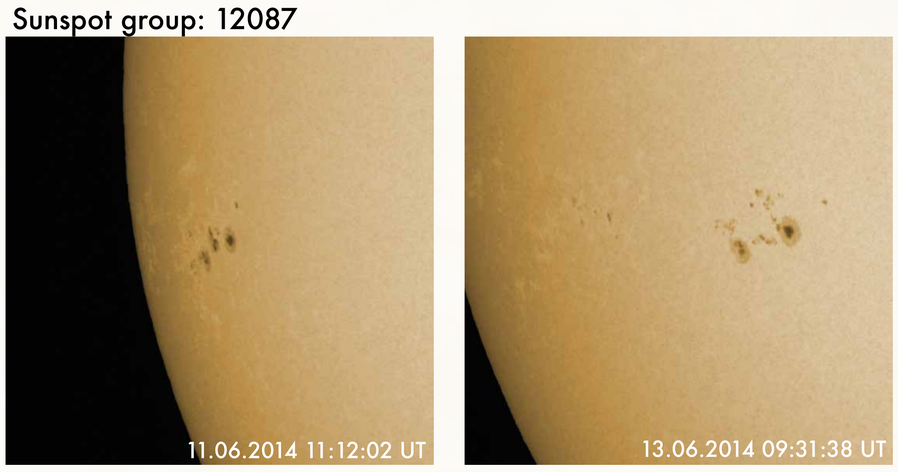


27 August 2015, sunspot group: 12403, M2.9 (05:44 UT) flare

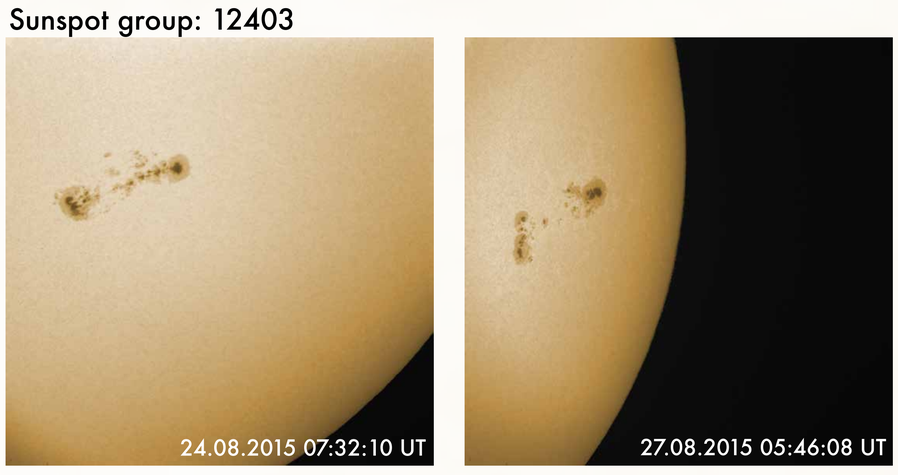


Photosphere

Sunspot group: 12087



Sunspot group: 12403



Acknowledgements:
This work has been supported by the **ESF** project **PoKRet** and Croatian Science Foundation project 6212 "Solar and Stellar Variability" (**SOLSTEL**). We thank tehnicians Nikša Novak and Toni Visković for performing observations on the telescope.

For more information about Hvar Solar Telescope visit:
http://oh.geof.unizg.hr/index.php/en/instruments/solar-telescope
Correspondence to: **jcalogovic@geof.hr**