The LSO/KSO Hα prominence catalogue – cross-calibration issues

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Abstract: Prompt report on extension of the Lomnicky Peak Obsevatory (LSO) Hα prominence catalogue for the epoch 1967 – 2009 (Rušin et al., 1988, 1994) onwards incorporating observations of the Kanzelhöhe Observatory for Solar and Environmental Research (KSO) is presented. Main aim is focused on cross-calibration issues faced when comparing data acquired at two observatories which use different observing setups and detection techniques. Using data of 20 common Hα prominences gained in 5 different days in August/September 2009 significance of differences of the derived Hα prominence parameters are investigated. Reduction of the Kanzelhöhe observations and following adaptation of the KSO Hα prominence parameters to the Lomnicky peak Hα prominence catalogue scale are presented confirming that no special homogenization is needed to create a common catalogue data set. The new common LSO/KSO Hα prominence catalogue is intended to be continued in the future.

Introduction

It is well-known fact that time-latitude distribution of Hα prominences (and filaments) can provide a possibility for investigation of global properties of large-scale magnetic fields on the solar surface. After Secchi's discovery (Secchi, 1872) of the polar zone of Hα prominences migrating poleward this topic has attracted serious interest (e.g., Abetti, 1957, Waldmeier, 1973, Makarov and Sivaraman, 1985, Bumba et al., 1990, Dermendjiev et al., 1994, Minarovjech et al., 1998, Callebaut et al., 1998, Rušin, 2000, Minarovjech, 2007, Li, 2010). Understanding of the cycle-to-cycle variability and complexity of the multiple polar zones and their relation to the last evolutionary stages of individual magnetic cycles require continuous observations of Hα prominences and creation of a homogeneous long-term Hα catalogues of such data thereafter incorporating both the latest and the very first observations of the previous solar cycles.

Our contribution presents a progress report on extension of one of the most prominent Hα prominence catalogues available - the Lomnicky Peak Observatory (LSO) Hα prominence catalogue 1967 – 2009 (Rušin et al., 1988, 1994) - onwards incorporating current observations of the Kanzelhöhe Observatory for Solar and Environmental Research (KSO). It is expected that continuation of this catalogue will provide data set for research of the solar cycle variability.

LSO Hα prominence catalogue

- **Telescope:** 20cm Zeiss coronagraph (Lexa, 1963)
- **Hα filter:** interference filters (passband ~0.5 nm)
- **Film camera:** Praktina IIA (24 x 36 mm)
- **Observing procedure:** 9 partly overlaping exposures taken along the limb to cover all position angles
- **Reduction method:** projection of the developed images for drawing of the prominences for their positions, shapes and estimation of their intensity
- **Catalogue:** period May 1967 – September 2009, 41512 prominences, 35,3% average time coverage, parameters: YY/MM/DD.DD, Carrington rotation, longitude, latitude, length along the limb (degrees), height (arcsec), area (degrees x arcsec), brightness (subjective estimate 1-3)
- **References:** Rušin et al., 1988, 1994
- **Main results:** time-latitude long-term cycle distribution of the prominence zones: main butterfly
- shape zones and multiple polar zones, predictions of solar cycles (e.g., Bumba et al., 1990, Dermendjiev et al., 1994, Minarovjech et al., 1998, Minarovjech, 2007, Rušin, 2000)

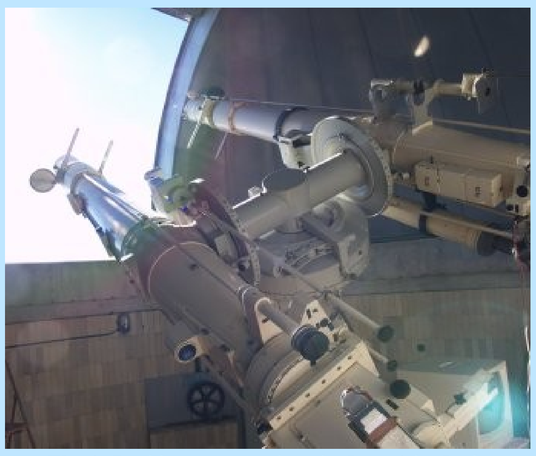


Fig. 1: Double coronagraph at the Lomnicky Peak.

KSO Hα prominence data

- **Telescope:** refractor D/f 100/2000 for full-disk patrol in Hα line (Otruba, 1999, 2002)
- **Hα filter:** Lyot filter - passband 0.07 nm
- **CCD camera:** Pulnix TM-4200GE, 12bit, 2kx2k
- **Observing procedure:** 3 full-disk exposures daily with exposures 5ms, 20ms, 50ms for the prominence catalogue program and CESAR archive with its near real-time service *(http://cesar.kso.ac.at)*
- **Reduction method:** reduction for mean dark current and sky brightness, merging of 3 exposures, intensity normalisation to the disk center intensity
- **Dedicated software:** IDL code for a semi-automatic calculation of the prominence catalogue parameters from the KSO normalized images
- **Parameters:** basic LSO prominence catalogue parameters and some additional ones: maximum, mean, total brightness, precise area

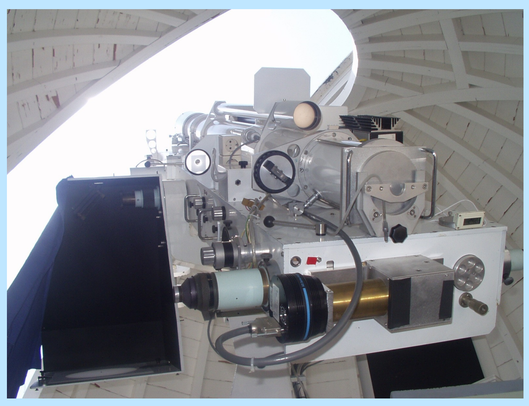
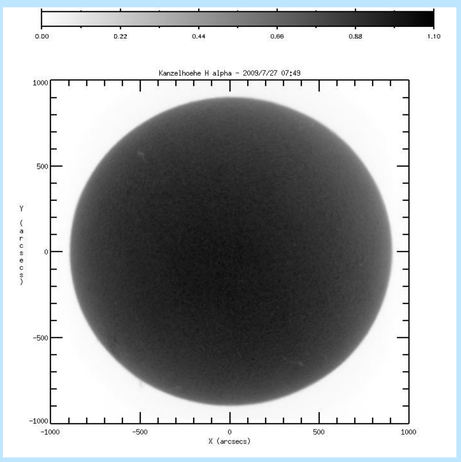


Fig. 2: Telescopes at the Kanzelhöhe Observatory.



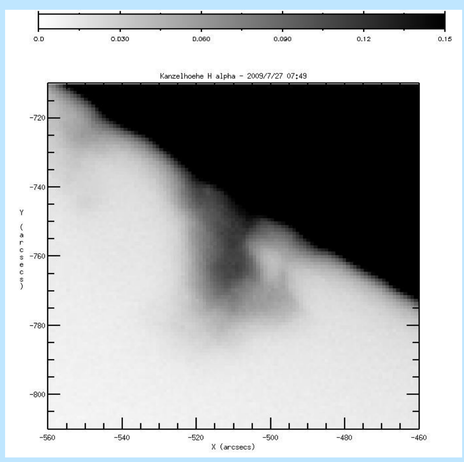


Fig. 3: Example of the calibrated KSO full-disk 5 ms image (left) and a part of the prominence 60 ms exposure after calibration of its intensity relatively to the disk center - test images of 27/07/2009. The test example shows typical spatial resolution and S/N ratio of the KSO images used for the LSO prominence catalague extension.

Cross-calibration of KSO and LSO data

In August and September 2009 parallel observations of prominences at both observatories were performed (Fig.4). Data of 4 days were selected for cross-calibration of the derived prominence parameters (25, 30, 31/8, 1/9). In total 20 prominences were determined without doubt as nearly common in both data sets. 7 KSO prominences were not found in the LSO data and 3 LSO prominences were missing in the KSO data. Inspecting all KSO images we found in total 5 couples of prominences which are related to just single prominences in the LSO data. Oppositely, 2 couples of the LSO prominences were found to be related to single prominences in the KSO data.

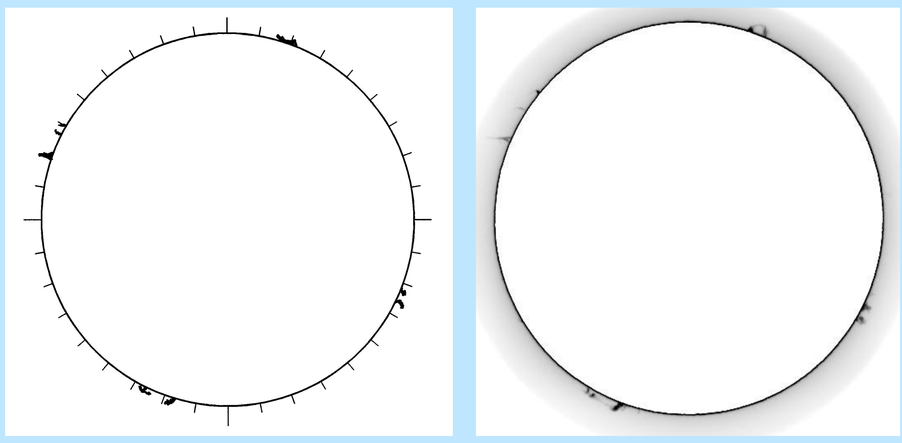


Fig. 4. Example of a pair of the LSO and KSO final images taken om 30/08/2009. These images have been used for determination of the prominence parameters for the catalogue purposes. The LSO image (left, 06:10 UT) is processed to a B/W two level scale. The KSO image (right, 09:50 UT) with continuous intensity scale and the sky background subtracted is shown with the disk data omitted.

Results

Main interest has been focused on the heliographic longitude and latitude parameters of prominences as these are crucial for determination of their time-latitude distribution. Scatter plots and linear fitting of latitude (Fig.5) and longitude (Fig.6) parameters of prominences determined from both, KSO and LSO data, show fairly good agreement of the results with overall shifts for only -0.65 and -1.95 degrees and 1σ scatter of 13.5 and 6.9 degrees for the latitude and the longitude data respectively.

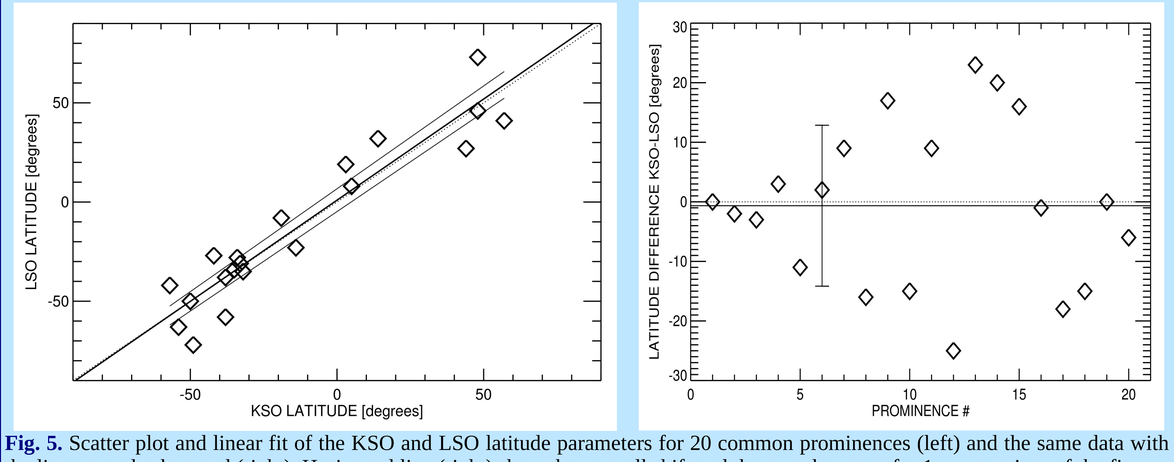


Fig. 5. Scatter plot and linear fit of the KSO and LSO latitude parameters for 20 common prominences (left) and the same data with the linear trend subtracted (right). Horizontal line (right) show the overall shift and the error bar stem for 1σ uncertainty of the fit.

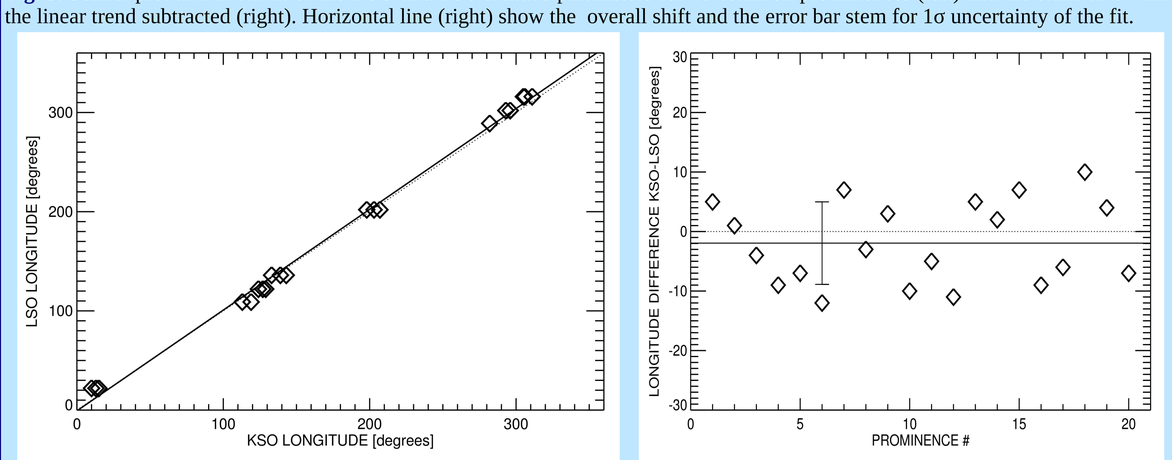


Fig. 6. Scatter plot and linear fit of the KSO and LSO longitude parameters for 20 common prominences (left) and the same data with the linear trend subtracted (right). Horizontal line (right) show the overall shift and the error bar stem for 1σ uncertainty of the fit.

Besides quite close KSO and LSO results there are also prominences with considerably larger latitude differences. Differences seem to be mostly caused by: significant difference of the intensity scale between the final LSO and KSO images (two smaller separated LSO prominences can be seen as one larger KSO prominence which interconnects the LSO ones, e.g. Fig.4, near south pole), different filter passbands, different time of observations, actual scattering conditions during exposures. Significantly outlaying latitude difference data (latitude difference more than ~10 degrees) are supposed to be just consequences of our too benevolent relation of completely different prominences together.

Conclusions

Special data acquisition procedure started in August 2009 at the Kanzelhöhe Observatory using its Hα patrol instrumentation and the data reduction of the KSO Hα prominence images in order to extend the Lomnicky peak Hα prominence catalogue. It is successfully tested that no special homogenization is needed to create a common catalogue data set. Reasons of the data scatter can be explained by the differences of the observing procedures at the KSO and LSO observatories and different data type and quality. The new common LSO/KSO Hα prominence catalogue is intended to be continued in the future with at least 2 times better time coverage.

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