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The LSO/KSO Hα prominence catalogue: cross-calibration of data

J. Rybák[1], P. Gömöry[1,2], R. Mačura[1], A. Kučera[1], V. Rušin[1], W. Pötzi[2], D. Baumgartner[2], A. Hanslmeier[3], A. Veronig[3] and M. Temmer[3]

[1] *Astronomical Institute of the Slovak Academy of Sciences 059 60 Tatranská Lomnica, The Slovak Republic, (E-mail: rybak@astro.sk)*

[2] *Kanzelhöhe Observatory for Solar and Environmental Research, Institute of Physics, University of Graz, A-9521 Treffen, Austria*

[3] *Institute for Geophysics, Astrophysics, and Meteorology, Institute of Physics, University of Graz, Universitätsplatz 5/II, A-8010 Graz, Austria*

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Abstract. We present work on the extension of the homogeneous prominence catalogue created for the epoch 1967 – 2009 at the Lomnicky Peak Observatory (LSO) by incorporating new data acquired at the Kanzelhöhe Observatory for Solar and Environmental Research (KSO). We use data of 20 Hα prominences observed almost simultaneously at both observatories during four days in August/September 2009 to analyze the significance of differences of the determined parameters used in the Hα prominence catalogue. A reduction of the data from KSO and adaptation of the resulting parameters to fit the parameters of the LSO catalogue confirm that no special homogenization is needed to create a common catalogue data set. Thus, we justified that the LSO catalogue could be extended onward in the future using a more comprehensive database of observations from KSO.

Key words: Sun: prominences – Sun: solar cycle – Catalogs

1. Introduction

It is a well-known fact that the 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, especially in polar branches. The variability and complexity of the multiple polar branches and their relation to both, the latest and very first evolutionary stages of individual magnetic cycles, require creation of homogeneous long-term Hα catalogues of prominences to cover as many solar cycles as possible. This paper reports on the extension of one of the most prominent Hα prominence catalogues available – the Lomnicky Peak Observatory Hα prominence catalogue 1967 – 2009 (Rušin *et al.*, 1988, 1994) – onwards incorporating current data taken at the Kanzelhöhe Observatory for Solar and Environmental Research (KSO) to the historical data acquired at the Lomnicky Peak Observatory (LSO). Such an extension will gain rich observational material, because there are more observing days at KSO than at LSO.

2. The LSO catalogue and the KSO data

The LSO prominence catalogue is based on the data taken with the 20 cm Zeiss coronagraph (Lexa, 1963) equipped with an Hα interference filter (passband $\sim$0.5 nm), and a film camera Praktina IIA. The standard observing procedure consisted of nine partly overlapping exposures taken along the solar limb to cover all position angles. The developed images were then used for determination of eight parameters of each prominence related to its position, shape and intensity. Such a method was used for the period between May 1967 and September 2009. The catalogue lists 41512 prominences with 35.3 % average time coverage (Rušin *et al.*, 1988, 1994).

The most relevant results derived from the catalogue concern the time-latitude long-term distribution of the prominence branches. Main branches, exhibiting the butterfly effect, and multiple, well-structured, polar branches were found (*e.g.*, Bumba *et al.*, 1990; Dermendjiev *et al.*, 1994; Minarovjech *et al.*, 1998; Minarovjech, 2007; Rušin *et al.*, 2000).

The full-disk patrol Hα images taken at KSO are now used to extend the LSO catalogue. In particular, three full-disk images with exposure times of 5 ms, 20 ms, and 50 ms are regularly taken once a day for the prominence catalogue program. These observations are made using a 100/2000 refractor, a Lyot Hα filter (passband 0.07 nm) and a Pulnix TM-4200GE 12-bit 2 k$\times$2 k camera (Otruba, 1999, 2002). The data are corrected for mean dark current and sky brightness. Afterwards all three images are merged together and intensities are normalized to the disk center intensity. Dedicated software for a semi-automatic calculation of the prominence catalogue parameters from the KSO images has been developed.

3. Results on cross-calibration of the data

We performed coordinated observations of prominences at both observatories in August and September 2009 (see Fig. 1). Data taken in four days, *i.e.*, four couples of images, were selected for cross-calibration of the prominence parameters. In total 20 prominences were determined as common in both data sets. Moreover, in five of these cases we found a single prominence in the KSO data but in the LSO data, in fact, a couple of prominences placed close to each other were detected. On the other hand, two couples of the LSO prominences were identified as a single prominence in the KSO data. Additionally, seven KSO

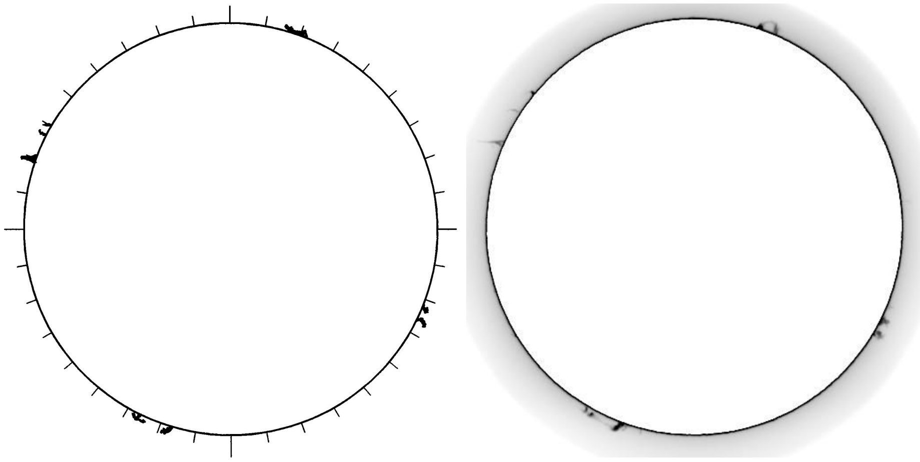

Figure 1. An example of a pair of the LSO and KSO final images taken on August 30, 2009. These images were used for determination of the prominence parameters for the catalogue purposes. The LSO image (left, 06:10 UT) is processed to a B/W two level scale. The KSO image (right, 09:50 UT), with a continuous intensity scale and the sky background subtracted, is shown with the disk data omitted.

prominences were not found in the LSO data and three LSO prominences were not detected in the KSO data.

Our main interest focused on the heliographic longitudes and latitudes of prominences as these are crucial for determination of a time-latitude distribution of prominences. The scatter plots and linear fitting of latitudes and longitudes of prominences determined from both, the KSO and the LSO data, showed fairly good agreement. We found that the overall shifts are only -0.65 and -1.95 degrees and the 1σ scatters are 13.5 and 6.9 degrees for the latitude and longitude data, respectively.

Besides prominences observed at both, the KSO and the LSO observatories, revealing parameters that are in good agreement, we found also prominences which exhibit considerably larger latitude differences. These differences seem to be mostly caused by:

1. significant difference of the intensity scale between the final LSO and KSO images (large arcade prominences with a fine intensity interconnection between two bright footpoints are identified as a single prominence in the KSO data while in the LSO data they are interpreted as two independent structures placed at different positions compared to the position of the prominences observed at KSO, *e.g.*, Fig. 1, near the south pole);
2. different filter passbands;
3. significant difference in time of observations;
4. different weather conditions during exposures.

Significantly outlaying differences of latitudes of prominences (more than ∼10 degrees) are a consequence of identification of completely different prominences as corresponding ones.

4. Conclusion

A dedicated data acquisition procedure started at KSO in August 2009 in order to extend the LSO catalogue of Hα prominences. A successful test showed that Hα observations of prominences performed at the KSO could be used to extend the LSO catalogue of Hα prominences. The reported scatter of parameters which can be explained by the differences of the observing procedures at the KSO and LSO observatories and by a different data type and their quality must be taken into account but they have no significant effect on general properties of the catalogue. No changes of the current observing procedures applied at the KSO is planned to match better the previous observing procedures used at the LSO. The new common LSO/KSO catalogue of the Hα prominences is intended to be continued in the future. With the KSO data we expect better time coverage of observations.

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