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An electronic archive of the solar prominence observations at Lomnický Štít coronal station

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Abstract. Observations of solar prominences at the coronal station at Lomnický Štít have their prominent footing in the station's research programme of the study of solar activity, in particular the dynamics of prominences and their relation with the properties of the green corona (530.3 nm, Fe XIV). First sporadic observations of prominences date back to 1962, while systematic ones (covering the full disc of the Sun, irrespective of the fact whether a prominence was present or not) started in 1968. The basic data on prominences such as their position, height, brightness and area are published on a regular basis in the Solar Geophysical Data. From a large number of observations made at Lomnický Štít, an electronic archive of prominences was created and we plan to digitalize some of the most intriguing material. The paper describes the way the filing is performed, how the data are to be further processed and used for the study of solar activity.

Key words: solar prominence – digitalisation

1. Introduction

Solar prominences (see Figure 1) rank among the most spectacular and interesting manifestations of solar activity. Although they have systematically been observed for more than 130 years, we are still lacking a satisfactory explanation of their origin, basic physical properties and their intimate link with other manifestations of solar activity like eruptions, coronal mass ejections, etc. There have been attempts to classify prominences according to various criteria like, e.g., their shape (Pettit, 1943), the speed of their development (Menzel and Evans, 1952), their brightness and the ratio of the intensities of various spectral lines observed in their spectra. On the other hand, prominences are also observed in the vicinity of sunspots and across the wole solar disc, being thus an invaluable tool for getting information about the properties of magnetic field on the Sun as a whole, in particular in the regions near the poles. The properties of their latitudinal distribution in the course of a solar cycle play a crucial role in our understanding of solar activity. Thus, for example, it has been found that the motion of so-called polar branches of prominences towards the poles, whose onset is around the minimum of a solar cycle, is always the same and independent of the strength of the solar cycle as ascertained from the number and area

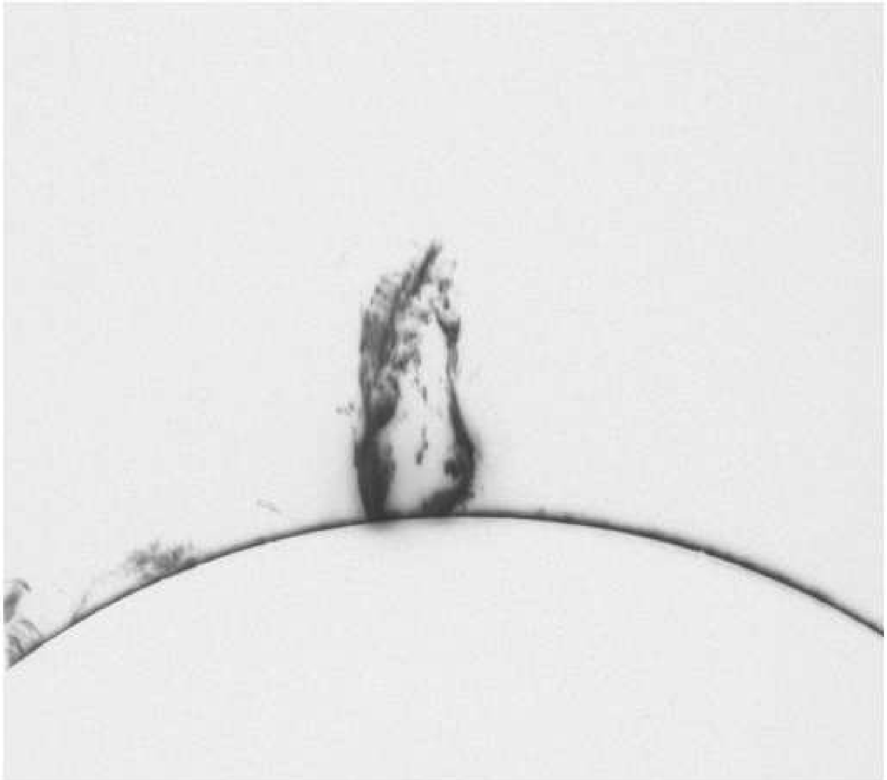

Figure 1. An Interesting part of eruptive prominence as observed at the Lomnický Štít coronal station on April 3, 2001.

of sunspots, e.g., Waldmeier (1973), Minarovjech et al. (1998), or dependence in the time-shift to the polar regions for the N- and S-hemispheres, e.g., Dermendjiev et al. (1994). McIntosh (1972) developed guidelines for inferring magnetic polarities on the Sun from observations of filaments and filament channels.

In this paper we describe the electronic filing of observations of prominences at the coronal station Lomnický Štít for the whole duration of the observing programme. A particular attention will be given to the procedure of how to "unify" the data across the whole solar disc. We shall also briefly address the question of improving the quality of the data acquired.

2. Observations and data archivation

Systematic photographic observations of solar prominences - as part of the multinational framework of so-called patrol service began at the Lomnický Štít coronal station of the Astronomical Institute of the Slovak Academy of Sciences at the end of 1967. Before, in the years 1962-67, the observations were carried out on an irregular basis in the sense that we observed only those areas where a prominence was present. By a systematic observation we understand any observation for a fixed, predefined positional angle irrespective of the fact whether there is a prominence in the particular position or not; eruptive prominences have a different programme. Observations of prominences are made by the 20-cm coronagraph whose equivalent focal length is 400 cm and which is equipped with an H-alpha filter of the FWHM of about 1.0 nm. By the end of 2003, there have been made about 3500 observations for about 4500 observing days. These observations have gradually been catalogued; the first catalogue features observations carried out up to 1986 and it was published in a hardbound edition. This catalogue has already turned out to be an important source of information for a number of statistical studies of prominences, e.g., an analysis of changes of the height of prominences above the solar limb with the phase of a solar cycle, e.g., Duchlev et al. (1989). Observations of prominences are carried out photographically along the whole circumference of the solar disc by the coronagraph equipped with an optical caroussel. The basic observation comprises a calibration picture of the center of the solar disc, using the neutral filter of the known-permeability, and subsequent 9 pictures of the solar limb with the step of 40 degrees of arc; one starts at the north pole and goes through east, south and west back. The first picture features the date of the observation, the others only real times of the observation. Figure 2 gives an example of an observation made on August 9, 2001. Observations of this kind are mainly used for:

- patrol service of the solar atmosphere above the solar limb in the H-alpha line;
- monitoring of prominences for the Solar Geophysical Data;
- creation of the so-called sequence of prominences containing information about their basic properties like brightness, height, range, position and area.

Up to now, the observations have been archived in 105 photo-safety-deposit-boxes of slide films, which contain about 52200 pictures. In order to carry out a proper conversion of these photo-data into an electronic form, it was necessary to do first a careful inventory of all the observations, bring all the safety-boxes to one place, place and number them in chronological order. Then, we edited the basic data about every single observation, namely the date and time of observation, the number of the corresponding safety-box and sheet of the film. Finally, the individual slides were scanned and the corresponding data were recorded on CDs.

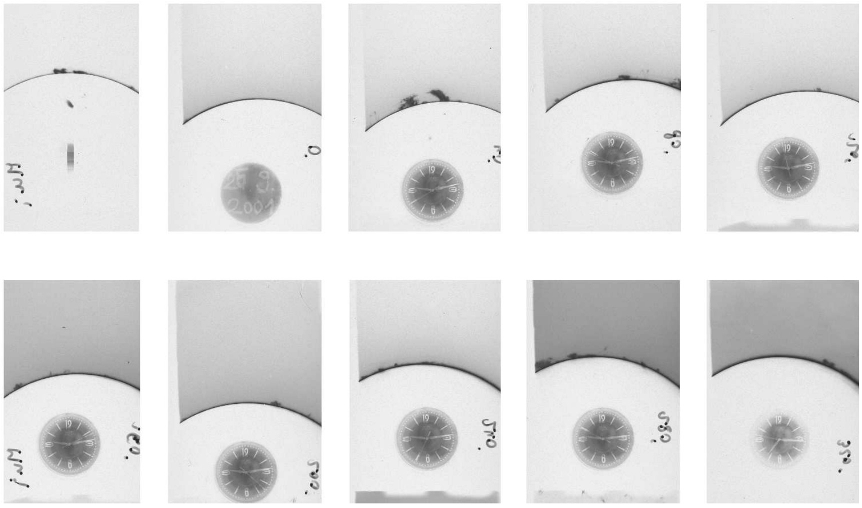

Figure 2. A prominence on August 9, 2001 (in inverse color).

3. Significance of digitalization

Any astrophysical observation is in its essence unique for in astrophysics we cannot repeat an experiment under the same condition. The data have thus value when considered in the proper temporal context only. This implies that one cannot dismiss data of poorer quality. These can always be improved with the help of technological progress of both observational and recording devices/instruments; this especially concerns a conversion of classical data records into a digital form. A classical archive, even if properly created and well-kept, is characterized by time-consuming and cumbersome search procedures for finding particular data. Moreover, it is always necessary that those asking for data have to be personally present during the search. An electronic archive not only offers a very easy and almost instantaneous acquisition of the data, but, if available for free on the Internet, it is accessible for anyone. It is also possible to create a "virtual" observatory when one can access observations that are currently being performed. Last, but not least, an electronic archive can easily be copied and, so, it is much better protected against its casual destruction than a classical one.

4. A film scanner NICON 8000 ED

Scanning of individual observations on the film slides of a standard size was done by a film scanner NICON 8000 ED. This scanner is especially suitable for conversion of film materials into an electronic form and their subsequent processing using computer. Part of the scanner is a software Nicon-Scan, which allows scanning into some widely-used, related softwares like Adobe Photoshop, Irfan, Corel, etc. This software can also be used as an independent application, where scanned film data are stored on CDs, DVDs, etc. The scanner NICON 8000 ED can be used for scanning the following materials:

– Slides of a striped shape, both negatives and positives, monochromatic and color;

– Framed slide diapositives;

– Framed diapositives of medium size 6 x 4, 6 x 6, 6 x 7, 6 x 8, a 6 x 9 cm;

– Rolled films 120/220;

– Films 59 x 82 mm for electron microscopes;

– panoramatic films 24 x 58, or 24 x 65 mm;

– 16 mm film materials;

During the process of scanning one can do the following adjustment/improvement of the film:

– to safely remove parts of the picture/image damaged by dust or scratch;

– to reestablish true colors and lower the "graininess" of the material;

– select and zoom-in a particular area of the picture/image;

– to set up resolution and size of the file of a stored image (maximum resolution 4000 px/in, maximum "depth" of a scan 14 B);

– to change brightness, contrast and color tuning within the whole range of scale;

– focussing up

5. An example of data processing

As an example of an analysis of a single set of basic observations of prominences shown in Fig. 2, we can line-up all the pictures taken along the limb of the Sun and thus get a "complex" picture of the shape and distribution of prominences for a particular time, as depicted in Fig. 3.

Similarly, adjusting properly individual digitized images one can get an animated movie showing temporal evolution of a particular prominence.

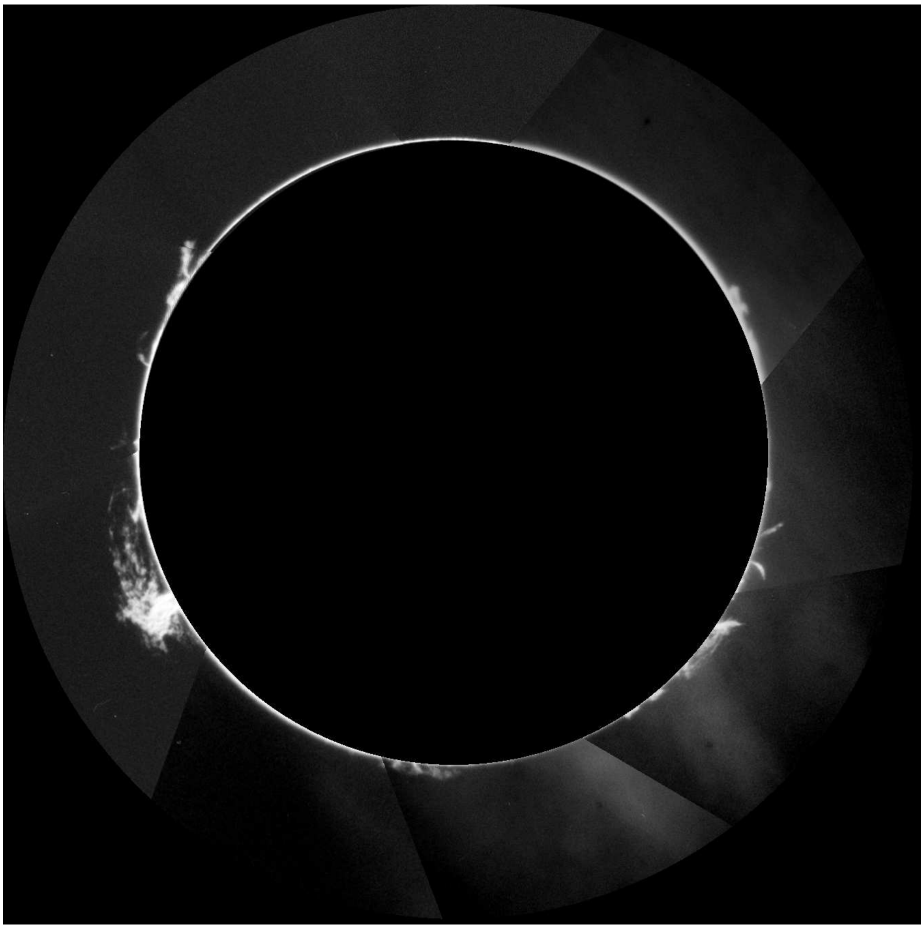

Figure 3. The full-disk solar prominences as observed on August 9, 2001, at the Lomnický Štít coronal station. The full-disk image was artificially prepared from single observations as shown in Figure 2. The N is a the top, the E on the left. The fain white-light color does not belong to the white-light corona. It is an effect of background conditions during observations. The same is valid for Figure 2, the lower part of the series.

6. Conclusion

The advantages of an electronic filing of prominences observations can succinctly be summarized as follows:

– easy access to the whole set of data for the relevant scientific community;

– complete elimination of a tedious search for particular data;

– enabling the supply of new data on a regular routine basis.

Moreover, as soon as all the coronagraphs are properly equipped, photopgraphic observation can be completely abandoned, being replaced with fully digital acquisition and subsequent processing of the data.

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