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Coronal partings

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Abstract

The basic observational properties of "coronal partings"—the special type of quasi-one-dimensional magnetic structures, identified by a comparison of the coronal X-ray and EUV images with solar magnetograms—are investigated. They represent the channels of opposite polarity inside the unipolar large-scale magnetic fields, formed by the rows of magnetic arcs directed to the neighboring sources of the background polarity. The most important characteristics of the partings are discussed. It can be naturally assumed that—from the evolutionary and spatial points of view—the partings can transform into the coronal holes and *visa versa*. The classes of global, intersecting, and complex partings are identified.

Keywords: Solar magnetic fields; Coronal structures

1. Introduction

X-ray investigations of the Sun in the recent decades revealed a number of specific coronal structures, such as the bright X-ray points (Golub et al., 1974) and coronal holes (Altschuler et al., 1972; Fuerst ad Hirth, 1975; Timothy et al., 1975; Nolte et al., 1976). The coronal holes (CH) attracted especial attention after discovery of their geoefficiency (Krieger et al., 1973; Neupert and Pizzo, 1974; Nolte et al., 1976). However, genetic and spatial relations between CH and other coronal structures and magnetic fields are still investigated poorly. So, it is interesting to look for the additional large-scale morphological features in the solar corona and to reveal their relation to the previously-known ones.

With this aim in view, during the last 15 years we performed a visual inspection of a large number of images regularly provided by the leading space- and ground-based observatories. First of all, we used the data by *Yohkoh* SXT[1] (Tsuneta et al., 1991) and *SOHO* EIT (Delaboudinière et al., 1995). In the recent time, we began to employ also the very-high-quality images by *SDO* AIA (Pesnell et al., 2012). To confront the coronal structures visible in soft X-rays and extreme ultraviolet (EUV) with the associated magnetic fields, we used the observations of photospheric magnetic fields mostly by *SOHO* MDI[2] (Scherrer et al., 1995) and, recently, by *SDO* HMI (Pesnell et al., 2012). Synoptic magnetic maps by the ground-based observatories were also occasionally

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[1] The most part of original data utilized in the present paper were downloaded from the archive at http://www.lmsal.com/SXT, which was later relocated to another address: http://ylstone.physics.montana.edu/ylegacy/.

[2] The original data are available in the archive: http://sohowww.nascom.nasa.gov.

http://dx.doi.org/10.1016/j.asr.2015.11.020
0273-1177/

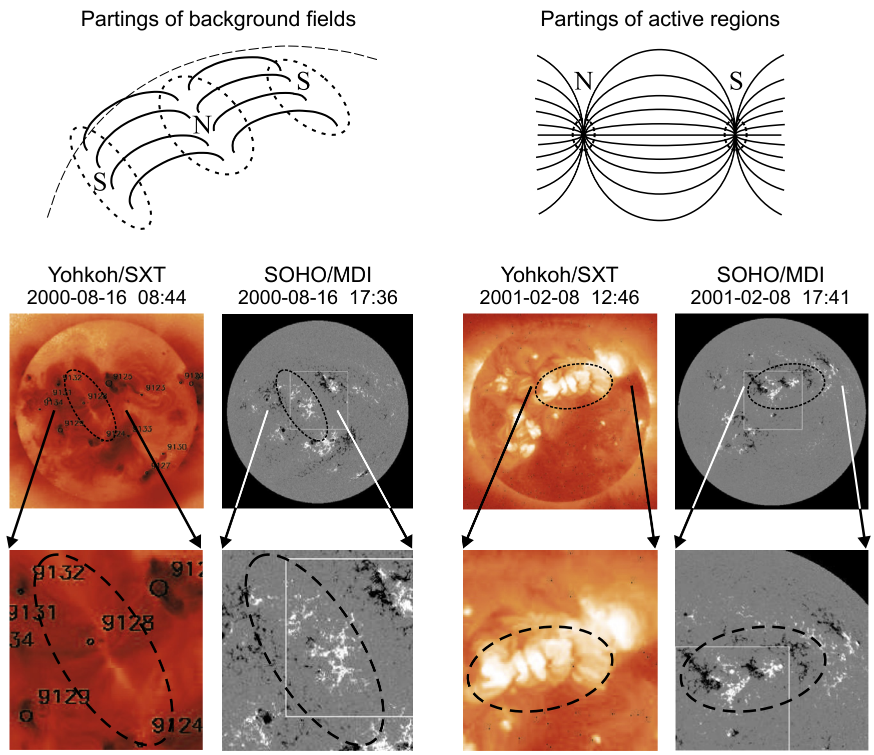

Fig. 1. Scheme of the partings of background fields with an example for 16 August 2000 (left-hand side) and of the active regions with an example for 08 February 2001 (right-hand side). The patterns of soft X-ray emission (left column) and photospheric magnetic field (right column) are given for each case. The images by *Yohkoh* SXT and *SOHO* MDI involve a number of irrelevant designations, which should not be taken into account. Besides, *Yohkoh* SXT images in the left- and right-hand sides are in the inversed palettes (negative and positive).

employed. In total, we have analyzed over 4000 spectroheliograms and magnetograms, starting from 1999.[3]

In particular, we searched for the characteristic elongated X-ray and ultraviolet structures with a reduced brightness, which were associated with the unipolar regions. (It is necessary to discriminate them from the filaments, which are localized at the boundaries between different polarities.) As a result, it was found that the magnetic field lines, represented by the X-ray loops, over the regions of magnetic field of the same sign often form the specific channels between two rows of the arcs directed oppositely, i.e. toward the regions of another polarity (Fig. 1). Because of their similarity to a hair parting—where hairs play the role of the field lines—Nikulin (2003) suggested to call them the coronal partings (CP).

A few years later, Molodenskii and Starkova (2007) justified theoretically formation of such partings and performed their computer simulation. They also concluded that these partings are the inevitable and natural component of the magnetized solar atmosphere, representing the "sign-reversal lines for the normal component of the curvature vector of the magnetic lines".

So, it is the aim of the present paper to give a short review of the most important morphological features of CP, revealed in the course of our long-term investigations, as well as to discuss their relation to other coronal structures.

[3] Unfortunately, the so long period of data collection resulted in some nonuniformity of the graphic formats as well as a number of parasitic designations in the images presented below.

2. Basic morphological features

2.1. Definitions

The coronal partings can be subdivided into two groups: CP of the large-scale background fields (Fig. 1, left-hand side) and the partings of active regions (AR), which represent the short and narrow channels inside the strong fields of AR (Fig. 1, right-hand side). In such a case, the most fraction of the magnetic flux of AR and the parting is enclosed between the leading and trailing parts of the sunspot group. However, if there are other AR or floccules nearby, then the peripheral part of the flux is connected to them. As a result, a short narrow channel is formed between the deviating field lines. It is usually located perpendicularly to the axis of the group and passes through the sunspots themselves. When the sunspots disappear and the respective magnetic fields decay, the coronal partings of active regions can be transformed into CP of background fields.

2.2. Distinction between the coronal partings and holes

To emphasize that CP and CH are different structures, let us formulate the main differences between them: