ON THE POSSIBILITY OF IDENTIFYING CORONAL HOLES ON SYNOPTIC MAPS OF THE GREEN CORONA

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The coronal holes of the Skylab period are treated to identify them with the low-brightness regions in our synoptic maps of the λ 530.3 nm emission corona. Possibilities and difficulties of this identification are discussed.

INTRODUCTION

The coronal holes were identified as a very important feature on the Sun, namely for their responses in geoactivity. Most of the physical and morphological studies of them are, of course, related to the period of the manned Skylab missions, when excelent pictures of the Sun in X-ray and XUV were taken. On acquiring a fairly good understanding of the physical substance of the holes, attempts appeared to extend into the past the period in which the position and properties of the holes could be identified and studied from other type of observations. Broussard et al. (1978) have used X-ray and XUV images obtained from rockets, OSO-6, OSO-7, and some others, to investigate coronal holes and their solar wind associations throughout the whole sunspot cycle 20. Waldmeier (1975) has reported that it is possible to distinguish coronal holes on heliographic maps, constructed from daily observations of the green coronal line 530.3 nm. This is possible because the intensity of this line decreases strongly in regions of low density and temperature (Waldmeier, 1971), which are properties the coronal holes have been shown to posses. In this connection Waldmeier (1975) pointed out that for such regions on coronal synoptic maps he already used the term "löcher", which stands for holes in German, more than twenty years ago (Waldmeier, 1957). Guldbrandsen (1975) maintains that the known facts on solar sources of high-speed plasma streams, presented during the last 4 decades, almost inevitably seem to lead to the conclusion that the solar M-regions (Bartels, 1932) should be identified with the central portion of magnetically open solar regions, or coronal holes. In ad-

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dition, it is to be said that in several papers of Guldbrandsen the low green-line intensity regions are found to have very similar geophysical consequences as they were ascribed to the hypothetical M-regions.

RESULTS

In the light of the above-mentioned facts, but in contradistinction to the general conclusions of Waldmeier and Guldbrandsen, we will try to show the possible identity of the low green-line intensity regions and coronal holes, in details. For this purpose the synoptic tables of the green corona (prepared as described by Sýkora, 1971) were visualized for the period of the Skylab missions and then the positions of the coronal holes, taken from Bohlin and Rubenstein (1975), were drawn into them (see Figure 1). Isophotes are in absolute coronal units, the regions of intensity lower than the surroundings are hatched (of course, they are not necessarily the lowest intensity regions on a given map), and coronal holes are cross--hatched and, at the same time, the generally accepted numbering of the Skylab-period holes is given. In Figure 1 the following can be seen: (1) Parts of polar coronal holes reaching up to our maps (they only cover ±60° within equator) certainly fit in well with the low

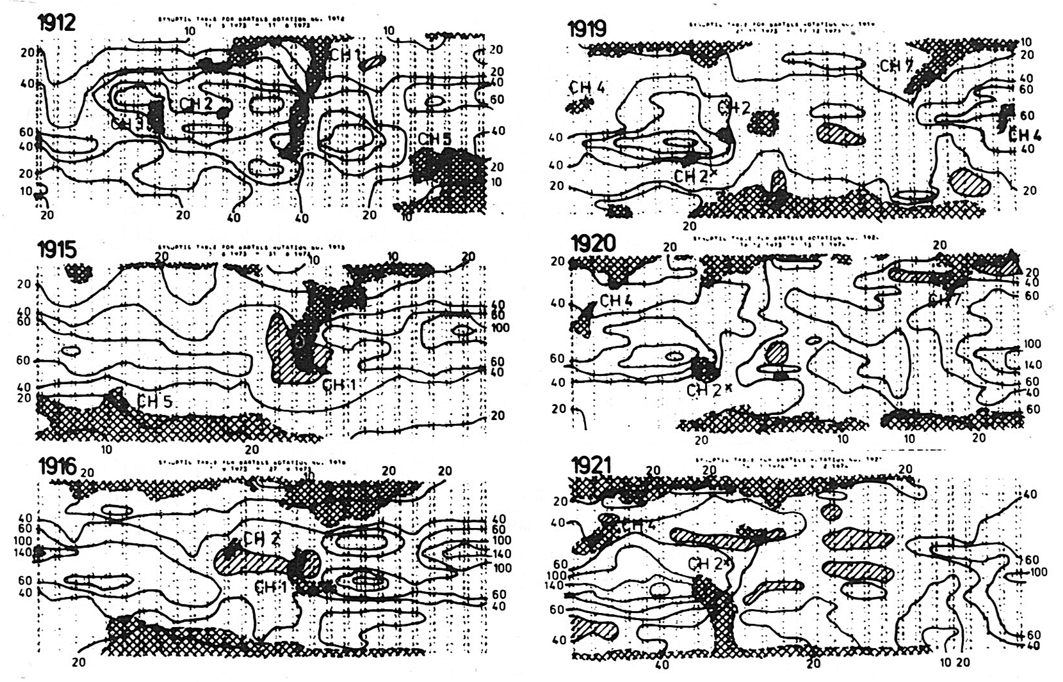

Figure 1. Synoptic charts of the green corona for indicated Bartels rotations. Details see in the text.

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coronal intensity regions towards the poles. (2) The low-latitude holes are somewhat more complicated. In some cases they clearly agree in position with the low corona (CH1, CH2 in Bartels rotations Nos. 1915, 1916 and 1919). Then there are cases in which both these features became displaced mutually for about 10-30° as, for example, CH1 shows in rot. No.1912, CH2^{x} in rot. Nos.1919 and 1921 and CH4 in rot. No.1921. Two sources of this displacement are very probable. Firstly, the coronal data are plotted as if they were measured at 12 00 U.T., but really they could have be observed at any hour of the given day. Secondly, the position of the green corona features are derived from limb observations, there is then uncertainty in the position of the low corona regions along the line of sight and perhaps the large-scale changes of position during some days, when the region was observed as a hole on the disk, are also possible. As Timothy et al. (1975) showed, the geometry and position of the holes must also be thoroughly determined. Owing to the said causes the found differences in position of both features are quite possible. (3) The last case are "small active region coronal holes" - SARCH - which are common phenomenon on the Sun (Bohlin and Sheeley, 1978; Nolte

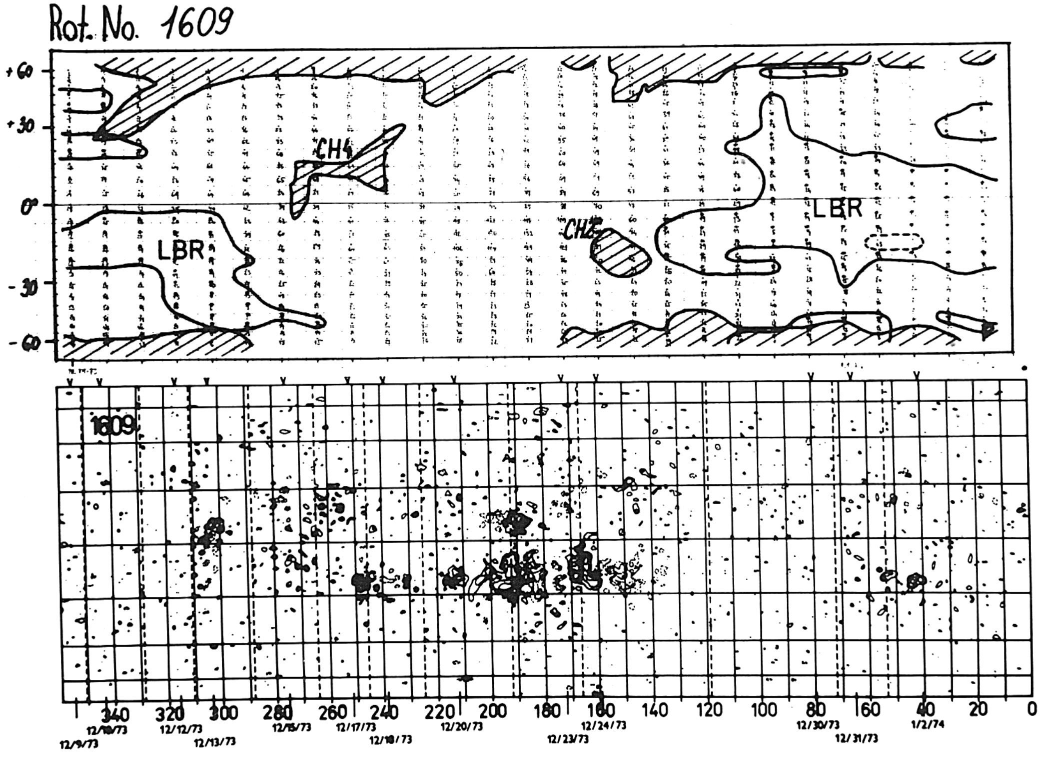

Figure 2. Green corona (above) and photospheric magnetic field (below) maps for Carrington rot. No.1609. In the coronal map the holes are hatched and low-brightness regions are indicated by "LBR". The holes CH4 and CH2^{x} are localized in clear area of higher coronal activity (compare lower magnetic map).

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et al., 1978). These holes are CH4, CH2^{x}, shown in Figure 2 (where photospheric magnetic field and coronal maps for Carrington rot. No.1609 can be compared). The holes CH4 and CH2^{x} are surrounded by or are in the vicinity of active regions. The corona in places where the holes are located does not show or shows only little decrease of brightness. There are many other regions in the interval from 320^{o} to 130^{o} longitude (and also outside it) which are almost totally void of disk and coronal activity, but there are no holes observed in these regions. We are of opinion that low green line intensity in SARCH really exists, but it is not possible to reveal it from limb corona observations because the disturbing influence of the adjacent active regions (once more the line of sight is working) which fact is strengthened by the dimensions of these holes usually not beeing very large.

CONCLUSIONS

This short communication may be summarized as follows:

(i) The coronal holes, at least those of the Skylab period, are characterized by low green corona intensities, in accordance with physically motivated expectations. This fact is more pronounced with polar holes and large low-latitude holes.

(ii) Owing to the spatial uncertainties in the limb corona observations and owing to the possible changes of the shape and position of the hole in time between its limb and disk passages, the mutual 10-30^{o} displacement in position of the holes and low brightness green corona regions seem to be quite comprehensible.

(iii) Probably rather frequent low-latitude coronal holes, adjacent to disk activity, can hardly be identified in our coronal maps for validity of (ii) in combination with small dimensions of such holes.

(iv) From the data presented here, but also from the inspection of much more extensive data on coronal holes, published in Broussard et al. (1978), we conclude that, if we can state that the coronal holes are characterized by low emission in the green coronal line, the contrary is not true. In no case we can say that each low-brightness green corona regions becomes evident as an X-ray or EUV coronal hole. Because of the known dependence of the green line intensity on disk activity, this result is in correspondence with the facts that "coronal holes do not seem to exist in the total absence of disk activity", and that in spite of very low green corona brightness at solar minima there are practically no holes observed in this period (Bohlin and Sheeley, 1978).

Although the relation of coronal holes and low-brightness green corona regions seem to be somewhat one-sided, we are still attempting to exploit the green corona synoptic maps, which are now in our possession, covering the last three cycles, to clarify these questions in greater details.

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