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Properties of the magnetic field in the coronal holes in solar cycle 23

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Abstract. The properties of the magnetic field in the coronal holes (CH) were considered during 1996-2002. The daily observations from the Kitt Peak observatory in the line HeI 10830Å were compiled. The measurement of the magnetic fields in the CH was carried out by comparing the data obtained from the Kitt Peak telescope and the magnetograms of SOHO/MDI. The dependence between the brightness of CH from intensity of the magnetic field and distributions of CH depending from the magnetic field and latitude were presented for minimum and maximum of the cycle. The latitude and the unipolarity degree of the magnetic field that influence on the brightness of the CH were examined. It was shown that the average magnetic field was 1-2G, the unipolarity degree of the magnetic field was 0.1-0.3 and brightness of the coronal holes increases with the average magnetic field. The latitude-time distributions of CH for different polarity were obtained.

The coronal holes (CH) are an important factor characterizing the solar activity. It is known that CH are the source of the high-speed solar wind, which effectively influences on the magnetosphere of Earth. Today the observations in the line Hel 10830A are remained the most effective type of the optic observations for identifying CH (Harvey & Recely (2002)). The regular daily observations in this line have been taking place on the Kitt Peak observatory since 1974. The relatively low amplitude of the cycle 23 allows us to examine the formation of CH at the backdrop of the smaller sunspot activity. The daily observations of the magnetic fields on SOHO/MDI with the small noise level permit to determine the intensity and structure of the magnetic fields in the coronal holes.

The formal automatic procedure was developed for the purpose of identifying the borders of the coronal holes by using the daily Kitt Peak observations in the line HeI 10830Å during 1996-2003. The coronal holes in HeI line are represented in intensity by the bright regions. It was found that the limited intensity is between 5-10 relative units. This allowed to define the magnetic properties of CH using the comparative analysis with magnitograms. The total number of the bright regions with the area more than $3x10^9 km^2$ was 17000. The number of the bright structures with the area more than $3x10^{10} km^2$ that can be associated with the CH was 3300. The latitude-time dependence of the coronal holes with the area more than $3x10^{10} km^2$ show us two types of the coronal regions: the high latitudes and pre-equator. The distribution of bright elements with the smaller area in the line HeI 10830Å was discussed in paper Tlatov & Tavastsherna (2002). The large and small structures are identical as a whole, what proves the uniform nature of the formation mechanism of the helium regions. The distribution of the coronal holes in solar cycle activity shows, that CH exit outside the sunspot zone, where the large-scale magnetic fields with the only one predominant polarity exist. Probably the main role in the formation of CH has the surface magnetic field of the Sun. The daily data from the SOHO/MDI magnitograph to analysis of the magnetic fields since 1996.

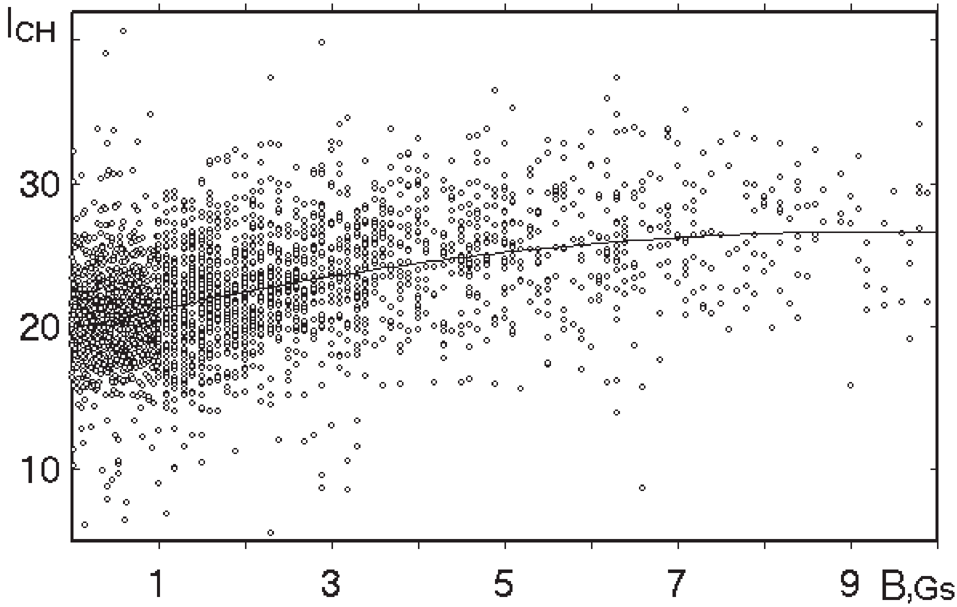

Figure 1. Distribution of brightness coronal holes from intensity of the magnetic field. Dependence can be presented as the formula: $Ich = 19.8 + 1.45B - 0.08 \cdot B^2$

Inside the border of the CH, underlined in the line HeI 10830Å, on the daily magnitograms the number of the magnetic elements of the positive and negative polarity was calculated. Using these data the mean value of the intensity of the magnetic field, magnetic flux and relative number of the elements of negative and positive polarity were found. The brightness of CH is the main criteria for their identification in the line HeI,. It depends on several parameters. One of those parameters is the value of the mean magnetic field. Fig.1 shows the distribution of coronal holes brightness, depending on the intensity of the magnetic field. This dependence can be presented as: $Ich = 19.8 + 1.45 \cdot B - 0.08 \cdot B^2$. We can see from Fig.1 that the growth of mean intensity of the magnetic field until 5G leads to the increase of the brightness of CH, than the satiate takes place.

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