Statistical properties of coronal hole rotation rates and their link to the solar interior

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Abstract

The present work discusses results of a statistical study of the characteristics of coronal hole (CH) rotation. We investigated CH rotation rates and studied their distribution over latitude and their area sizes. In addition, the CH rotation rates are compared with the solar photospheric and inner layer rotational profiles. We studied coronal holes observed within ±60º latitude and longitude from the solar disc centre during the time span from the 1 January 2013 to 20 April 2015, which includes the extended peak of solar cycle 24. We used data created by the Spatial Possibilistic Clustering Algorithm (SPoCA), which provides the exact location and characterisation of solar coronal holes using SDO/AIA 193 Å channel images. The average sidereal rotation rate for 540 examined CHs is 13.86 (±0.05) º/d. The latitudinal characteristics of CH rotation do not match any known photospheric rotation profile. The CH angular velocities exceed the photospheric angular velocities at latitudes higher than 35-40 degrees. According to our results, the CH rotation profile perfectly coincides with tachocline and the lower layers of convection zone at around 0.71 R⊙; this indicates that CHs may be linked to the solar global magnetic field, which originates in the tachocline region.