Magnetic structure of coronal dark halos

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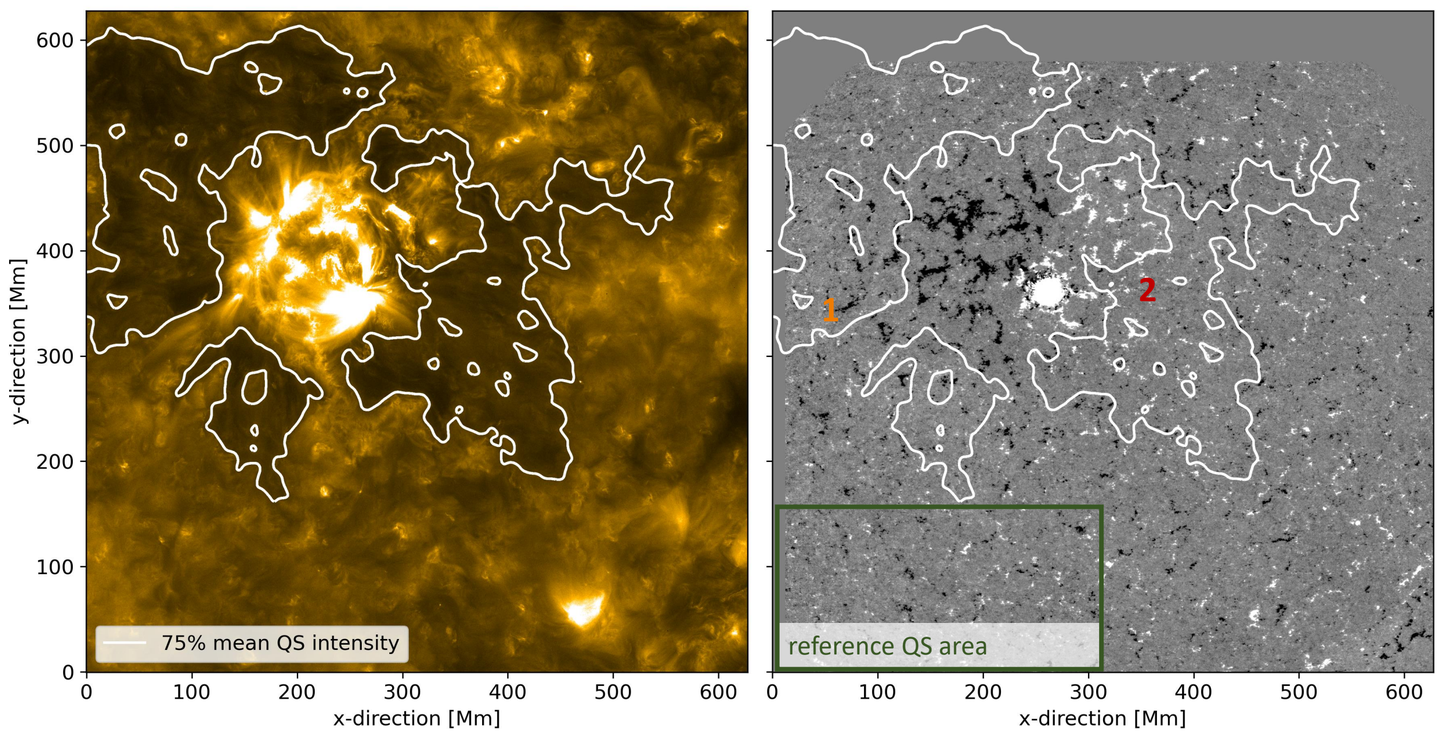
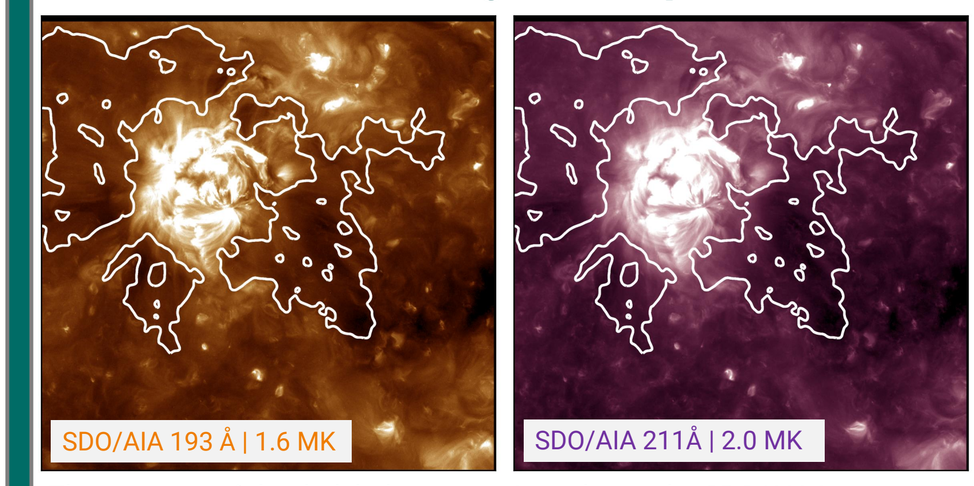
Coronal dark halos (also referred to as dark canopies or dark moats) are distinct areas surrounding active regions (AR) that are less bright in the extreme ultraviolet than the quiet Sun (QS) at low coronal temperatures of 1 MK.
We combine high-resolution Solar Orbiter observations from the SO/PHI and EUI instruments with SDO/AIA data to study the magnetic properties of and emission from the dark halos around the AR NOAA 12893.

Identification of dark halos via an intensity threshold of 75% of the mean reference quiet Sun intensity.



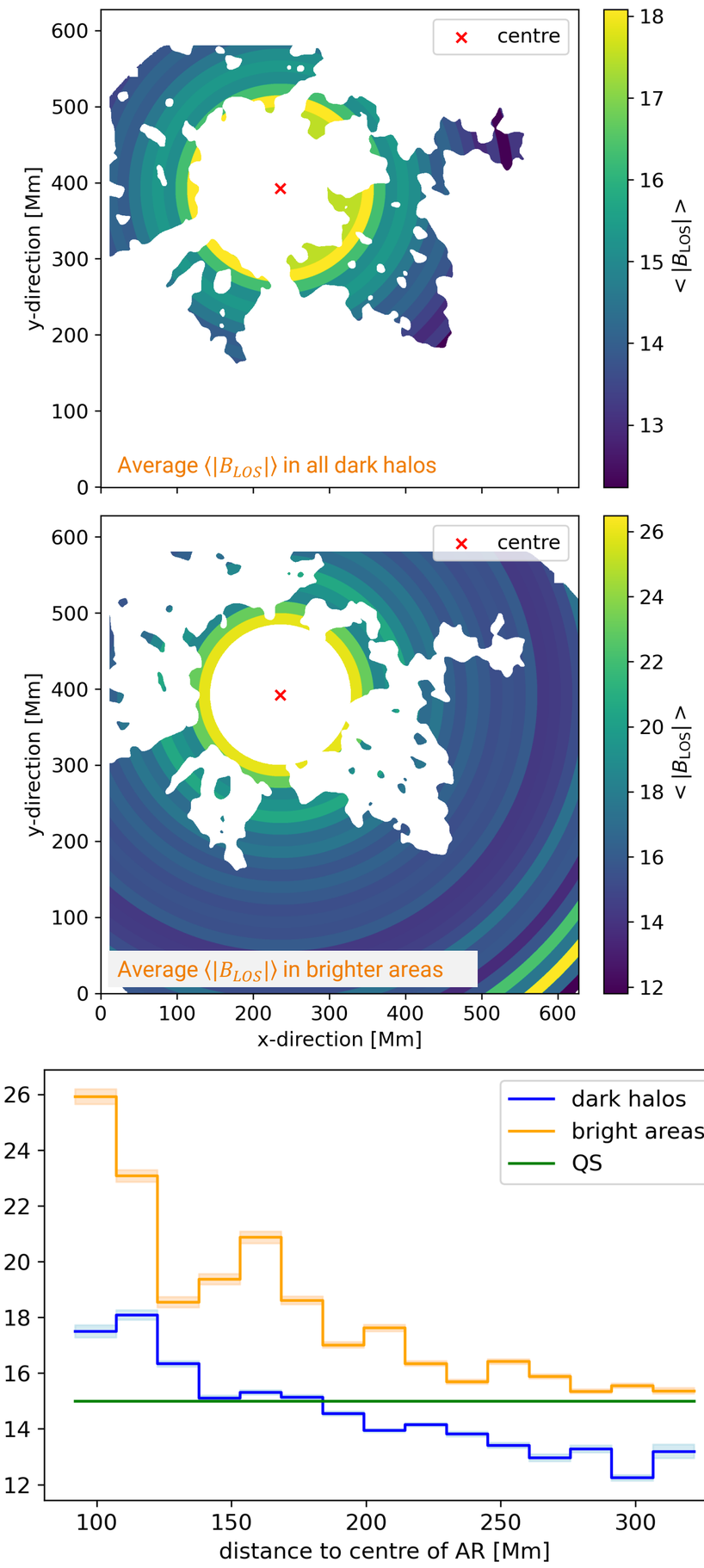
$EUI\text{-}HRI_{EUV}$ image and SO/PHI-HRT magnetogram (scaled to ±50 G) of 2021, November 5th 23:30 UTC. Contours of the dark halos are shown in white.

Dark halos seen at higher temperatures



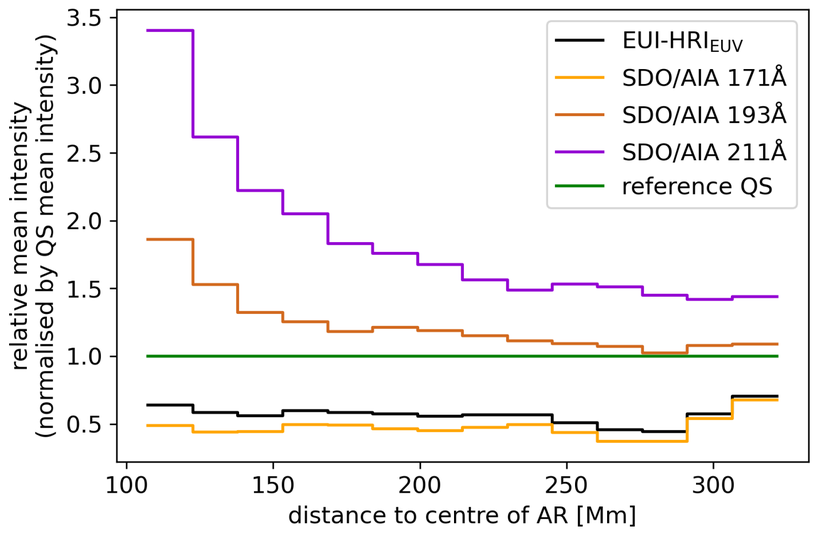
The contours of the dark halos are projected onto the SDO/AIA images.

Unsigned magnetic field



- $\langle|B_{\mathrm{LOS}}|\rangle$ decreases with increasing distance to the active region centre.
- The bright areas between dark halos harbour stronger magnetic fields.
- $\langle|B_{\mathrm{LOS}}|\rangle$ converges to the QS level in brighter areas, however, drops below this value inside the dark halos.

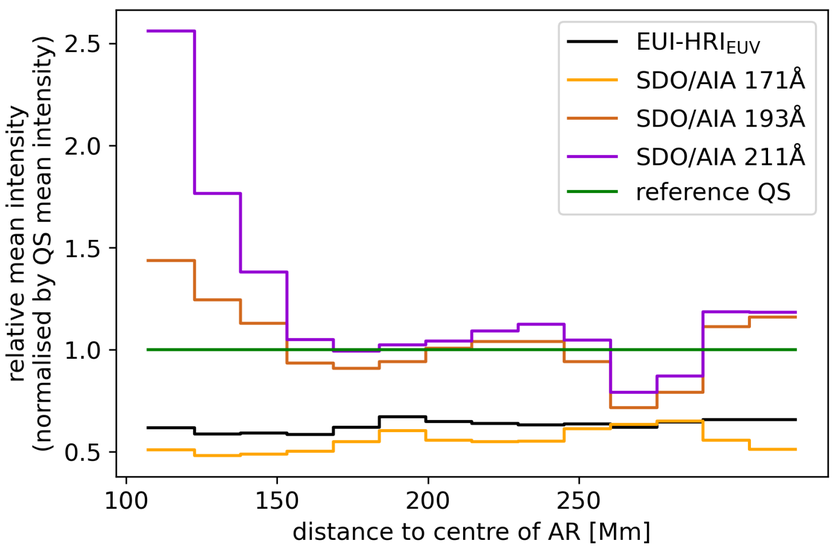
Coronal emission from individual dark halos at different temperatures in dependence of the radial distance to the AR centre



Cooler channels:
(<1 MK: 171, 174 Å)
- Little variation of intensity with distance

Hotter channels:
(≥1.6 MK: 193Å, 211Å)
- Strong emission at dark halos' inner boundary
- Strong decrease in intensity with distance

Special case: complex structure of overlapping dark halo and coronal hole



- Behaves similar to other dark halos up to a distance of ~250 Mm
- At the outer edge of the dark halo an on-disk coronal hole is starting to develop. This impacts the intensity in the 193Å and 211Å channels as dips around 270-290 Mm.

Possible explanations

The dark halos are areas of reduced magnetic flux, that even drop below the QS level. The formation of dark halos could hence be a consequence of reduced coronal heating, similar to coronal voids in the QS (Nölke et.al. 2023).

Singh et.al. 2021 suggest that pressure from the strong magnetic field of the AR presses down the magnetic field. Consequently, loops originating from within the dark halos are restricted in height and do not reach coronal temperatures.