Combining SO/PHI-HRT and SDO/HMI to characterise facular brightness at the limb

K. Albert[1], J. Hirzberger[1], N. A. Krivova[1], S. K. Solanki[1], X. Li[1], J. Sinjan[1], D. Calchetti[1], G. Valori[1], J. Blanco Rodríguez[3], D. Orozco Suárez[2], A. Gandorfer[1], J.C. del Toro Iniesta[2], J. Woch[1], and SO/PHI team

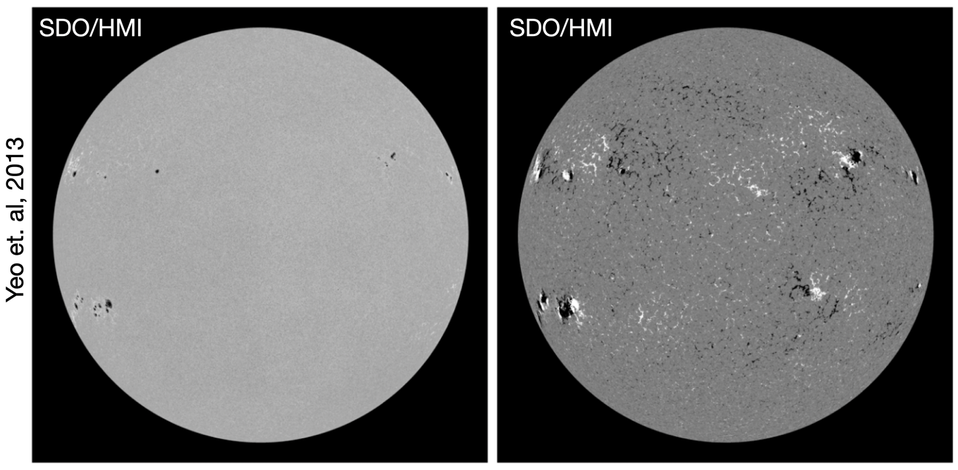
[1]*Max Planck Institute for Solar System Research, Göttingen, Germany;*
[2]*Instituto de Astrofísica de Andalucía (IAA-CSIC), Granada, Spain;* [3]*Universitat de València, Paterna-Valencia, Spain*

Abstract

We characterise solar facular and network brightness in relation to their viewing angle and the associated magnetic field strength. This relationship is key for modelling the solar irradiance variability, as well as for the better understanding of facular structure and behaviour. A single perspective limits our ability to accurately characterise these structures close to the limb, due to uncertainties in the determination of the associated magnetic field. A second perspective, where regions near the limb in the first view appear closer to the disc centre, can complement and improve our knowledge of near-limb B_{LOS}.

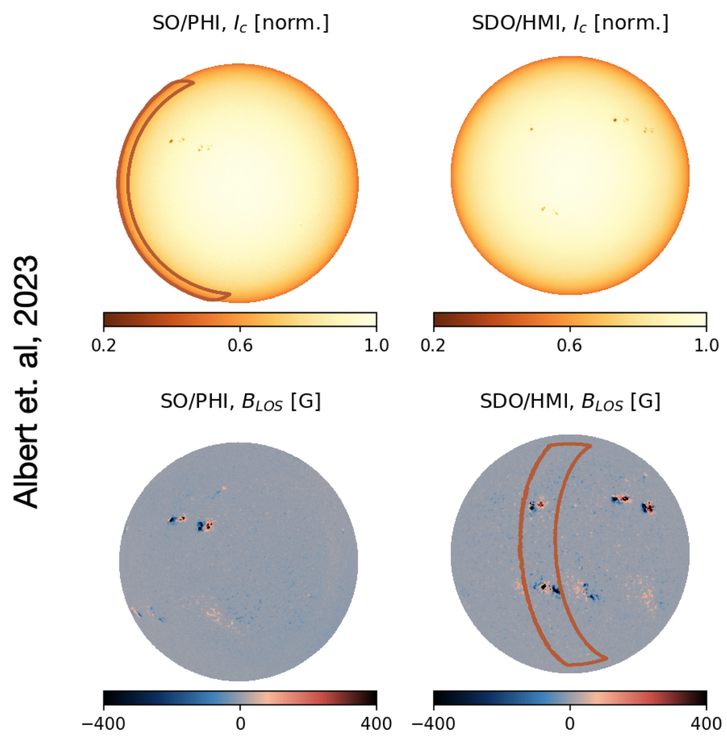
Methods

State-of-the-art SDO/HMI



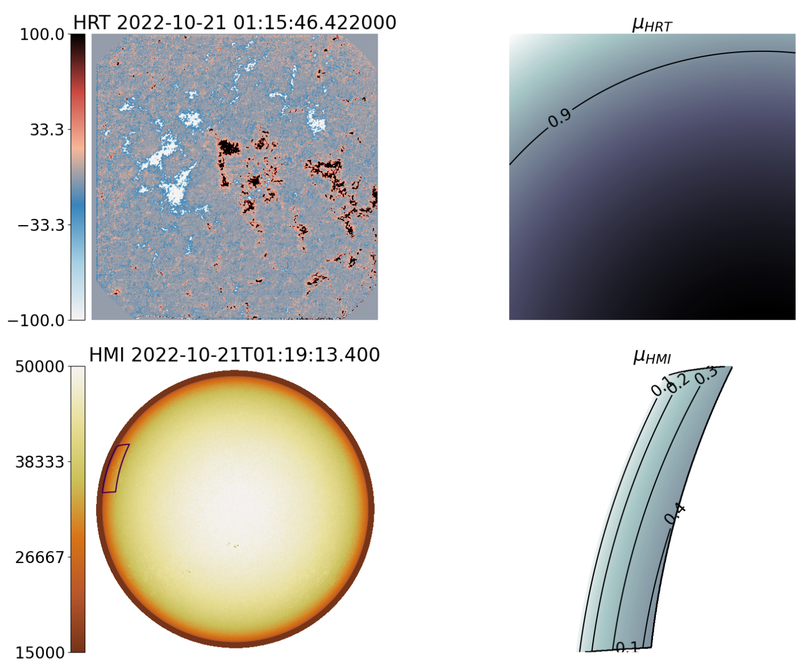
Prior to Solar Orbiter, only a single perspective was available. Study [2] uses SDO/HMI continuum images and line-of-sight magnetograms to derive the facular intensity contrast curves.

Two perspectives SDO/HMI + SO/PHI-FDT



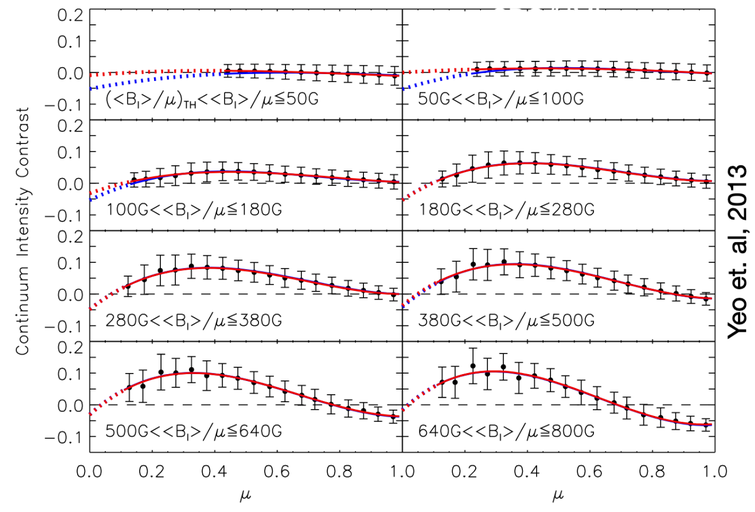
The first study to take the advantage of the additional perspective of SO/PHI used FDT data with SDO/HMI. These data were recorded at 60° angle separation. [1]

Two perspectives SDO/HMI + SO/PHI-HRT

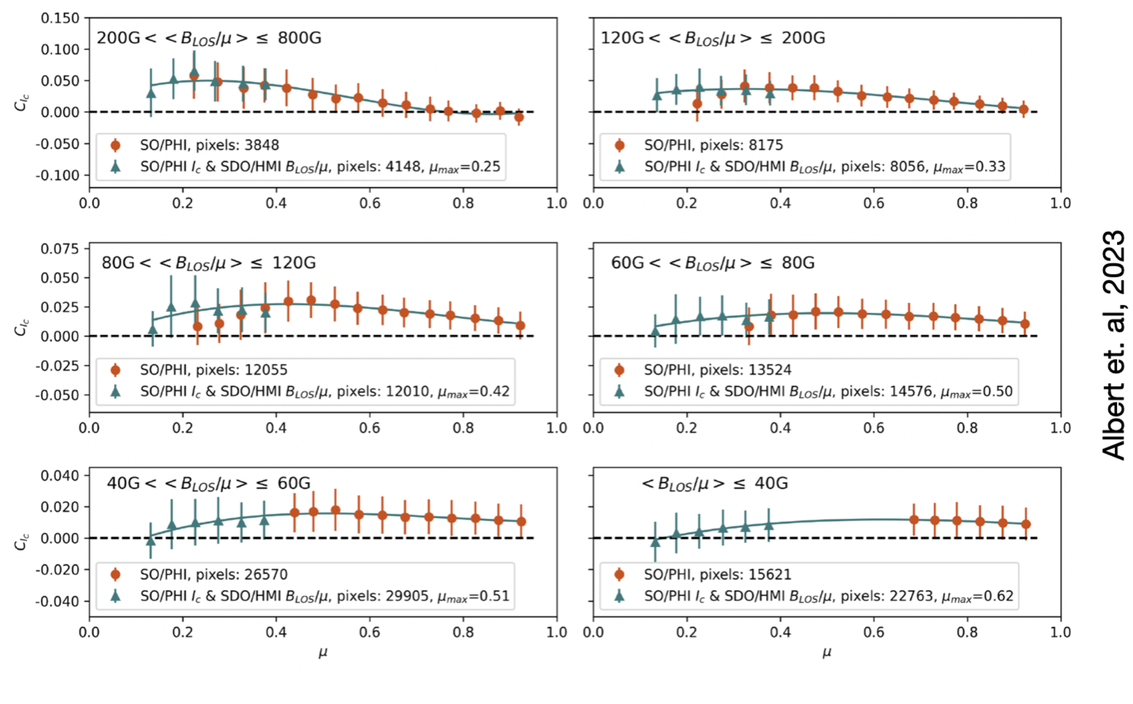


We can now profit from the newly available data from the SO/PHI-HRT, observed at disc centre. The observations span several days, when the spacecraft appeared from behind the Sun at quadrature (in Earth perspective), approaching smaller separation angles compared to Earth.

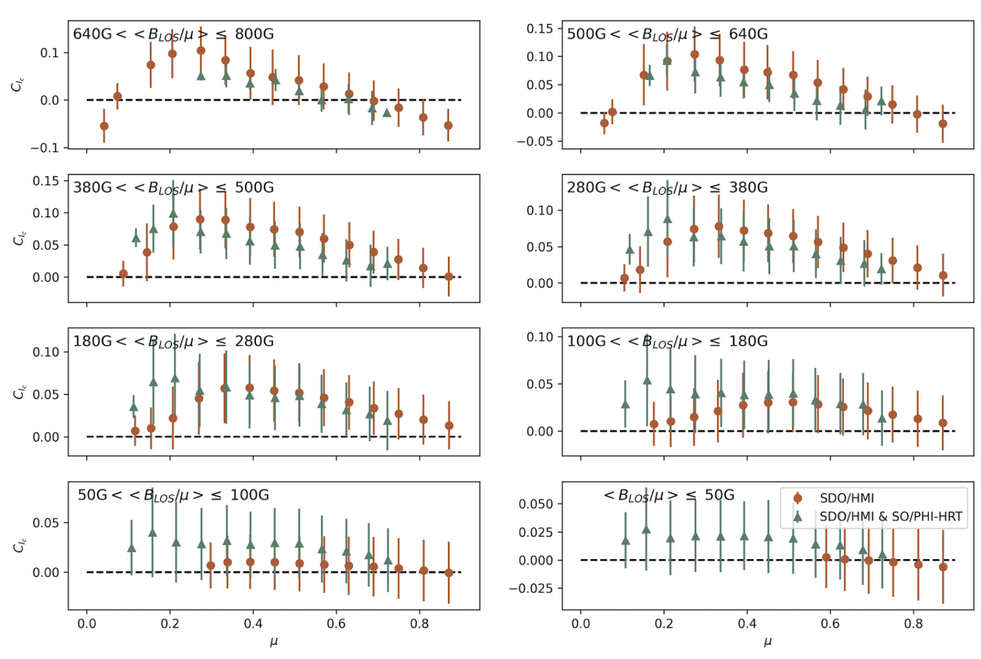
Results



From a single point of view, characterisation of facular brightness at the limb is incomplete [2], especially severely in the case of low magnetic fields.



By combining two vantage points, we can extend our knowledge of facular contrast to closer to the limb than from a single point of view.



The higher resolution data confirm some of the trends seen in [1], e.g, that the contrast of faculae associated with mid-range magnetic fields is underestimated at the limb ($\mu \lesssim 0.3$). At the same time, new questions arise, such as whether the observations of negative contrast at lower associated field strengths depends on the resolution and the selection of facular pixels.

What can we learn?

A second point of view can significantly improve our understanding of facular brightness close to the limb, as seen in [1]. However, the low resolution of the SO/PHI-FDT data did not allow the rigorous characterisation of faculae. Now we are using SO/PHI-HRT data together with SDO/HMI for a more conclusive study, as well as to better understand the influence of observational shortcomings on our results.

References

[1] Albert, K., Krivova, N. A., Hirzberger, J., et al. 2023, A&A, 678, A163

[2] Yeo, K. L., Solanki, S. K., & Krivova, N. A. 2013, A&A, 550, A95