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## Advancing High-Resolution Studies of Sunspot Penumbra Formation and Decay: new opportunities for the solar community provided by IBIS2.0, an upgrade of the Interferometric Bldimensional Spectrometer

Sunspot formation is the primary manifestation of magnetic flux emerging from the convection zone into the solar atmosphere. Among the various features of sunspots, the penumbra is particularly intriguing due to several unresolved issues, such as the interpretation of its formation and decay processes and understanding its bolometric brightness.

Recent high-resolution spectropolarimetric observations have proposed two scenarios for penumbra formation: the trapping of emerging horizontal field lines by a magnetic canopy and the sinking of existing magnetic fields from the chromosphere into the photosphere. These processes remain incompletely understood, although we recently provided new findings on the properties of the penumbral magnetic fields in the chromosphere at atmospheric heights unexplored in previous studies.

Additionally, studies on the dynamics of the Evershed flow during penumbra formation have provided some insights, but many questions remain. We present our results obtained on these topics using the Interferometric Bldimensional Spectrometer (IBIS).

The IBIS 2.0 project, an upgrade of IBIS that operated at the DST from 2003 to 2019, aims to address these gaps in knowledge. The upgraded instrument, to be installed at the Teide Observatory, will provide detailed spectropolarimetric data, capturing information along both photospheric and chromospheric lines in the 580-860 nm range. This will enable a comprehensive examination of magnetic flux emergence and its interactions with the magnetic canopy.

Overall, IBIS 2.0 will significantly enhance our understanding of sunspot penumbra formation and decay, providing a powerful tool for high-resolution solar research.

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