Mapping solar magnetic fields from the photosphere to the top of the chromosphere by the CLASP2 sounding rocket experiment

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The magnetic field in the solar atmosphere plays a key role in the energy transfer from the relatively cool solar surface of the photosphere to the overlying hot corona. The β=1 layer, where the ratio of the gas to magnetic pressure is equal to unity, lies in the chromosphere located between the photosphere and the corona. Above this layer (i.e., in the upper chromosphere) the magnetic field essentially dominates the structuring and dynamics of the plasma. Thus, the measurement of the magnetic field in this region is critical to understand the solar activities in the corona as well as in the chromosphere. To this end, we need to measure and model the polarization of ultraviolet (UV) spectral lines originating in the chromosphere, which encodes the information on the magnetic fields ([1]).

The Chromospheric LAyer Spectro-Polarimeter (CLASP2) sounding rocket experiment was carried out on 2019 April 11, providing the first ever spectrally and spatially resolved Stokes profiles (intensity *I*, linear polarization *Q* and *U*, and circular polarization *V*) across the Mg II *h* & *k* lines at 280 nm. During 155 s CLASP2 observed an active region plage and its surrounding enhanced network region (left panel of Figure 1) and detected significant circular polarization signals produced by the Zeeman effect in the Mg II *h* & *k* and in two Mn I lines. The Mg II *h* & *k* lines encode information from the middle to the top of the chromosphere, while the Mn I lines originate in the lower chromosphere. Through coordinated observations with the Solar Optical Telescope (SOT) aboard the Hinode satellite we measured also the photospheric magnetic field. By combining CLASP2 and Hinode/SOT, we have shown how the magnetic fields expand with height in the atmospheres of plage and network regions, coupling the different atmospheric layers. Moreover, the magnetic field at the top layer of the plage chromosphere shows a significant correlation with the Mg II *k* line core intensity and the inferred electron pressure (thermal energy density), providing clear empirical evidence that the heating in the plage chromosphere is of magnetic origin ([2]).

References

[1] J. Trujillo Bueno, E. Landi Degl'Innocenti, L. Belluzzi, Space Sci. Rev. 210, 183 (2017)

[2] R. Ishikawa *et al*, Sci. Adv. 7, no. 8 (2021)

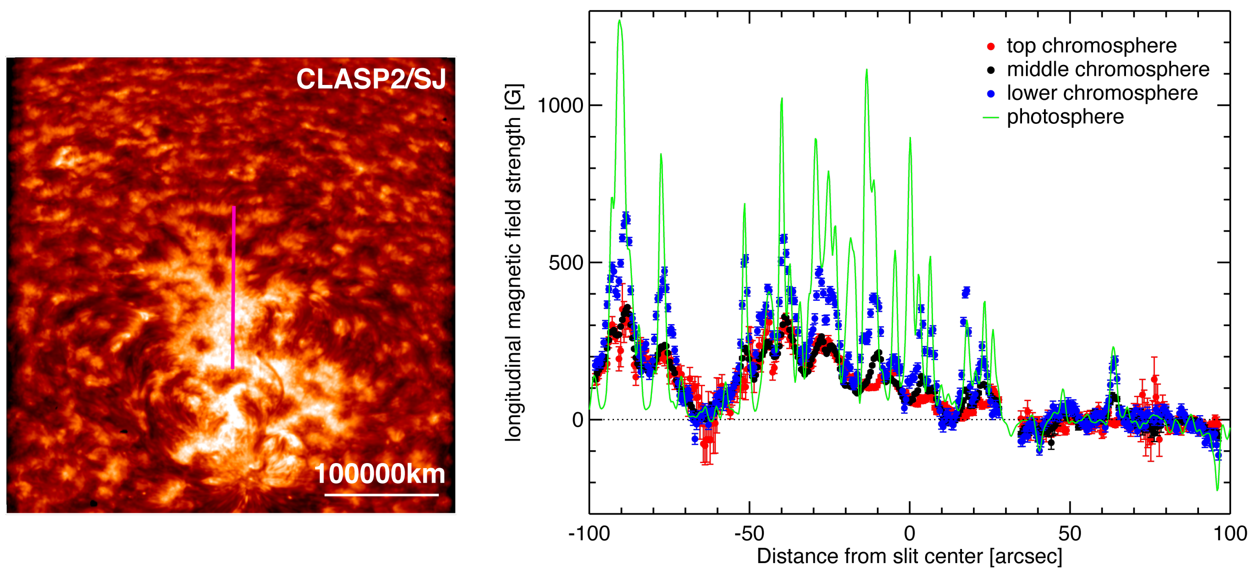

Figure 1. Left panel: intensity image of the chromosphere of the active region obtained with the slitjaw monitor system (SJ) of CLASP2. The pink line indicates the spectrograph's slit along which the polarization profiles are measured, and the longitudinal magnetic field (B_L) determined. Right panel: the spatial variation of B_L along the slit. The photospheric B_L (green line) was inferred from the Hinode satellite data, while B_L from the lower to the top layers of the chromosphere (blue, black, and red circles) were determined from the unprecedented CLASP2