# Exploring the Sun with Ultraviolet SpectroPolarimetry: The CLASP Sounding Rocket Series

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The magnetic field in the solar atmosphere plays a crucial role in the transfer of energy from the relatively cool (6,000 K) visible surface of the photosphere to the overlying hot (>$10^6$ K) corona. The β=1 layer, where the ratio of gas pressure to magnetic pressure equals unity, is located in the chromosphere, a critical region situated between the photosphere and the corona. Above this layer (i.e., in the upper chromosphere), the magnetic field dominates the structuring and dynamics of the plasma. Therefore, measuring the magnetic field in this region is essential for understanding solar activity in both the chromosphere and the corona. To achieve this, we must measure and model the polarization of ultraviolet (UV) spectral lines that originate in the upper chromosphere, as they encode valuable information about the magnetic fields [1].

To demonstrate the capability of UV spectro-polarimetry, a series of sounding rocket experiments CLASP were conducted in 2015 (CLASP), 2019 (CLASP2), and 2021 (CLASP2.1). In the first flight, the mission successfully performed spectropolarimetric observations of the hydrogen Lyman-α line (121.57 nm) and the Si III resonance line (120.6 nm), achieving very high polarization sensitivity [2]. For the first time, CLASP detected linear polarization produced by the scattering of anisotropic radiation in VUV lines and observed polarization signals indicative of the Hanle effect in the upper solar chromosphere. In the second and third flights, following an upgrade of the CLASP instrument, we carried out spectropolarimetric observations across the Mg II h & k lines, which are also strong UV spectral lines of great interest for probing the magnetic fields in the upper chromosphere. These missions yielded unprecedented measurements of polarization signals caused by the joint action of scattering processes and the Hanle, Zeeman and Magneto-Optical effects. Furthermore, through coordinated observations with the Solar Optical Telescope (SOT) aboard the Hinode satellite, we produced magnetic field maps extending from the photosphere to the upper chromosphere in an active region [3]. In this talk, we summarize the scientific findings from the series of CLASP experiments.

References

[1] Trujillo Bueno, Landi Degl'Innocenti, Belluzzi, Space Sci. Rev. **210**, 183 (2017)
[2] Kano, Trujillo Bueno, Winebarger, et al., The Astrophysical Journal Letters, **839**, L10 (2017)
[3] Ishikawa, Trujillo Bueno, del Pino Alemán, et al., Science Advances, **7**, 8 (2021)