The CLASP Telescope, Modified for Mg II

The CLASP instrument was originally designed for studying H Lyman-alpha (Bastian et al., 2012). For CLASP, we will use it with minor modifications to observe Mg II lines near 1096 nm. The instrument consists of a Cassegrain telescope, a dual-beam spectrophotometer assembly with a grating serving as a beam splitter, a polarimeter including a rotating waveplate and an identical pair of polarisation analysers, and a slit imaging spectrograph. The overall layout and basic design parameters are shown in the figure above. The optical elements that will be updated for CLASP are indicated by the red text in the figure.

The polarimeter system consists of rotating waveplates and two transmissive polarisation analysers. The rotating waveplate allows measurement of all components of the magnetic field in a 1D model, and with fixed waveplates, it allows measurement of components of the magnetic field in a 2D model. The optical components between the waveplate and the polarisation analysers are orientated to minimise magnetic polarization and spurious evolution: the rotating grating is parallel or perpendicular to the polarisation vectors of the waveplates, and the magnetic vector of the grating is tilted at the same angle. These configurations were adopted for CLASP: an end-to-end polarisation calibration of the spectropolarimetric system verified that the residual Q and U, respectively, corresponded to an azimuthal error of $<0.5\%$ (Haberreiter et al., 2016; Gomes et al., 2016).

We have considered the impact of the spectral resolution on the polarisation signatures by convolving the calculated Stokes profiles with Gaussian functions of different widths. A spectral resolution of at least 0.01 nm is sufficient to recover the linear Q and U signals without significant deterioration, and to detect the antisymmetric U signals for longitudinal fields as weak as 0.02 (see figure below).

Acquisition and Demodulation

The CLASP instrument is a modified rocket flight in the spring of 2019. During flight we will observe three targets. The first is at a limb center position in the solar corona. The second target is a strong field (50 G) region, such as plage, to constrain the three components of the magnetic field measured by the full Stokes vector. Finally we will position the slit perpendicular to the limb, sampling a quiet region, and with the slit extending 20° above the limb. This last target enables investigation of the CLV in linear polarization in the center of the Mg II line (sensitive to the plasma density) and in the wings of the Mg II 6 and 10 lines (sensitive to the magneto-photonic effects). Ideally, if solar conditions allow, we will sample the whole range of field angles of the plasma, and the magnetic vector of the field lines will be similar to facilitate comparison of their measurements. A slit width of 200° is adequate to quantify the CLV across the quiet Sun target, and also provides sufficient sampling of a plage region.

All the raw data are returned without onboard processing; demodulation will be done on the ground using all of the flight data. First, we derive fractional polarizations D, Q, and U using only the data from a single channel. Every successive set of 16 images of the corresponding to one rotation of the waveplate, will cancel out non-orthonormalities in the waveplate and fringe patterns caused by the waveplate and its mount. Signals from one channel will be verified by comparing to those from the other channel, and both signals will be summed to obtain the final Stokes profiles after calibration and alignment of the two channels. This procedure cancels possible polarisation errors in the single-channel demodulation caused by time variation of source intensity and time variation of instrument pointing since the two channels take orthogonal pairs of polarisation simultaneously.

The table below demonstrates the flowdown of requirements from the science objectives to the CLASP instrument capabilities.