Optical Alignment of the High-Precision UV Spectro-Polarimeter (CLASP2)

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Introduction

Chromospheric LAyer Spectro-Polarimeter (CLASP2)

- **aims**
  1. to explore the magnetic fields in the upper chromosphere.
  2. to measure full Stokes parameters in the Mg ii h & k lines near the 280 nm to study wavelength-dependent variations in the polarization caused by the joint action of scattering processes and the Hanle and Zeeman effects.

In this study, we will present

- about the new optical design of the CLASP2 spectro-polarimeter.
- about the method for achieving the optical alignment of the CLASP2 spectro-polarimeter.
- our results by comparing with our requirements (RMS spot radius \(< 13 \mu m\) at the edge of the slit).

Spectro-Polarimeter

<table>
<thead>
<tr>
<th>Spectrograph Type</th>
<th>Inverse Wadsworth Mounting</th>
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<tbody>
<tr>
<td>Grating Type</td>
<td>Spherical constant-line-space grating with 1303 mm(^{-1}) groove density</td>
</tr>
<tr>
<td>Spectral Window</td>
<td>Mg ii k (279.64 nm) &amp; h (280.35 nm) lines</td>
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<tr>
<td>Plate scale</td>
<td>0.5 arcsec/pixel (spatial) &amp; 0.005 nm/pixel (spectral)</td>
</tr>
</tbody>
</table>

Optical Design of the Spectro-polarimeter (SP)

- The CLASP2 SP follows very successful design concept of the CLASP1.
  - It is composed of two channels that are optically symmetric.
  - It allows to measure the orthogonal states of polarizations by using the \(+1^a\) order beams diffracted by a spherical grating, simultaneously.
  - The CLASP2 SP was refurbished with the minimal modification from the CLASP1 instrument.
  - **Red letters in the figure of ‘Optical Design of the CLASP2’ show the new optics for the CLASP2.

**The newly fabricated mirror (M4 & M5) were applied to the Al+MgF\(_2\) coating to improve the reflectivity over the wavelength range of 280±1 nm.**

After coating, we performed the reflectivity measurement of their witness samples.

** Measured reflectivity of the witness samples (WIs) of the off-axis parabolic mirror (left), the off-axis convex hyperbolic mirror (middle), and the fold mirror (right). The WIs are 1-inch flat mirrors that were simultaneously coated with the flight mirrors during the coating processes. The dashed and solid lines represent p- and s- polarized light.

- The measured reflectivity of all witness samples is larger than 85% at the predetermined Angle of Incidence (AOI).
- Our results shows that it satisfies our required specification (>80% near the 280 nm) of the SP mirrors.

Optical Alignment of the Spectro-polarimeter

- **Difficulty of the alignment of the CLASP2 spectro-polarimeter**
  - Image quality is complexly linked to the adjustment of grating, M3, and M4.
  - We used two camera brackets (CLASP1 and CLASP2 camera brackets)
  - The Mg ii light source is too faint compared to the other light sources
  - We performed the preliminary alignment as much as possible with a visible-light (VL) grating (VL light source).

- We established an efficient alignment procedure as follows:

**Summary and Discussion**

- We established and performed an efficient optical alignment procedure for the CLASP2 SP.
  - The maximum RMS spot radius determined by using the 2D Gaussian function is 12.2 \(\mu m\) at the edge of the slit.
  - **The RMS spot radius measured by 2D Gaussian function is measured overestimated compared to the real RMS spot radius.** In addition, if we consider the influence of the pinhole array, we think that the RMS spot radius is less than the current value.
  - Therefore, the alignment is succeeded to satisfy our requirement (< 13 \(\mu m\) at \(±10^{\circ}\)).
  - Even though, we achieved a satisfactory RMS spot radius, one may wonder

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