

L'-band AGPM vector VORTEX coronagraph's first light on LBTI/LMIRCAM

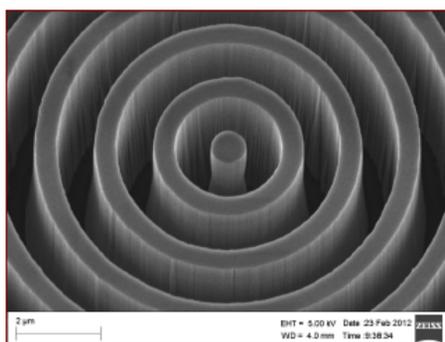
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Overview

We present the first science observations obtained with the L'-band AGPM coronagraph recently installed on LBTI/LMIRCAM. The AGPM (Annular Groove Phase Mask) is a vector vortex coronagraph made from diamond sub-wavelength gratings tuned to the L'-band. It is designed to improve the sensitivity and dynamic range of high-resolution imaging at very small inner working angles, down to 0.09 arcseconds in the case of LBTI/LMIRCAM in the L'-band. During the first hours on sky, we observed the young A5V star HR8799 with the goal to demonstrate the AGPM performance and assess its relevance for the ongoing LBTI planet survey (LEECH). Preliminary analyses of the data reveal the four known planets clearly at high SNR.

The AGPM Vector Vortex Coronagraph



- Excellent discovery space (360° FOV, IWA = $1 \lambda/D$)
- Achromatic
- High transmission ($\approx 90\%$)
- Focal mask + Lyot stop
- Best AGPM-L has $\sim 500:1$ null depth on the peak (lab measurement)

AGPMs recently installed on world-leading IR cameras:

- AGPM-N on VLT/VISIR (June 2012)
- AGPM-L3 on VLT/NACO (Nov. 2012)
- AGPM-L4 on LBT/LMIRcam (Feb. 2013)

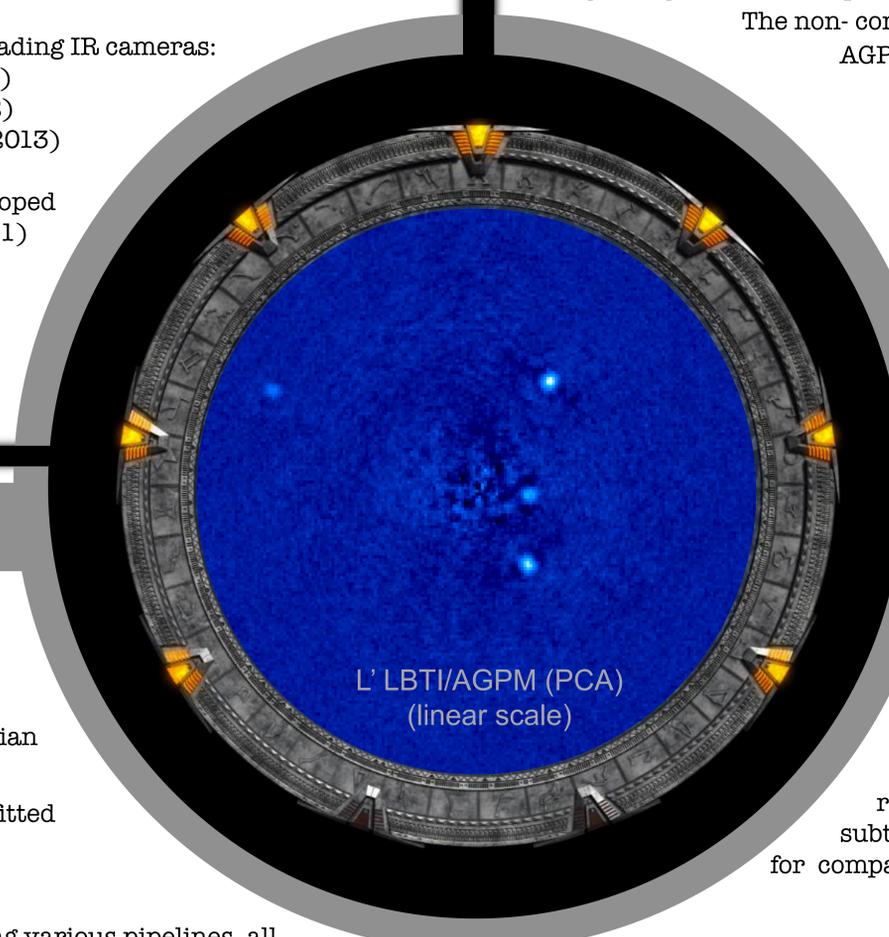
2nd generation AGPM currently developed for ELTs (goal peak null depth $>1000:1$)



LBTI/LMIRcam observations

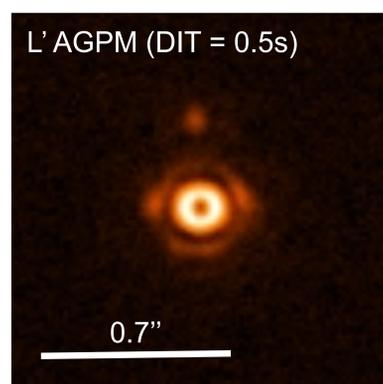
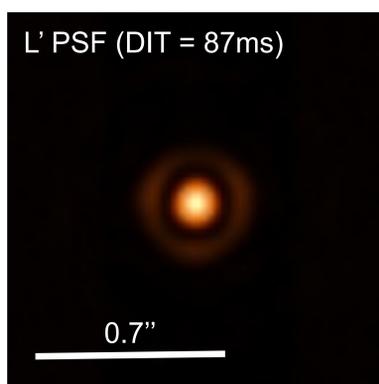
HR8799 was observed for approximately 3.5 hours on October 17th 2013 during the first commissioning run of the AGPM. The observations were obtained around transit in single-telescope mode. The seeing was fair during the first 30 minutes ($1.2''$ - $1.4''$) and good for the remaining of the observations ($0.9''$ - $1.0''$). The AO loop was locked with 200 modes first and with 400 modes after 30 minutes. The observing sequence was composed of 1000 frames of 0.5s each followed by a sequence of 300 frames of nearby empty sky region with the same integration time. The star position was recentered at the beginning of each sequence to achieve the maximal extinction.

The non-coronagraphic PSF through the Lyot stop and AGPM was frequently/regularly calibrated during the observing sequence by placing the star far from the vortex center.



DATA REDUCTION

- Frame centering by bidimensional Moffat fit of LMIRcam's secondary reflection (see right image below);
- Rejected frames $3\text{-}\sigma$ away from median center;
- Removed bad AO frames (based on fitted Moffat slope profile);
- Frames coadded by group of 15;
- ADI-PCA processing performed using various pipelines, all leading to consistent results: LBTI/LEECH (Skemer), JPL/SPCA (Kuhn), and ESO/ULg/Vortex (shown above in the center);
- Typical single frame shown below:



RESULTS

$5\text{-}\sigma$ detectability in terms of contrast for point-like companions around HR8799 (solid line). The dotted line represents the raw contrast curve (without considering self-subtraction). The four-known planets are shown for comparison (magnitude from Skemer et al. 2012).

