SCExAO: new high-performance coronagraphs ready for science

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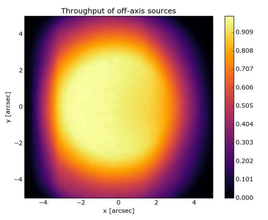
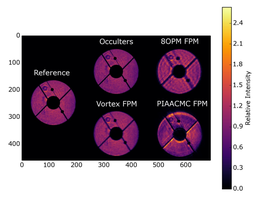
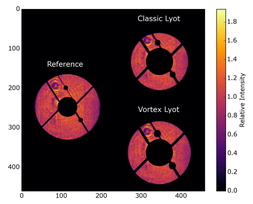
THROUGHPUTS



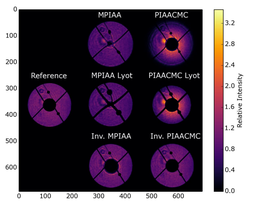
Measured in the pupil plane by scanning the source. Some vignetting outside the field of view of CHARIS



Throughput of focal plane masks in H-band: 93 to 99%

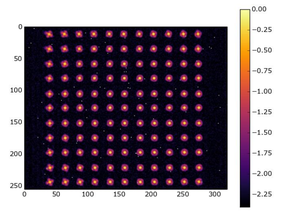


Throughput of Lyot masks in H-band: Classic: 63 %, Vortex: 78%



Throughput of PIAA and inverse PIAA lenses: ~96%, MPIAA Lyot: 86%, PIAACMC Lyot: 77%

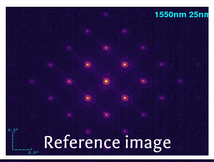
OFF-AXIS ABERRATIONS



Off-axis sources show astigmatism aberrations, due to the various OAPs. Significant only at large separations.

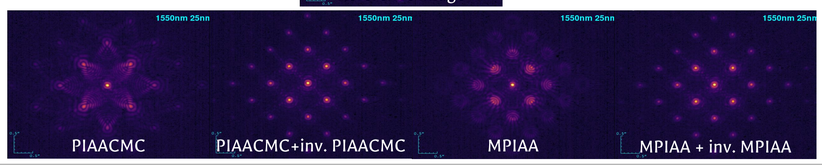
A speckle grid is added to create off-axis sources.

A narrowband filter is used to avoid chromatic dispersion of speckles.



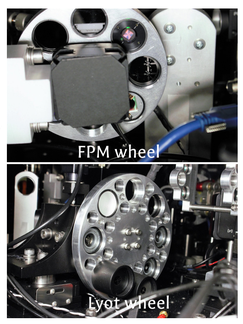
MPIAA and PIAACMC lenses create strong aberrations for off-axis sources.

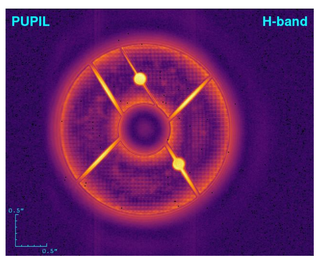
Inverse MPIAA and PIAACMC lenses remove these aberrations.



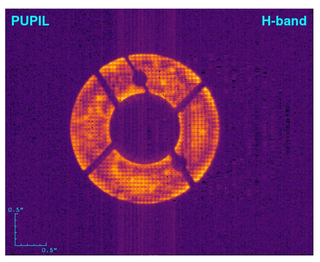
LYOT CORONAGRAPHS

- Design: SCExAO
- Wavelength range: J to K band
- 9 occulter masks originally designed for the PIAA
- 1 dedicated Lyot mask
- Routinely used on-sky (masks #3 and #1), only broadband coronagraph for now.

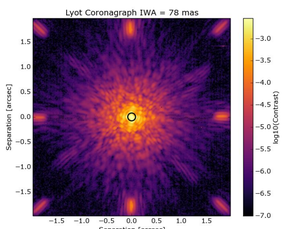




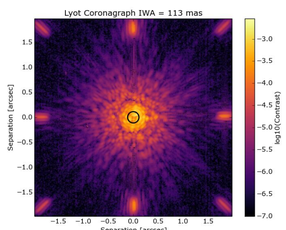
Pupil image after FPM



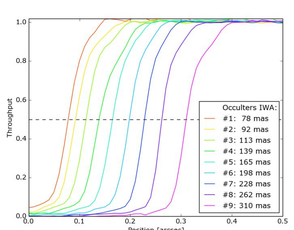
Pupil image after Lyot



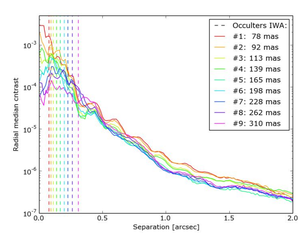
Contrast mask #1



Contrast mask #3



IWA measurement

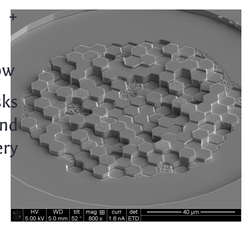


Laboratory contrast curves

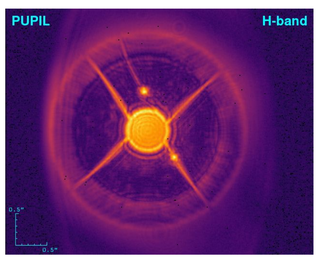
PIAACMC

- Design & fabrication: SCExAO + UofA + Cornell
- Wavelength range: H band for now
- First generation of masks fabricated on Silicon, second generation on Silica (coming very soon!)
- 1 dedicated Lyot mask.

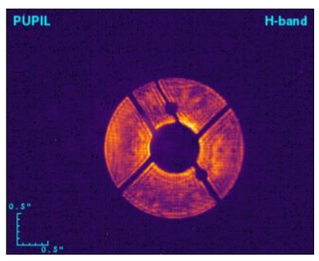
(See Justin Knight's poster #10706-200)



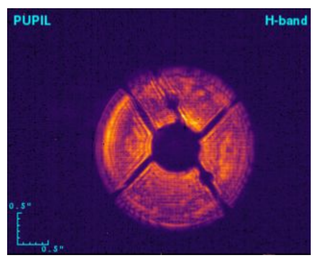
Fabricated FPM



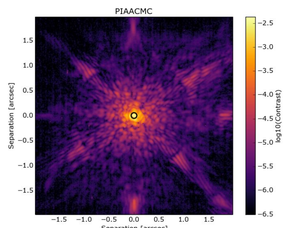
Pupil image after FPM



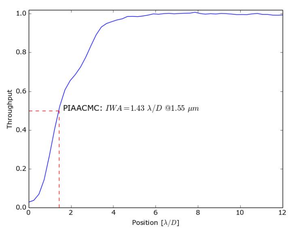
Pupil image after Lyot



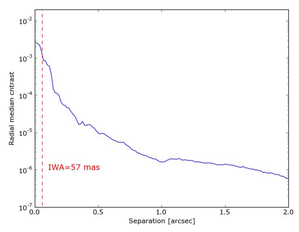
Pupil after inverse PIAACMC



Contrast measurement



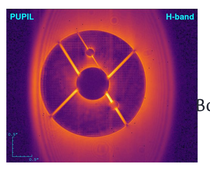
IWA measurement



Laboratory contrast curves

VVC AND MPIAA+VVC

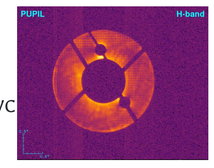
- Design & fabrication: JPL + SCExAO
- Wavelength range: H band for now, J band coming soon, broadband?
- 2 Lyot masks: w/o and w/ MPIAA lenses
- Go-to coronagraph with HiCIAO
- Coronagraph for MEC
- The MPIAA lenses allow for 1l/D IWA



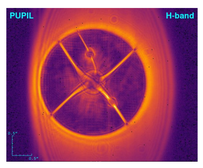
Pupil image after FPM

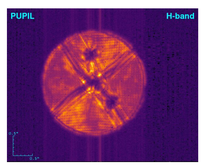
Top: VVC only

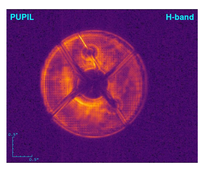
Bottom: MPIAA+VVC

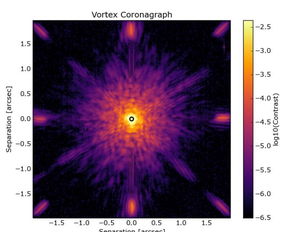


Pupil image after Lyot and inv. MPIAA

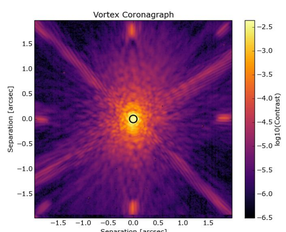




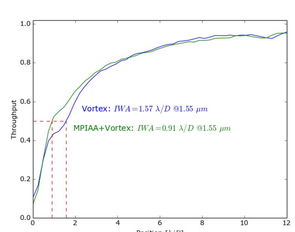




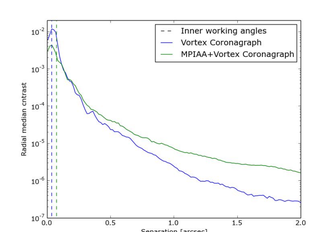
Contrast VVC



Contrast MPIAA+VVC



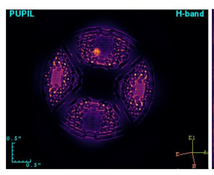
IWA measurement



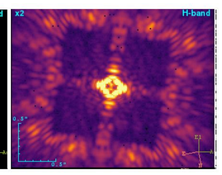
Laboratory contrast curves

SHAPED PUPIL

- Design: Princeton
- Wavelength range: broadband
- Pupil mask, used with occulter spots. Used on-sky to see HR8799e



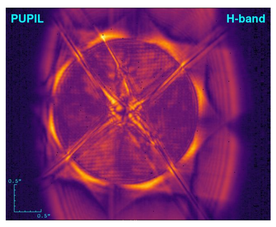
Pupil image



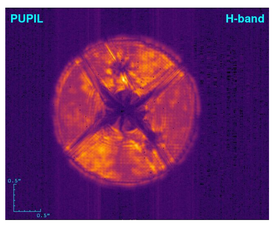
Focal plane image

MPIAA+8OPM

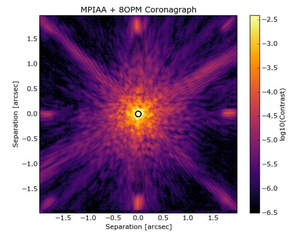
- Design & fabrication: Univ. of Hokkaido + NAOJ + SCExAO
- Wavelength range: H band
- 1 shared MPIAA Lyot mask
- The MPIAA lenses were originally designed for the 8OPM



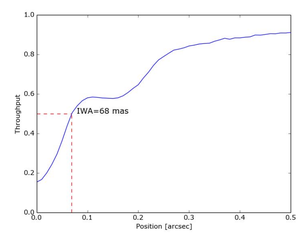
Pupil image after FPM



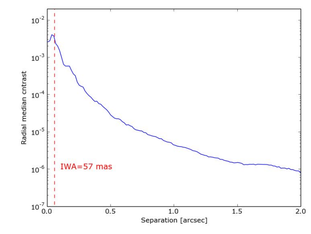
Pupil image after Lyot



Contrast measurement



IWA measurement

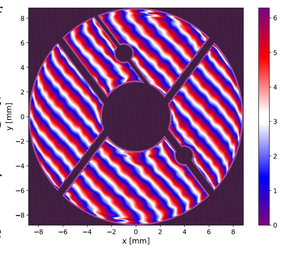


Laboratory contrast curves

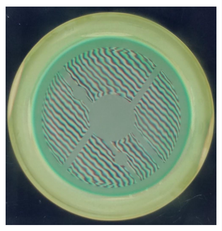
vAPP

- Design & fabrication: Univ. of Leiden + SCExAO
- Wavelength range: Broadband
- Creates symmetric dark zones around 1st order PSFs, from 2 to 11 l/D
- A residual central spot is kept for image quality control
- 2 other defocused spots are created for phase diversity.

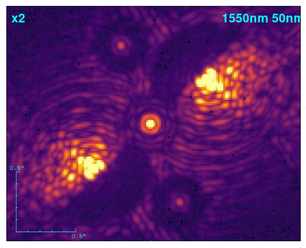
(See David Doelman's presentation #10703-8 about vAPP testing)



Design



Fabricated vAPP



Focal plane image

Focal plane ND mask design

Focal plane image after ND mask to avoid saturation on CHARIS

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1. N. Jovanovic, et al. "The Subaru Coronagraphic Extreme Adaptive Optics System: Enabling High-Contrast Imaging on Solar-System Scales", PASP, 127, 890–910, 2015.
2. F. Martinache, et. al., "Speckle control with a remapped pupil PIAA coronagraph", PASP, 124, 1288M, 2012.
3. N. Jovanovic, et al. "Artificial Incoherent Speckles Enable Precision Astrometry and Photometry in High-contrast Imaging", ApJ Letters, 813, 2, L24, 2015.
4. J. Lozi, et al., "Phase-Induced Amplitude Apodization on Centrally Obscured Pupils: Design and First Laboratory Demonstration for the Subaru Telescope Pupil," PASP, 121, 1232, 2009.
5. O. Guyon, et al., "High Performance PIAA Coronagraphy with Complex Amplitude Focal Plane Masks", ApJ, 190, 2, 2010.
6. J. Kuhn, et al., "An H-band Vector Vortex Coronagraph for the Subaru Coronagraphic Extreme-Adaptive Optics System", PASP, 130, 985, 2018.
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8. F. Snik, et al., "The vector-APP: a broadband apodizing phase plate that yields complementary PSFs", Proc. SPIE, 8450, 84500M, 2012.
9. N. Murakami, et al., "Recent progress on phase-mask coronagraphy based on photonic-crystal technology", Proc. SPIE, 9143, 914334-8, 2014.