Hitting the diffraction limit: first results of the AGPM-VORTEX project

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The birth of a concept

- FQPM $\rightarrow$ sub-wavelength gratings $\rightarrow$ Annular Groove PM

- Advantages of the AGPM
  - Inner working angle $\approx 1 \lambda/D$
  - Clear $360^\circ$ discovery space
  - Achromatic (SG design)
  - Easy to implement

Mawet, Riaud, Absil & Surdej 2005
Grating design/optimization

L band. Period = 1.42 µm, angle = 3.00°
Etching on CVD diamond

• Nanoimprint lithography + dry plasma etching
  • N band (grating period = 4.6 µm)
  • L band (grating period = 1.4 µm)

• Parameters close to optimal ... need to test!
Setting up the bench

“Yacadire” @ Paris-Meudon
Anguish...
High performance

Delacroix et al. 2013

Vortex
Bliss!
Installation at VLT

Don’t break a priceless device
NACO: science demonstration

Raw image of β Pic

Post-processed image

Peak rejection ~ 50:1

Absil et al. 2013
Sensitivity to inner planets

Absil et al. 2013
The $\beta$ Pic disk at L band

- Warped, inner component
  - Disk detected down to 10 AU (0.4")
- Spine offset and bowed (anisotropic scattering)

Milli et al., submitted
First light with LBT/LMIRCam

Peak rejection ~35:1
(far from optimal)

Preliminary sliding PCA data reduction, not throughput-corrected
(courtesy J. Kuhn, JPL/Caltech)
The VORTEX project

- **WP1: Exploitation of 1\textsuperscript{st} generation AGPMs**
  - Install, test and optimize AGPMs on 10m-class telescopes
  - Perform the observations / analyze the data

- **WP2: Development of 2\textsuperscript{nd} generation AGPMs**
  - Better L, M, N band AGPMs
  - Shorter wavelengths (K, H, ... where’s the limit?)
  - Beyond topological charge = 2

- **WP3: Test and validation of new ideas**
  - Exploitation of photon orbital angular momentum (OAM)
  - Post-vortex speckle cancellation techniques
  - Optimal apodization
A vortex in your instrument?

- We’re currently baking more L-band AGPMs

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