An L-band Vector Vortex Coronagraph for NACO: the AGPM Project

O. Absil¹, C. Delacroix², C. Hanot¹, D. Mawet³, S. Habraken¹, J. Surdej¹, M. Karlsson⁴

¹ Institut d’Astrophysique et de Géophysique, University of Liège, Belgium
² HOLOLAB, University of Liège, Belgium
³ Jet Propulsion Laboratory, NASA, USA
⁴ Ångström Laboratory, University of Uppsala, Sweden

Why the L band?

- Planet/star ratio much more favourable than in near-IR
  - See e.g. detection of β Pic b (Lagrange et al. 2010)
- Strehl ratio increases as $\lambda^{6/5}$
  - As high as 70-80% in L band on AO-assisted 10-m class telescope
- Background is still OK
  - L=17 in 1 hour $\rightarrow$ 10 Myr old 1 M$_{Jup}$ planet reachable at 30 pc

BUT ... Lower angular resolution

Need an L-band coronagraph with a small Inner Working Angle on a 10-m class telescope

The NACO-AGPM project

- The NAOS-CONICA (NACO) instrument at VLT
  - The sole 10-m class AO-assisted L-band camera in the Southern hemisphere
- The Annular Groove Phase Mask (AGPM) coronagraph
  - Vector vortex coronagraph (VVC, see D. Mawet’s poster)
  - Made of zero-order (sub-lambda) grating (ZOG)
  - 360° discovery space down to 1 $\lambda$/D
- Manufacturing (see C. Delacroix’s talk)
  - Transparent substrate in L-band $\rightarrow$ diamond
  - Etching of the grating with dry plasma at Ångström Laboratory

End-to-end simulations of NACO-AGPM

- Large gain in the 0.1-0.5” region

Estimated sensitivity in Jupiter masses at 0.2”

- E.g. young K and M dwarfs
  - From 8 to 200 Myr, d < 50 pc
- NACO: near-IR WFS
  - K < 9 $\rightarrow$ 40 targets
  - Pupil tracking, 10 mas rms pointing, ADI (angle > 45°)
- SPHERE: visible WFS
  - V < 10 $\rightarrow$ 25 targets

Excellent complementarity

- L-band NACO-AGPM could be as good as H-band SPHERE at 0.2”, provided that AGPM is to specs