# Experimental results with axi-symmetric circular phase mask coronagraphs

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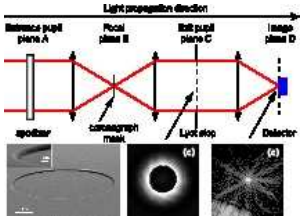
## Abstract:

-Context: coronagraphy, key technology of current & future instruments for exoplanet imaging & spectroscopy, both in ground & space.
-Advantages of circular phase mask coronagraphs: small IWA, high contrast levels, little sensitive to aperture geometry, no blind axes in the final images
-Problem: few demonstration of these concepts in lab, Roddier & Roddier phase mask (RRPM) coronagraph validated last year (M. N'Diaye et al 2010)
-Objectives: demonstration of the most advanced concepts (Apodized Roddier phase mask [ARPM], Dual zone phase mask [DZPM] & colored apodizer phase mask [CAPM] coronagraphs)
-Means: new and operational coronagraph test bench working in the visible
-Results: First lab tests & preliminary results for the ARPM coronagraph

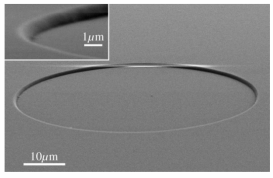
## Circular phase mask coronagraph




*Generic layout*

-RRPM coronagraph: theoretical perfect on-axis starlight extinction
-ARPM coronagraph: theoretical perfect starlight suppression at one wavelength
-DZPM & CAPM coronagraphs: good starlight suppression over large spectral bandwidths

## Feasibility of the circular phase mask

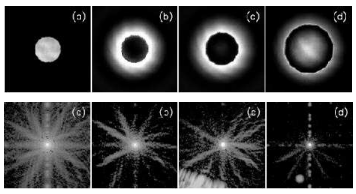



*Our RRPM*

Scanning electronic microscope image of second-generation RRPM designed by LAM & manufactured by GEPI of Paris Obs.
Diameter d=65µm
White line is an artifact.

**0.8nm rms roughness**
**<1µm transition zone (<1% mask diameter)**

## Experimental validation of RRPM coronagraph

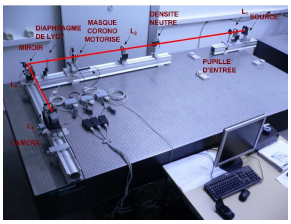



*Images obtained in lab*

Set of images obtained w/o (a) and with RRPM coronagraph (b,c,d) in the pupil (top) and image (bottom) plane. Mask radius: 0.455 λ/D (b), 0.516 λ/D (c) and 0.741 λ/D (d).

**-10^5 contrast measured at 5.7λ/D**
**-Feasibility of circular phase masks demonstrated**

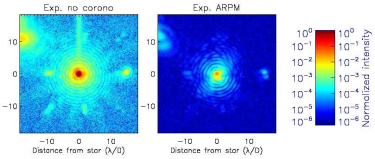
## Demonstration of ARPM coronagraph: *Preliminary results*




*Picture of of our test bench*

Experimental setup:
-Source of λ=680nm
-Apodized entrance pupil of diameter D=5.5mm (Throughput=72%)
-RRPM with f/91 beam
-16-bit camera
-HASO for WF calibration

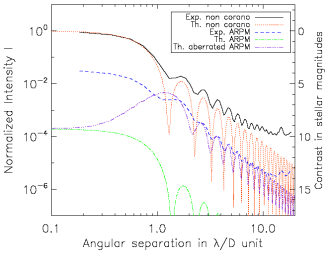
## First results with ARPM coronagraph in lab




*Images obtained in lab*

Estimate of the mask upstream aberrations:
-tip/tilt and defocus not measured
-Astig 45: 54 nm rms
-Total (32 modes measured after defocus): 44nm rms

## Discussion




*Theory vs experiment*

**Good agreement between theory with aberrations & exp. results except on-axis (Defocus aberration, mask decentering?)**

**Upcoming: use of a DM for WF correction**

**Aim: to get close the ultimate perf. of the ARPM coronagraph in lab**

## Conclusions & perspectives: Experimental validation of circular phase mask coronagraphs:

-ARPM coronagraph (work in progress),
-DZPM, Zernike sensor phase mask (ZSPM) & CAPM coronagraphs (next step)
Next step: On-sky demonstration of circular phase mask coronagraphs
Final aim: Innovative, easy-to-build & efficient coronagraphs for the next generation space & ground-based instruments

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