Apodized apertures using a Mach-Zehnder interferometer

Laboratory results

Alexis Carlotti[1] – Gilbert Ricort[1] – Claude Aime[1] – Youssef El Azhari[2] – Rémi Soummer[3]

1 : Université de Nice Sophia-Antipolis, Nice
2 : Ecole Normale Supérieure, Marrakech
3 : American Museum of Natural History, New-York

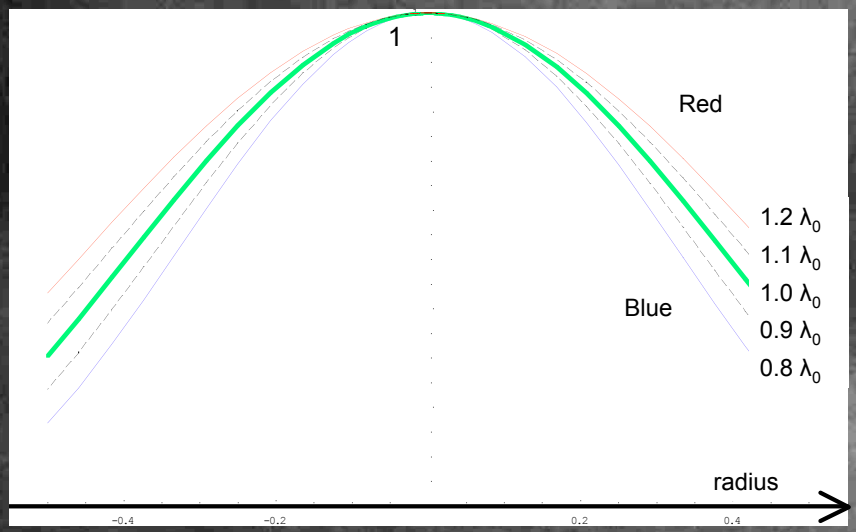
Towards a Wide Band

Prolate Apodized Lyot Coronagraph

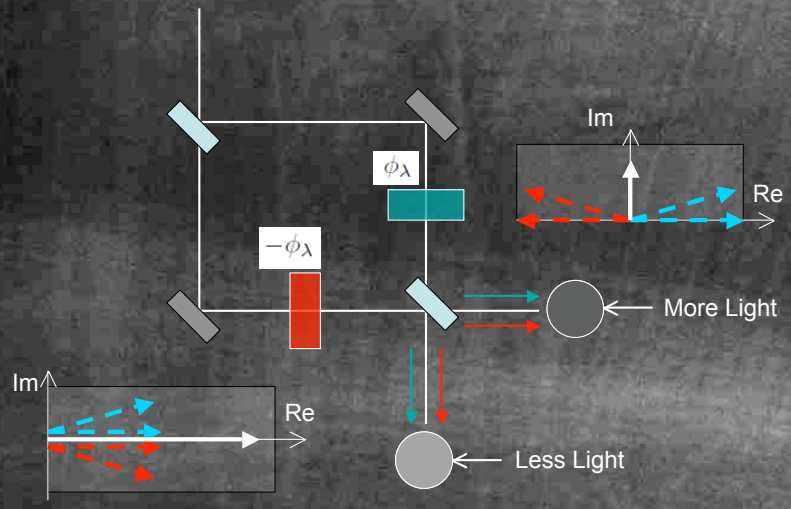
- Aime et al. , A&A, 2001 :
  « Interferometric apodization of rectangular apertures. Application to stellar coronagraphy »
- Pueyo et al. , SPIE, 2004 :
  « High-dynamic-range imaging: amplitude and phase control »
- Aime (Pasp, 2005) :
  « Principle of an Achromatic Prolate Apodized Lyot Coronagraph »
- Pueyo (EDP, 2006) :
  « Achromatic Prolate Coronagraph using Interferometric Apodisations »

- Spheroidal Prolate apodization :
  optimal light concentration in the focal plane.
- One Lyot mask size & different psf's :
  need to compensate for the diffraction chromatism.

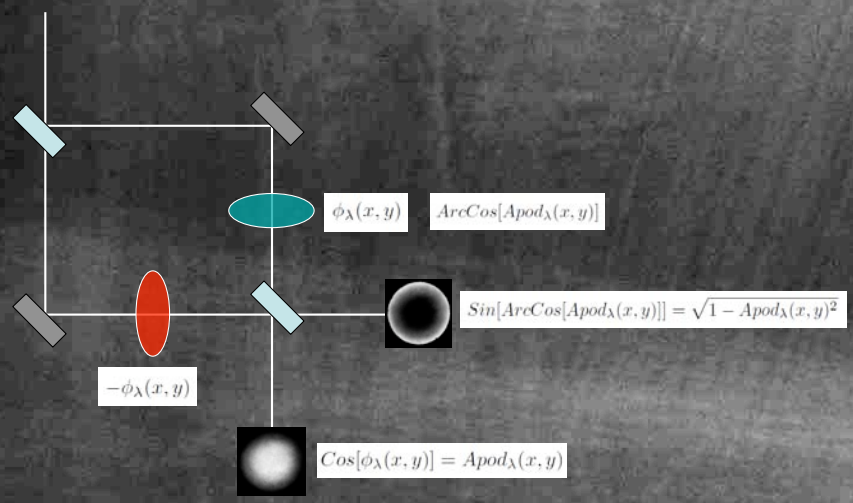
Ideal prolate transmission



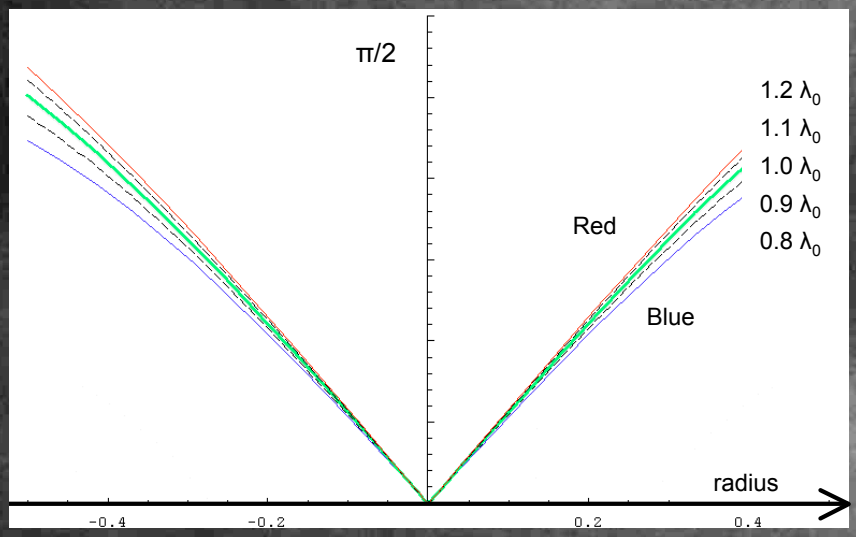
Mach-Zehnder Interferometer



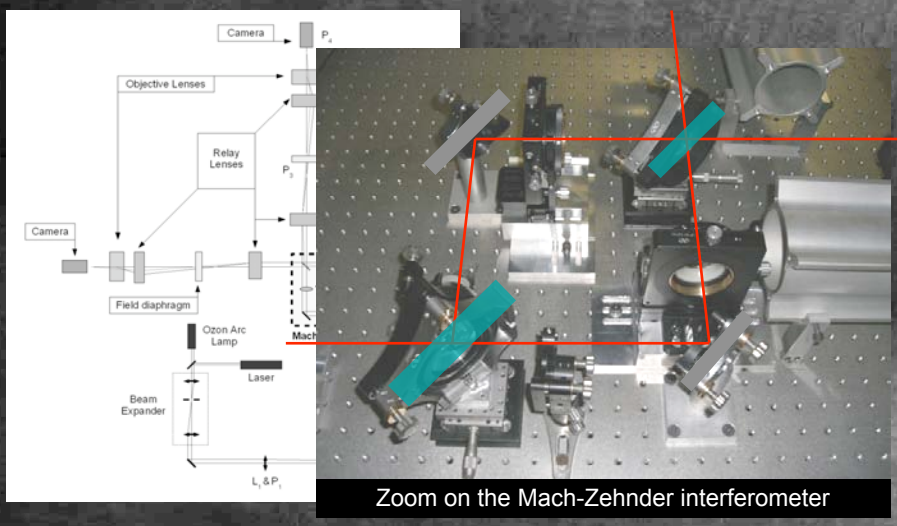
Modeling the pupil



Phase for a prolate apodization

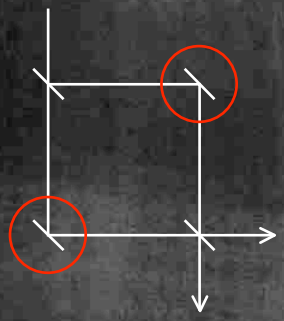


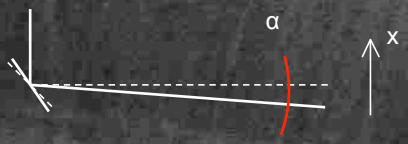
The experiment



Zoom on the Mach-Zehnder interferometer

1-D Apodization

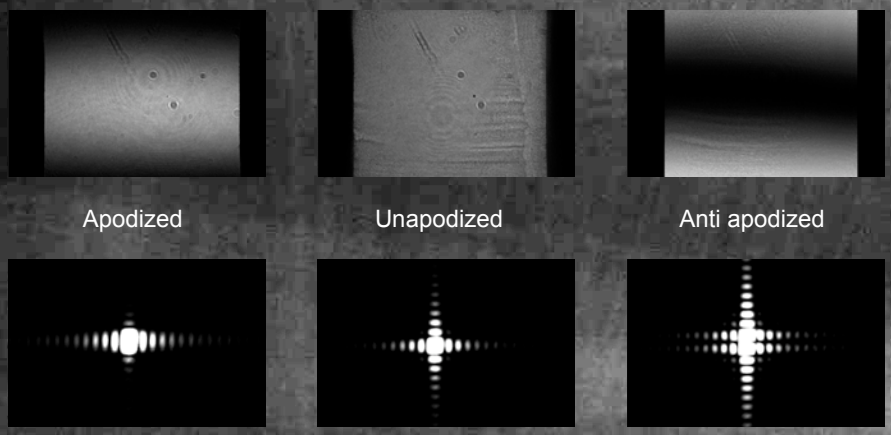




One axis apodization : $\phi(x) = \pi \frac{\alpha x}{\lambda}$

1-D Results

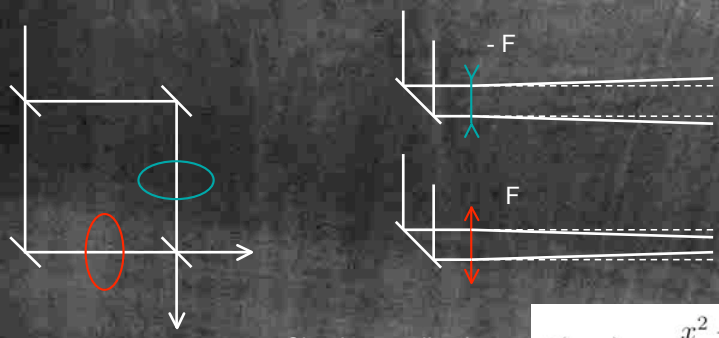
Laser Light - Square aperture



Apodized | Unapodized | Anti apodized

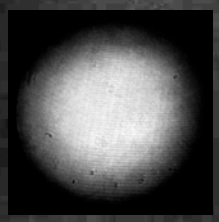
Circular apodizations

Spherical lenses C&D – «optician» quality

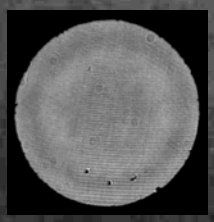


Circular apodization : $\phi(x,y) = \pi \frac{x^2+y^2}{\lambda F}$

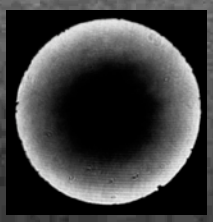
Circular Results



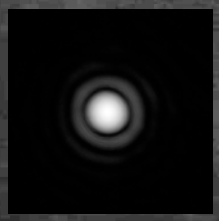
Apodized

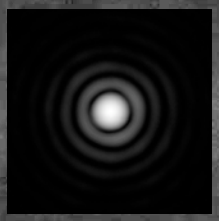


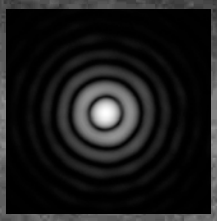
Unapodized



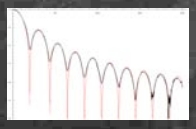
Anti apodized



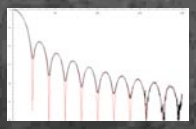




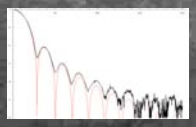
A very good accordance



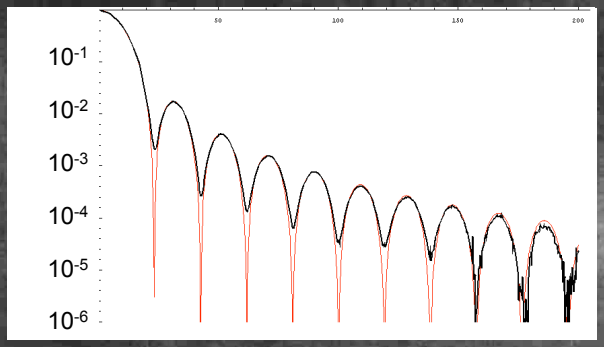
Anti apodized



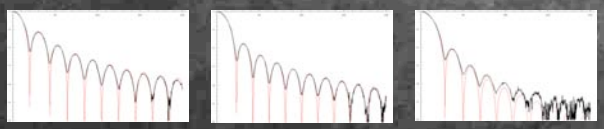
Unapodized



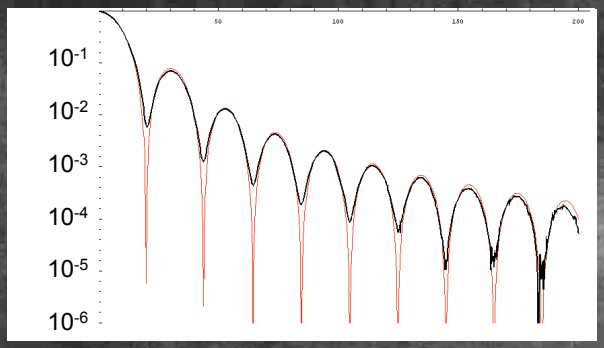
Apodized



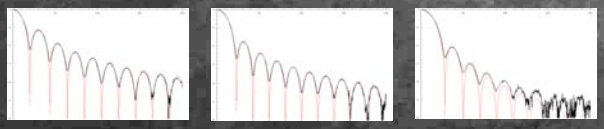
A very good accordance



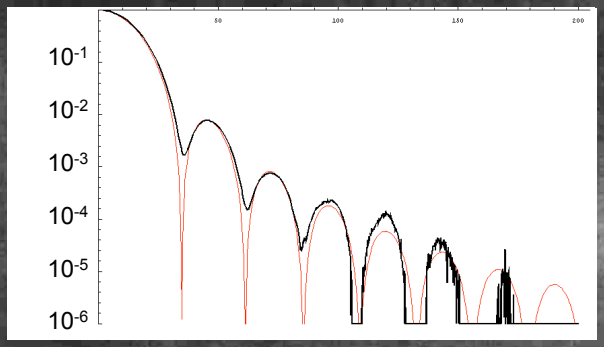
Anti apodized Unapodized Apodized



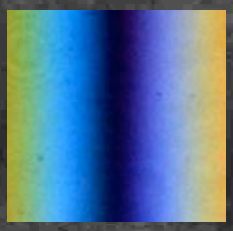
A very good accordance



Anti apodized Unapodized Apodized



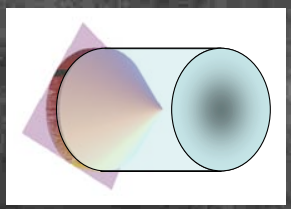
First polychromatic tests

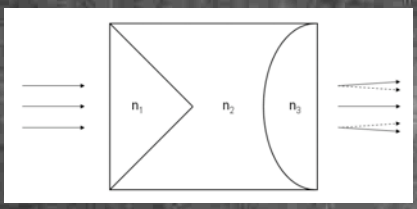


Extremely small coherence length (< 1 µm)

Conclusion

- Any type of apodization can be produced :
  - The phase induces the attenuation.
  - It's chromaticity enables an achromatic coronagraph. Results are in good accordance with the theory.
- Soon a spectral study of the apodization
- Future tests on « prolate phase » materials.





Thank you.

Alexis Carlotti

alexis.carlotti@unice.fr

Université Nice Sophia Antipolis - LUAN
Parc Valrose
06108 Nice – France