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CORONAGRAPH FEASIBILITY STUDIES ON FRIDA

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We propose a way to introduce stellar coronagraphy within FRIDA (inFRared Imager and Dissector for Adaptive Optics [AO] system of the Gran Telescopio Canarias, GTC). We represent the FRIDA coronagraph performance that could be achieved. We also give a few words about the usefulness and limits of coronagraphy.

FRIDA is being designed to provide high quality imaging in broad and narrow band, and spatially resolved spectroscopy with the use of an Integral Field Unit. The presence of a stellar coronagraph inside its optical assembly would allow to reach the direct imaging of faint objects close to brilliant stars, like exoplanets or circumstellar disks, and a spectral analysis of them.

The study is focused here on the main two focal plane mask coronagraph: the Classical Lyot Coronagraph (CLC, an opaque mask) and the Roddier & Roddier Coronagraph (CRC, a π phase shifting mask). GTC aperture is hexagonal so, to improve the starlight extinction results, a inscribed circular diaphragm is placed in the entrance pupil. Adding an adequate Gaussian apodization mask to the aperture allows the increase of the coronagraph performance. It can be designed by means with a doublet of lenses with the same refraction index and where the divergent one is in an absorbing neutral density glass characterized by the Optical Density (OD). The presence of the telescope secondary mirror shadow within the entrance aperture, associated with the coronagraph focal plane mask, makes appear a central illumination at the coronagraph exit pupil center. To block these undesired diffraction effects, an obscuration disk is put in the corresponding plane.

The coronagraph configuration for FRIDA is illustrated in Figure 1 and the corresponding results in Figure 2. Choosing $OD = 0.10$ for the Gaussian apodization mask provides a star intensity decrease by a factor 10^6 (or 15 magnitudes).

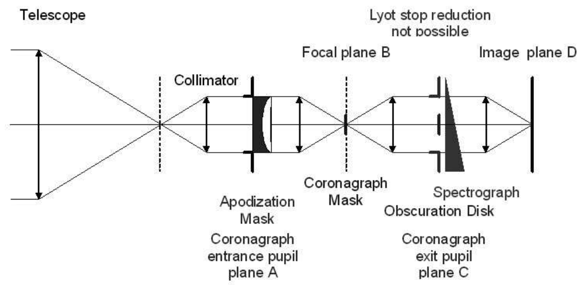

Fig. 1. Configuration for FRIDA optical assembly.

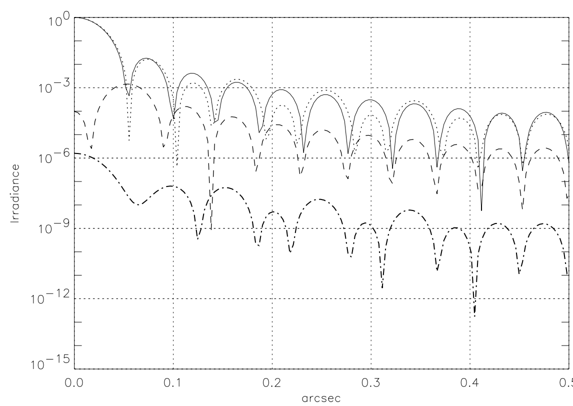

Fig. 2. Plot in log scale of the axial image intensity profile for a CRC with a Gaussian apodized centrally obstructed circular aperture (dash dot) compared with the Airy pattern (solid), the only apodized (dotted) and the CRC (dashed) profiles. All profiles are normalized to the central intensity of the Airy pattern and represented at 2.2 μm.

In the case of ground-based observations, coronagraphs reduce the coherent part of the AO corrected Point Spread Function (PSF) and Differential imaging technique defeats the speckles noise in the PSF halo. So, both combined in FRIDA are expected to allow the study of faint companions.

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