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Performance tests on the SPHERE-IFS

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Abstract. Until now, just a few extrasolar planets (30 out of 860) have been found through the direct imaging method. This number should greatly improve when the next generation of High Contrast Instruments like Gemini Planet Imager (GPI) at Gemini South Telescope or SPHERE at VLT will became operative at the end of this year. In particular, the Integral Field Spectrograph (IFS), one of the SPHERE subsystems, should allow a first characterization of the spectral type of the found extrasolar planets. Here we present the results of the last performance tests that we have done on the IFS instrument at the Institut de Planetologie et d'Astrophysique de Grenoble (IPAG) in condition as similar as possible to the ones that we will find at the telescope. We have found that we should be able to reach contrast down to 5×10^{-7} and make astrometry at sub-mas level with the instrument in the actual conditions. A number of critical issues have been identified. The resolution of these problems could allow to further improve the performance of the instrument.

Keywords. instrumentation, Direct imaging

1. Introduction

Imaging of extrasolar planets is a very challenging goal because of the very large luminosity contrast (of the order 10^{-6} for young giant planets and of the order of 10^{-8}-10^{-10} for old giant and rocky planets) and the small angular separation (few tenths of arcsec for a planet at ∼10 AU around a star at some tens of pc) between the host star and the companion objects. However, a number of different project are either now running (e.g. Project 1640 at the 5 m Palomar Telescope - see Crepp *et al.* 2011) or are going to begin like the Gemini Planet Imager (GPI) at the Gemini South Telescope (Macintosh *et al.* 2006) or SPHERE at the ESO Very Large Telescope (Beuzit *et al.* 2006). This last instrument, in particular, includes three scientific channels that are a differential imager and dual band polarimeter called IRDIS operating in the near infrared between the Y and the Ks band (Dohlen *et al.* 2008), a polarimeter called ZIMPOL that will look for old planets at visible wavelengths (Thalmann *et al.* 2008) and an Integral Field Spectrograph

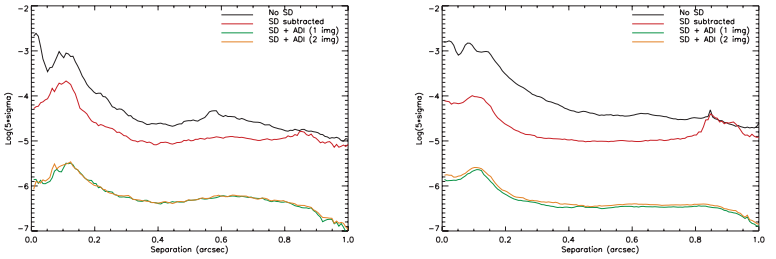

Figure 1. Contrast plot for IFS operating in the YJ-mode (left panel) and in the YH-mode (right panel).

(IFS) operating in the near infrared between the Y and the H band (Claudi *et al.* 2008). In the next paragraphs we will present the results of the laboratory tests on the IFS.

2. Test description

Tests on the IFS instrument were held in January and February 2013 at the *Institut de Planetologie et d'Astrophysique de Grenoble* (IPAG) facility with the aim to validate functionality of the science and calibration templates and to preliminary estimate the performances of the instrument. The tests were performed both in the YJ (0.95 - 1.35 micron) and in YH (0.95 - 1.65 micron) mode using the appropriate combination of Lyot coronagraph and apodized mask.

Data were then reduced exploiting the Data Reduction and Handling (DRH) software that allows to perform all the required calibrations and the speckle subtraction procedure through the spectral deconvolution (SD) method (Sparks & Ford 2002). A further speckle suppression can be obtained applying angular differential imaging (ADI) (Marois *et al.* 2006). Given that we do cannot perform any rotation of the field of view during our tests, we can just perform a simulation of the method so that our results have to be regarded as just an estimation of the contrast that we will be able to get.

3. Results

In Figure 1 we display the 5σ contrast plot that we can get for the IFS operating both in the YJ-mode (left panel) and in the YH-mode (right panel). A contrast better than 10^{-6} can be obtained for both the modes appropriately combining SD and ADI. To further confirm this results we add a number of simulated planets to the raw data at different separations and with luminosity contrast of 10^{-5} and 10^{-6} and reduced these data following the same procedure. All simulated planets are visible with a S/N greater than 5.

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