EPSC Abstracts
Vol. 8, EPSC2013-623, 2013
European Planetary Science Congress 2013

SPHERE IFS: Performance And Results

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Abstract

SPHERE is an exo-solar planet imager, which goal is to detect giant exo-solar planets in the vicinity of bright stars and to characterize them through spectroscopic and polarimetric observations. It is constituted by three scientific instruments different in working wavelength range, observation modes and Field of view. In particular the Integral field spectrograph (IFS) is the instrument that will give a closer glance to the central star. In this contribute we'll describe the results of the high contrast test and performance of this instrument that is going to have its first light at the end of this year.

1. Introduction

SPHERE ([1]) is a complete system with a core made of an extreme-Adaptive Optics (AO) turbulence correction, pupil tracker and NIR and Visible coronagraph devices. At its back end, a differential dual imaging camera and an integral field spectrograph (IFS) work in the Near Infrared (NIR) Y, J, H and Ks bands (0.95 $\leq\lambda\leq$2.32 μm) and a high resolution polarization camera covers the visible (0.6 $\leq\lambda\leq$0.9 μm). The IFS is a low resolution spectrograph (R~50) which works in the near IR (0.95$\leq\lambda\leq$1.6 μm), an ideal wavelength range for the detection of planetary features. The IFS [2] will cover a field of view of about 1.7 x 1.7 square arcsecs reaching a contrast of 10^{-7}, giving an high contrast and high spatial resolution "imager" able to search for planet well inside the star PSF.0.

2. Performance test

During the last months a series of performance tests have been performed at the IPAG facilities in Grenoble – France. Both calibration and deep "science" images have been taken during these tests exploiting the telescope and turbulence simulator customized at this aim. Science images were taken using different coronagraph and IFS mode (YJ or YH mode) combinations. The data reduction of these data has been performed exploiting the pipeline for the Data Reduction and Handling (DRH) appositely prepared for the instrument. In particular, the speckle suppression is performed through the spectral deconvolution method ([3]).

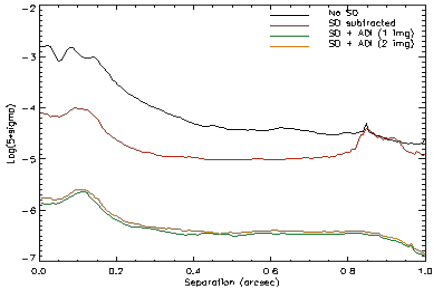

Figure 1 – Example of contrast plot obtained from the IFS data analysis

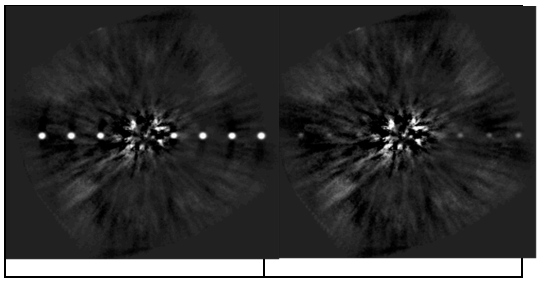

Figure 2 – Images obtained for simulated planets at different separations from the central star and with a contrast of 10^{-5} (left) and 10^{-6} (right)

An evaluation of the angular differential imaging method ([4]) effectiveness on these data has been performed by a subtraction of reduced images taken

at different moments. To further tests the robustness of these results, simulated planets with a contrast of 10^{-5} and of 10^{-6} have been injected into the images at different separations (0.2 -0.8 arcsec) from the "star". In Figure 1 we display the contrast plot obtained for IFS YH-mode with an apodized Lyot coronagraph. Similar results are obtained with the IFS YJ-mode. The images obtained for the simulated planets are showed in Figure 2.

2. Extrasolar Planets Detectability

Taking into account the performances of both SPHERE common path and the IFS, we can foreseen to detect all the planet show in Figure 3. The simulations were done with the MESS code ([5]). The synthetic population probed included 10 planets per star, with masses between 0.5 and 40 Mjup and semi-major axis smaller than 30 AU, generated following the distributions by Cumming et al. 2008. Per each star, the plot shows the smallest of the detectable planets.

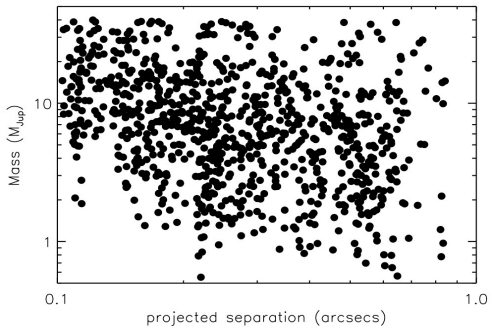

Figure 3: Mass vs semi-major axis of the planets detectable with SPHERE around a sample of 1231 young nearby possible targets.

6. Summary and Conclusions

The results of the tests described demonstrate the capability of the SPHERE-IFS instrument to fulfill the request to obtain a luminosity contrast of the order of 10-6 to 10-7. With these performances the Instrument will allow to find new warm giant planets in a region of the space around the star that is out of reach for most of classic methods for extrasolar planets search. Moreover it will permit to have low resolution spectra of not transiting planets.

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