METEOR OASIS: Optimized AGN Spectro-Interferometric Sensor

Observing Active Galactic Nuclei using Optical Spectro-Interferometry combined with Reverberation Mapping yields the mass of the central super massive black hole and a direct distance measurement of the AGN, potentially up to z>2 with the E-ELT. With the VLTI, these observations need breakthroughs in sensitivity as well as in accuracy and resolution. This requires specific instruments, optimized for medium spectral resolution observations of AGNs with the VLTI. This METEOR presents the different aspects of the conception and optimization of such an Optimized AGN Spectro-Interferometric Sensor: OASIS

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Active Glactic Nuclei

Active Galactic Nuclei are extremely bright sources, powered by accretion on a central super massive black hole (SMBH), that can be observed at very high redshifts. The exact geometry of gas and dust transport toward and away from the central accretion disk remains unknown.

Reverberation Mapping

Reverberation Mapping (RM) is based on the delays between variations in the visible light from the central accretion and their echoes in gas clouds emission lines or dust torus IR emission. RM give *linear equivalent sizes* of AGN structures, in light days (or months). This yields indirect, geometry dependent, estimates of the SMBH mass and AGN distance.

Differential Interferometry

Differential Interferometry (DI) with the VLTI (or spectro-astrometry with an E-ELT) give new geometry constraints and *angular equivalent sizes* of AGN structures. Combining linear measures from RM and angular measures from DI with the proper geometry description from spectro-interferometry yields direct distance measurements, with potentially important cosmological applications. However, almost all targets of interest are too faint for the state of the art VLTI instruments. This implies the design of an instrument or a fringe-tracker optimized for the spectro-interferometric observations of very faint targets.

OASIS

In general, spectro-interferometry requires the analysis of 4 dimensional information (space, wavelength and time). But each measure and each pixel are an additional source of noise. An optimized instrument uses the relationships between the different dimensions (space and time are related by propagation speeds, space and wavelengths by the Doppler effect) to obtain specific parameters with the minimum number of measures. OASIS is an instrument specifically designed for differential interferometry of AGN emission lines.

This METEOR illustrates the methodology to optimize a spectro-interferometric instrument for a specific science goal with the following steps: (1) a short presentations of the main characteristics and features of AGNs; (2) An introduction to Reverberation Mapping; (3) A presentation of Differential Interferometry and spectro-astrometry angular measures of AGNs; (4) A presentation of the methods to code and compress the information in spectro-astrometry; (5) An introduction to the Signal-to-Noise Ratio analysis of spectro-interferometric measures; (6) An optimization of the exposure time and other fringe stabilization parameter as a function of seeing variations; (7) A global optimization combining all these parameters.

The evaluation for each step will be a short essay summarizing the presentations and the papers discussed for each topic.

The final evaluation will be based on the computation of the parameters of an OASIS instrument for a visible interferometer, by analogy with the existing work that has been made for the VLTI in the near infrared.

References

Rakshit, S., Petrov, R.G., Meilland, A. and Hönig, S. F., *Differential Interferometry of QSO broad-line regions*, MNRAS 447, 3, 2015

Hönig, S. F. et al *A dust-parallax distance of 19 megaparsecs to the supermassive black hole in NGC 4151*, Nature 515, 7528, 2014

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