METEOR High-Contrast Imaging Instrumentation (HC2I)

Planets beyond our solar system (exoplanets) concentrate a major part of modern astronomy though the development of the most powerful instruments since 1995, the date of the first detection (51 pegasi-b). Most of the known exoplanets, numbering in the thousands, have been detected using indirect methods, but direct imaging starts to widen the discoveries. This module provides a global introduction to the outstanding exoplanet search problem, in particular it presents the dedicated technological and instrumental requirements for direct imaging.

Theory

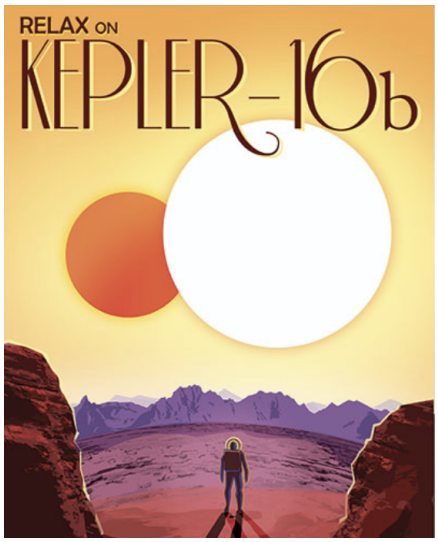
by P. Martinez, L. Abe, F. Martinache

The module focusses on extreme adaptive optics high-contrast instrument development aiming at deep contrast over a small and highly-corrected field of view. Searching for exoplanets with direct imaging is one of the major modern scientific drivers, but it suffers from a load of technological obstacles as the contrast and separation issues (contrast ratio and angular separation between a planet and its host star) demands exquisite image quality and stability.

The general astrophysical background behind this appealing science problematic, the state-of-the-art of exoplanet paradigm, as well as the actual maturity of technological developments to get to high-contrast imaging from the ground and from space will be presented during this module. A general description and associated limitations of various systems and sub-systems included in high-contrast imaging observatories will be detailed. This will in particular include a thorough description of telescope architectures, noise limitations, active/phasing/adaptive optics, coronagraphy, wavefront sensor, observational and post-processing strategies, and component specifications. A review of all existing and future projects will be discussed.

Applications

by P. Martinez, L. Abe, F. Martinache



Specialized courses including laboratory practice, numerical modeling, and performance evaluation of various systems making up a high-contrast instrument will be explored. Theses courses will cover the area of the telescope architectures, laser guide star systems, active optics, phasing optics, adaptive optics, diffraction suppression systems, wavefront sensors, etc. System dimensioning will be highlighted including deformable mirrors, optics, sensors, detectors, along with the basic principle of setting up an error budget. In particular, this module will benefit from numerical modeling training to simulate part or a whole system, and will take advantage from a privileged access to the SPEED instrumental facility (Segmented Pupil Experiment for Exoplanet Detection) at the Lagrange laboratory. The SPEED project that is supported by the Observatoire de la Côte d´Azur, Lagrange laboratory, The Nice Sophia-Antipolis University, the Région PACA, ESO, CNES, Airbus Defense and Space, and the European Union) is a $R\&D$ platform in view of the future high-contrast imaging instruments for the european-extremely large observatories (E-ELT).

Students following this module are expected to acquire knowledge of both theoretical and practical basics in high-contrast imaging instrumentation, including laboratory experimentation, numerical modeling, system dimensioning. They will focus on international projects and instruments, and benefit from intensive training by research.

See also

Exoplanets explained (PhD Comics)
The SPEED project
NASA exoplanet webpage
European-ELT project

Contact

☎ +33 (0)4 92 07 63 39
✉ patrice.martinez@oca.eu