Super Earth Explorer: SEE - COAST

J. Schneider, P. Riaud, A. Boccaletti
D. Mawet, G. Tinetti

Observatoire de Paris & IAP - France
Institut d’Astrophysique de Liege - Belgium
Cosmic Vision

Cosmic Vision is the ESA roadmap for 2015-2025

- call for proposal in early 2007
- several mission class (Astrophysics, Solar System, Fundamental Physics):
  - medium : < 300M€ - launch 2018
  - large : < 650M€ - launch 2020
  - xlarge : > 650M€ - launch >2020 (+ other space agencies)
- proposal submission by June 2007
- down-selection by the end of 2007 (3 M missions out of 40)
- assessment phase by ESA in 2008
- 2009 : 2M missions out of 3
- definition study 2009 - 2010
- 2011 : 1M mission out of 2
- launch (medium class) : 2018

Exoplanet proposals (main ones):
- Pegase (technology demonstrator, 2/3 spacecrafts) : medium class
- PLATO (improved CoRoT) : medium class
- DARWIN (4/5 spacecrafts) : xlarge

=> room/need for a scientific precursor to DARWIN : SEE-COAST
SEE - COAST management

SEE-COAST stands for:

Super Earth Explorer - Coronagraphic Off-Axis Space Telescope
- a scientific precursor to DARWIN
- a technological precursor to TPF-C

PI: J. Schneider (Obs. Paris)

A large European consortium:
(France, Belgium, Switzerland, Italy, Nederland, UK, Germany)

ULg / CSL / LESIA / LUTH / LUAN / ETH-Zurich / IAP / Obs. Geneva
LAOG / ONERA / DLR / U. Vienna / U. Nantes / U. Torino

International Collaboration: JPL, CSA

contact Jean.Schneider@obspm.fr

A. Boccaletti

In Spirit of Bernard Lyot, Berkeley, 2007
The ultimate goal of exoplanetology is the search for life on exoplanets

There is no reliable biosignature without a good physico-chemical characterization of the planet: the goal for SEE-COAST

Main objectives:
- Jupiter-like planets,
- exo-zodiacal disks,
- Super-Earths around nearby stars

Explore diversity of planets in 0.4 - 1.2µm:
- atmospheric composition, clouds, (spectra)
- atmospheric pressure: (Rayleigh scat.)
- albedo & internal structure
- surface conditions (colour, inhomogeneities)
- polarization
- variabilities (seasonal, random)
- surroundings (rings, companions)

=> not feasible with: SPHERE/GPI, JWST, ELTs?
Jupiter-like planets

Spectra of cold giant planets ➞ Chemical composition

Rayleigh scattering ➞ pressure, surf. reflectivity

Polarisation ➞ Clouds / albedo

Time variation ➞ variation of temperature
Super Earth planets

A. Boccaletti  
In Spirit of Bernard Lyot, Berkeley, 2007
Super Earth planets

from Woolf et al. (2002) and Tinetti et al. (2006)
Visible off-axis Telescope @ L2

1.5 m in diameter (as a minimum)

Optimized for High contrast imaging

Ultra-smooth mirror (WFE $\lambda/100$ rms @ 633 nm)
+ calibration (differential imaging)
+ active correction

Low resolution spectroscopy and polarimetry
Scientific Payload

FOV: 3'' x 3''
spectral range: 400 – 1250 nm
spectral resolution: 40
Preliminary simulations:

- > 600 targets considered (FGKM)

=> a few Super Earths potentially detectable
Conclusions

Challenges:
- super-polished mirror (λ/200 rms)
  already achieved on EUV mirrors (Ø 40cm)
  Ion Beam figuring
  development for Eclipse
- Active control with DMs (Trauger et al.) => feasibility in space

Key technologies:
- Achromatic coronagraphs
  . Zero Order Gratings: 4QPM and AGPM in development for SPHERE
    (see poster by D. Mawet)
  . attenuation of $10^5$, $R=2$ achieved with a proto. (talk by P. Baudoz)
- Integral Field Spectrograph (heritage of SPHERE / GPI)
- differential polarimetry (heritage of SPHERE)

Complementary to:
- SPHERE / GPI (2010-2011): giant planets (>1M$_J$), very young or nearby. NIR
- JWST NIRCAM / MIRI (2013): older giant planets (T>300-400K). NIR & MIR
- ELTs (>2016-2018): giant planets to rocky planets (super Earths): NIR

US collaboration is mandatory! (primary mirror, active correction, …)