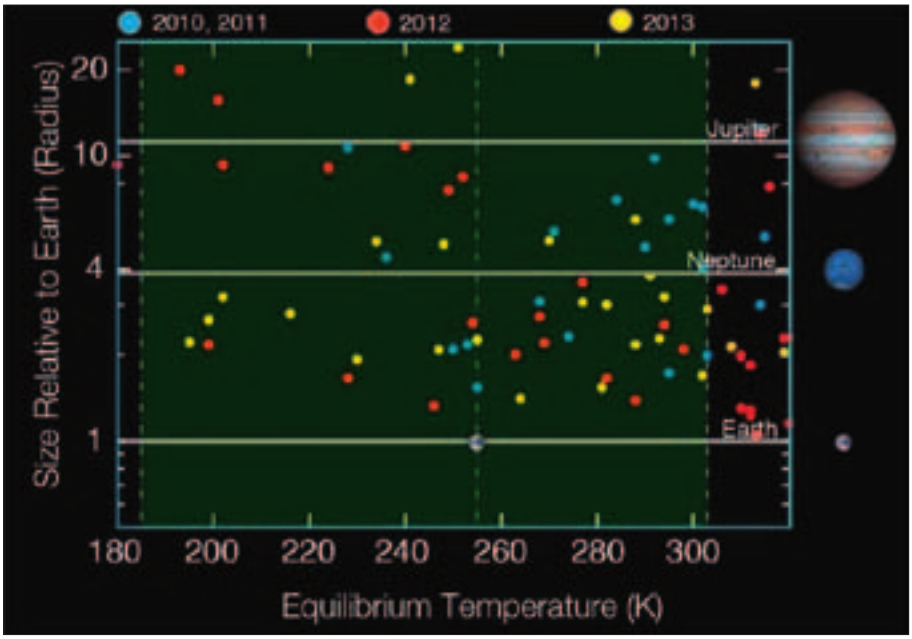
ETAEARTH

Measuring $\eta_{\oplus}$: Characterization of Terrestrial Planetary Systems with Kepler, HARPS-N and Gaia



© NASA

Candidate planets in the Habitable Zone detected by Kepler.

Alessandro SOZZETTI
Project Coordinator

ABSTRACT

ETAEARTH will provide the first ever quantitative answer to an age-old question of mankind: 'How common are Earth analogs in our Galaxy?'. This goal will be achieved by combining the unprecedented photometric precision of NASA's Kepler mission, the unrivalled precision of ground-based radial-velocities from the HARPS-N spectrograph, and ESA's Gaia mission's exquisitely accurate parallaxes, which underpin the physical properties and occurrence rates of terrestrial extrasolar planets with unprecedented accuracy.

CHARACTERIZATION OF EARTH ANALOGS

The ETAEARTH project is a transnational collaboration between European countries and the United States setup to optimize the synergy between space- and ground-based data whose scientific potential for the characterization of extrasolar planets can only be fully exploited when analyzed together.

We will use the HARPS-N spectrograph for 5 years to measure dynamical masses of terrestrial planet candidates identified by the Kepler mission. With the unique combination of Kepler photometric and HARPS-N spectroscopic data we will learn for the first time about the physics of their interiors. Some of these planets will have characteristics (masses, radii) similar to Earth, and they might be orbiting within the habitable zone of stars much like our Sun. We will carry out selected experiments in the Kepler field (mass measurements of multiple-planet systems and circumbinary planets) to probe models of planet formation, orbital migration, and long-term dynamical evolution.

We will search for planets similar to Earth orbiting a carefully selected sample of nearby bright solar-type stars, providing suitable candidates for spectroscopic characterization of their atmospheres with next-generation space observatories. We will combine Kepler, HARPS-N and Gaia data products of stars in the Kepler field to underpin the occurrence rates of terrestrial planets ($\eta_{\oplus}$) as a function of stellar properties with unprecedented accuracy. ETAEARTH will finally provide the first ever quantitative answer to an age-old question of mankind: 'How common are Earth analogs in our Galaxy?'.

Our unique team expertise in observations and modelling of exoplanetary systems will allow us to fully exploit the potential for breakthrough science intrinsic to this cutting-edge, multi-techniques, interdisciplinary project, making the best use of data of the highest quality gathered from NASA and ESA space missions and ground-based instrumentation.

QUESTIONS & ANSWERS

What is the project designed to achieve ?

ETAEARTH will make the best use of data collection techniques of the highest quality gathered from NASA and ESA space missions and ground-based instrumentation: Kepler photometry; HARPS-N spectroscopy; Gaia astrometry. Within the 5 years of the project, ETAEARTH will determine physical properties and occurrence rates of terrestrial planets ($\eta_{\oplus}$) as a function of stellar characteristics with unprecedented accuracy.

Why is this project important for Europe and how does it benefit European citizens ?

The ETAEARTH project will help place the European community in the future of planetary science, and it will provide inspiration for younger scientists in cross-disciplinary fields. ETAEARTH will allow transferring the scientist's curiosity towards some of the most fundamental questions of modern astronomy (is the Earth unique? How varied is the class of potentially habitable terrestrial planets?) across European society.

How does the project exceed the current state of knowledge ?

The ETAEARTH project will, for the first time, combine the highest-precision datasets available to the scientific community working on exoplanets, gathered with three different ground-based, as well as space-borne techniques. ETAEARTH will ultimately bring us closer to finding answers to age-old questions concerning the uniqueness of the Earth as a habitat.