

## Shaping the Italian contribution to HWO



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# From Planet Formation to Bio-signatures: An OPAL for the Habitable Worlds Observatory

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The Habitable Worlds Observatory (HWO) is designed to directly image and characterize temperate exoplanets, searching for signs of life through UV-optical-infrared spectroscopy. During the ongoing science and technology maturation phase it is particularly important to realistically inform target characterization and selection to consolidate and optimize the mission capabilities.

The OPAL (Origins of Planets for Ariel) project, developed to support ESA's exoplanetary observatory Ariel, is producing thousands of synthetic atmospheric models for giant planets by simulating their formation from their native circumstellar disk to mature atmospheres. OPAL is born from the merging of two large computing projects on LEONARDO and PLEIADI and is powered by the INAF-developed Arxes suite of planet formation codes.

OPAL's simulation infrastructures and methodology can be extended to the simulations of terrestrial planets, the main target of HWO, to provide realistic spectra based on physical formation pathways. These spectra can serve as a predictive database to guide observational strategies for key HWO objectives: identifying promising bio-signature targets, constraining chemical diversity, and testing retrieval methods. This talk presents the scientific scope of OPAL, its application to the Ariel mission and its relevance for HWO, highlighting how physically grounded simulations can refine our expectations and interpretations of habitable exoplanets.

**Authors:** POLYCHRONI, Danai (Istituto Nazionale di Astrofisica (INAF)); TURRINI, Diego (Istituto Nazionale di Astrofisica (INAF))

**Co-authors:** Dr POLITI, Romolo (Istituto Nazionale di Astrofisica (INAF)); PACETTI, Elenia (Istituto Nazionale di Astrofisica (INAF)); SIMONETTI, Paolo Matteo (Istituto Nazionale di Astrofisica (INAF)); FONTE, Sergio (Istituto Nazionale di Astrofisica (INAF)); SCHISANO, Eugenio (Istituto Nazionale di Astrofisica (INAF)); Dr ZUSI, Michele (INAF); MOLINARI, Sergio (Istituto Nazionale di Astrofisica (INAF)); Dr IVANOVSKI, Stavro Lambrov (Istituto Nazionale di Astrofisica (INAF)); MUSMECI, Giovanni

**Presenter:** POLYCHRONI, Danai (Istituto Nazionale di Astrofisica (INAF))

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