Shaping the Italian contribution to HWO

Report of Contributions

https://indico.ict.inaf.it/e/3258

Contribution ID: **1** Type: **not specified**

SHARP: an advanced Near-IR spectrograph to unlock the Universe beyond Habitable Worlds

Friday 11 July 2025 09:45 (10 minutes)

SHARP is a conceptual study for a near-IR (0.9-2.4 mu) spectrograph designed to exploit the capabilities of future ground-based AO-assisted Extremely Large Telescopes (ELTs) and space-based Habitable World Observatory (HWO). The instrument concept is driven by the goal of creating a spectrograph capable of tackling the most important questions in astrophysics and cosmology, from exploring primordial galaxies to studying the properties of candidate Habitable Worlds, bridging the gap between the local and the distant Universe. This requires versatility to accommodate diverse observational needs. SHARP consists of two main units: NEXUS, a slit Multi-Object Spectrograph (MOS) optimized for detecting the faintest sources, and VESPER, a multi-object Integral Field Unit (multi-IFU) designed for brighter ones. The high angular resolution, multi-object capabilities, and near-IR coverage enable studies of stellar and planetary formation, exoplanet atmospheres, high-redshift galaxy properties, as well as the search for primordial Population III stars. SHARP would leverage the HWO aperture to surpass the capabilities of NIRSpec@JWST, complementing other UV/Vis spectrographs and enabling spectroscopy of High-Resolution Imager observations in the near-IR. In this talk the main scientific drivers, the resulting main requirements and the basic properties of SHARP will be summarized.

Author: SARACCO, Paolo (Istituto Nazionale di Astrofisica (INAF))

Presenter: SARACCO, Paolo (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Space missions and instruments

Contribution ID: **2** Type: **not specified**

Venus and Earth as analog environments for the characterization of terrestrial exoplanets looking at HWO in the context of the AVENGERS initiative

Thursday 10 July 2025 11:40 (10 minutes)

Several missions have been recently selected to explore Venus, that during the next decade will focus on the analysis of its atmosphere, surface and interiors. Additionally, missions have been selected to search for and characterize terrestrial exoplanets and potentially habitable worlds, with the Habitable Worlds Observatory being the next generation space telescope devoted to this type of analysis. With the explosion of terrestrial exoplanets discoveries, the current available data seem to show how some of them may be characterized by very dense and very likely CO2-rich atmospheres. In this context, Venus (and Earth) can be used a natural laboratory to constrain the models for potentially habitable environments. One possibility is that terrestrial planets evolving toward Venus-like conditions at some point in their geologic history, may be a common stage of planetary evolution. Venus could have been like Earth in the past, including potentially hosting liquid bodies of water on its surface before developing into its current caustic state. Understanding why Venus and Earth at some point of their geologic history took completely different evolutionary paths is one key science question for a better understanding of the evolution of potentially habitable exoplanetary environments. To this regard, studying the interior, surface, and atmosphere of Venus and Earth assumes an even broader perspective, as these planets in particular may be considered as suitable analogs for many terrestrial exoplanets. During the upcoming years, the "Analogs for VENus'GEologically Recent Surfaces" (AVENGERS) initiative will provide useful insights into these key science questions by investigating terrestrial analogs of features found on Venus, and therefore applicable to similar exoplanets.

Author: Dr D'INCECCO, Piero (Istituto Nazionale di Astrofisica (INAF))

Presenter: Dr D'INCECCO, Piero (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Exoplanet Science

Contribution ID: **3** Type: **not specified**

The HWO perspective of the Italian JEDI collaboration - JEts and Disk @ INAF

Thursday 10 July 2025 16:05 (10 minutes)

The evolution of disks around young-low-mass stars and the related phenomena of accretion and outflows are hot topics in modern astrophysics. Our capability to investigate these key aspects for star- and planet-formation has recently received a boost thanks to the increasing quality of high spatial and spectral resolution observations and new analytic and numerical tools for theoretical studies.
The Italian JEDI - JEts and Disks @ INAF collaboration brings together researchers working in these fields, and it is a vibrant and growing community with multiple and complementary competences. In particular, JEDI researchers have extensive experience in space observations, built over time with many successful programs for JWST, HST, Herschel, Spitzer and other missions (with GO, GTO and archival data).
In this contribution we present our activities, highlight some of the open questions that can be answered with new instrumentation, and discuss the contributions we can make to the planning of the Habitable Wolds Observatory in the study of accretion and ejection in young stars in other galaxies, the detection and characterization of circumplanetary disks - including associated accretion and planetary jets, the analysis of shocks from accretion streamers, and the investigation of the smallest spatial and spectral scales of the jet launching regions, to establish the feedback of outflows on the planet formation process.

Author: RIGLIACO, Elisabetta (Istituto Nazionale di Astrofisica (INAF))

Presenter: RIGLIACO, Elisabetta (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Stellar Astrophysics

Contribution ID: **4** Type: **not specified**

Decoding the atmospheres of temperate rocky planets in the 2040s

Friday 11 July 2025 09:55 (15 minutes)

With complementary strategies, two main space missions in the 2040s (WHO and LIFE) are being designed in order to investigate and interpret the atmospheres of temperate, rocky exoplanets - including the search for biological signatures. In this short review I will recap the main science goals, the strategy of both observatories, and the reliance on scientific milestones of the previous decade, such as the exact mechanisms of the rocky-gaseous transition, atmosphere retention over geological times, and the diversity of rocky atmospheres. These earlier goals will be pivotal to put any putative measurement of biomarkers in context.

Presenter: BROGI, Matteo (University of Warwick)

Session Classification: Exoplanet Science

Contribution ID: **5** Type: **not specified**

Demographics of Terrestrial Planetary Systems: Now, and in the HWO Era

Thursday 10 July 2025 10:40 (15 minutes)

I will provide a brief overview of our present knowledge of the demographics of planetary systems with (temperate) terrestrial, rocky planets. I will then outline how convergent multi-technique observational approaches in the coming two decades will help maximizing the scientific return of HWO's primary goal of searching for biosignatures in the atmospheres of tens of potentially habitable Earth-like planets around the nearest solar-type stars.

Presenter: Dr SOZZETTI, Alessandro (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Exoplanet Science

Contribution ID: **6** Type: **not specified**

Synergies between Ariel and the Habitable Worlds Observatory

Thursday 10 July 2025 10:55 (15 minutes)

Presenter: MICELA, Giuseppina (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Exoplanet Science

Contribution ID: **7** Type: **not specified**

Sinergie tra PLATO e HWO

Thursday 10 July 2025 11:10 (15 minutes)

Presenter: PIOTTO, Giampaolo

Session Classification: Exoplanet Science

Contribution ID: **8** Type: **not specified**

Characterizing planet-host stars: the case of Ariel

Thursday 10 July 2025 11:25 (15 minutes)

The exoplanet characterization follows the axiom: know the star, know the planet. In order to achieve the goal of Habitable Worlds Observatory (HWO) for the search of other Earths, a precise and accurate knowledge of the properties of their host star is necessary. The NASA Exoplanet Exploration Program has already released a list of ~160 nearby targets identified as the most accessible to survey for potentially habitable exoplanets with HWO.

In this talk, I will present the methodologies and techniques we have applied for the homogeneous characterization of the Ariel mission candidate sample and demonstrate how this expertise can be leveraged to characterize the target list of HWO. Finally, I will highlight upcoming improvements in our techniques particularly by the 2040s in determining stellar atmospheric parameters, chemical abundances, and physical properties (mass, radius, age) and discuss their impact on the planetary systems.

Presenter: TSANTAKI, Maria (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Exoplanet Science

Contribution ID: **9** Type: **not specified**

The LIFE Mission - Characterizing other words and searching for life

Friday 11 July 2025 09:30 (15 minutes)

In this talk, I will discuss the Large Interferometer For Exoplanets (LIFE), a space mission project rooted in Europe, which has been gaining significant international support and traction over the last few years. I will summarize the scientific vision for LIFE, provide an overview of ongoing technology development efforts, and give an outlook about the overall development process.

As a space-based nulling interferometer operating at mid-infrared wavelengths, LIFE will be able to directly detect hundreds of exoplanets - with an expected 30 to 50 of which of size and temperature similar to Earth - and measure their intrinsic thermal emission spectroscopically. The wavelength range and mission design of LIFE offers unique and distinct advantages compared to other future missions and projects. This allows LIFE to search for atmospheric biosignatures in Earth-twin exoplanets, but LIFE can also find atmospheric biosignatures from biospheres that differ significantly from that of Earth in their composition or stellar environment. Also, LIFE has the capabilities to search for imprints of technology in exoplanet atmospheres, so-called technosignatures. This versatility allows LIFE to become the world's leading mission in the search for life beyond the Solar System. With a target launch no later than 2040, LIFE's vision and ambition go beyond standard agency-led development processes, motivating us to explore new private-public partnerships.

Presenter: QUANZ, Sascha (ETH Zurich)

Session Classification: Space missions and instruments

Contribution ID: **11** Type: **not specified**

Are We Alone? The Science Potential of Habitable Worlds Observatory.

Thursday 10 July 2025 14:00 (15 minutes)

Presenter: ARNEY, Giada

Session Classification: HWO NASA

Contribution ID: **12** Type: **not specified**

Opportunities for Transformative General Astrophysics with HWO

Thursday 10 July 2025 14:15 (15 minutes)

Presenter: TUMLINSON, Jason

Session Classification: HWO NASA

Contribution ID: **13** Type: **not specified**

HWO architecture - TBC

Presenter: FEINBERG, Lee (NASA, Goddard)

Session Classification: HWO NASA

Contribution ID: **14** Type: **not specified**

Habitable Worlds Observatory Architecture & Technology Development

Thursday 10 July 2025 14:30 (25 minutes)

Presenter: BOLCAR, Matt (NASA, Goddard))

Session Classification: HWO NASA

Contribution ID: **15** Type: **not specified**

Unveiling the star formation mechanism with HWO

Thursday 10 July 2025 15:05 (15 minutes)

Presenter: TRAFICANTE, Alessio (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Stellar Astrophysics

Contribution ID: **16** Type: **not specified**

Investigating the origin of stars with the Habitable World Observatory

Thursday 10 July 2025 15:20 (15 minutes)

Understanding the processes that lead to star formation is essential for addressing key questions in modern astronomy, from the origin of the Solar System to the evolution of galaxies. While a broad framework for star formation in the Milky Way has been established, several critical aspects remain unresolved. In particular, the influence of the
environment properties, such as stellar density and metallicity, is still not well understood. In this talk, I will highlight these open questions and discuss how the field is expected to evolve over the next two decades. I will also explore the potential contributions of the Habitable Worlds Observatory in advancing our understanding of star formation, and how its capabilities will complement those of
the ELT.

Presenter: SACCO, Giuseppe Germano (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Stellar Astrophysics

Contribution ID: **17** Type: **not specified**

Astrometry of resolved stellar populations with MAVIS and HWO

Thursday 10 July 2025 15:35 (15 minutes)

Presenter: MASSARI, Davide (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Stellar Astrophysics

Contribution ID: **18** Type: **not specified**

Tracing Galaxy Evolution with Resolved Stars: The HWO Perspective

Thursday 10 July 2025 15:50 (15 minutes)

In this talk, I will review our current understanding of resolved stellar populations in nearby galaxies, with particular emphasis on the progress enabled by JWST. I will then discuss the advances expected from the ELT, focusing on the unprecedented spatial resolution achievable with the MORFEO-MICADO system. Finally, I will explore future prospects opened by HWO and its potential to push the study of galaxy evolution through resolved stellar populations into new regimes.

Presenter: ANNIBALI, Francesca (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Stellar Astrophysics

Contribution ID: **19** Type: **not specified**

Solving reionization with HWO

Thursday 10 July 2025 16:45 (15 minutes)

Presenter: PENTERICCI, Laura (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Extragalactic Astrophysics

Contribution ID: **20** Type: **not specified**

Studying the intergalactic medium with a future space telescope

Thursday 10 July 2025 17:00 (15 minutes)

Presenter: D'ODORICO, Valentina (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Extragalactic Astrophysics

Contribution ID: **21** Type: **not specified**

AGN and Galaxy Evolution: Exploring the Final Frontier with HWO

Thursday 10 July 2025 17:15 (15 minutes)

Presenter: MARCONI, Alessandro (Dipartimento di Fisica e Astronomia, Università di Firenze)

Session Classification: Extragalactic Astrophysics

Contribution ID: **22** Type: **not specified**

Shaping the Future of Time-Domain and Multi-Messenger Astronomy with HWO

Thursday 10 July 2025 17:30 (15 minutes)

Presenter: PIRANOMONTE, Silvia (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Extragalactic Astrophysics

Contribution ID: **23** Type: **not specified**

New frontiers in cosmology in view of the Habitable World Observatory

Thursday 10 July 2025 17:45 (15 minutes)

I will present an overview of the frontiers and challenges for cosmology in view of the Habitable World Observatoryervatory

Presenter: MORESCO, Michele Ennio Maria (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Extragalactic Astrophysics

Contribution ID: **27** Type: **not specified**

Pyramid WaveFront Sensors and contactless active mirrors: a research program for high contrast imaging

Friday 11 July 2025 11:55 (15 minutes)

WaveFront sensing and control is considered an enabling technology for the the next generation space telescopes such as the HWO. We investigated the possible contributions of ground based Adaptive Optics for space telescopes and in particular the pyramid WaveFront Sensor and the concept of a contactless active primary mirror.
The PWFS, largely adopted on ground, is a pupil-conjugated sensor and is extremely sensitive at the low-mid spatial scales. We run a set of numerical simulations with the PWFS measuring the misalignment and phase steps of a JWST-like primary mirror, with natural guide stars in the magnitude range 8 to 14; we estimated a sensitivity far below 1 nm, while sampling at 1s cadence, in presence of photon and detector noise. In view of these results, the PWFS may help reducing the temporal stability requirements on the DM. In add, the PWFS signal may feed an advanced PSF reconstruction algorithm for contrast enhancement.
Concerning active mirrors: based on the technology of the adaptive secondaries (currently in use at LBT, VLT, e.g.), we developed a 40 cm mirror, 18 kg/m2, controlled by 19 voice coil actuators and capacitive position sensors, in a contactless control scheme. The optical surface floats at 300-1000 um from the mechanical support with no mechanical contact; such scheme potentially provides an intrinsic insulation from vibrations (and enhanced stability at no added cost) while reducing dramatically the mechanical spec of the support. The system is currently in the optical lab and we are assessing the rejection of external vibration and disturbances, while studying how to reduce its density to 14 kg/m2

Presenter: BRIGUGLIO PELLEGRINO, Runa Antonio (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Space technology

Contribution ID: **28** Type: **not specified**

HWO and its optics system: requirements, challenges and possible European contributions

Friday 11 July 2025 11:40 (15 minutes)

The implementation of the HWO optics system presents several challenging aspects, as it must work under unprecedented requirements. In addition to achieving the exquisite angular resolution, one must address the problem of the mirror mass (with an areal density mass goal of approximately 10 kg/cm^2), a wide range of operational thermal conditions, and a broad reflection wavelength band. In the US, the development of appropriate technologies for both the mirror substrates, the actuation systems, and the coatings started a few years ago. Still, the final trade-off has not yet been completed. In this context, we'll discuss ideas for a potential European contribution to implementing the optical system.

Presenter: PARESCHI, Giovanni (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Space technology

Contribution ID: **29** Type: **not specified**

PSF reconstruction from WFS data and other tools to make your images sharper and deeper

Friday 11 July 2025 12:25 (15 minutes)

Presenter: PEDICHINI, Fernando (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Space technology

Contribution ID: **30** Type: **not specified**

The Pollux instrument for HWO: a high-resolution spectropolarimeter from the far-UV to the near-IR

Friday 11 July 2025 09:15 (15 minutes)

Pollux is a high-resolution spectropolarimeter working from 100 nm to 1.6 microns proposed for HWO by a European consortium. Pollux will allow us to study stellar and (exo)planetary systems, as well as cosmic ecosystems. For example, Pollux will provide new insights on exoplanet formation and evolution, characterisation of the atmospheres and magnetospheres of stars and planets, and star-planet interactions. It will also allow us to resolve narrow UV emission and absorption lines, enabling us to follow the baryon cycle over cosmic time - from galaxies forming stars out of interstellar gas and grains, and planets forming in circumstellar disks, to the various forms of feedback into the interstellar and intergalactic medium - and from active galactic nuclei. The most innovative characteristic of Pollux is its unique spectropolarimetric capability in the UV, which will open a new parameter space. Its very high spectral resolution (~60000 to ~120000) and stability over a very large wavelength range will also be a major asset. We will summarise the main scientific drivers of Pollux and present its current design, technological challenges, and the Pollux consortium organisation.

Author: FOSSATI, Luca (Space Research Institute, Austrian Academy of Sciences)

Presenter: FOSSATI, Luca (Space Research Institute, Austrian Academy of Sciences)

Session Classification: Space missions and instruments

Contribution ID: **31** Type: **not specified**

AI Assisted observational strategies for HWO

Friday 11 July 2025 14:05 (15 minutes)

In this talk we will present how Machine Learning and AI-Assisted algorithms, based on fully Bayesian methods, may help to define the observational strategies of the Habitable Worlds Observatory (HWO) mission by maximizing the scientific returns while making the best possible use of the available observing time.
We will focus on the proposed fully-bayesian approach for radial-velocity follow up of TESS targets (e.g. Loredo et al 2012; Burt et al 2018; Cabona et al 2021) and we will review how this kind of methodologies for automatic scheduling will be used, in the next very few months, for ground-based spectrographic instrumentation (where scheduling constraints are more challenging compared to space-based observations.) for the European Southern Observatory NTT Son-Of-Xshooter (e.g. Asquini et al 2024).
The ability to leverage these algorithms will be relevant not only for an operational mission, which may still be far in the future, but also for assessing the scientific return on simulated observation plans. Taking into account the current expected performance of HWO instrumentations and the Bayesian-informed observation plans computed, it is possible to analytically assess the scientific return expected from the observations and how synergies between HWO and the next-generation ground-based instrumentation for extremely large telescopes (such as ANDES for the ESO-ELT) could be developed.

Presenter: LANDONI, Marco (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Space technology

Contribution ID: **32** Type: **not specified**

R&D for space-based High-Contrast Imaging in Europe

Friday 11 July 2025 12:10 (15 minutes)

In March 2024, a group of European researchers working on high-contrast imaging (HCI) for exoplanet research organized the first "R&D for Space-Based HCI in Europe"workshop at the Paris Observatory. A second edition was held in May 2025 in Heidelberg. Acknowledging Europe's long-standing contributions to HCI, the main goal of the workshop was to foster collaboration and provide an overview of ongoing activities and cutting-edge projects in the field across Europe. This contribution aims to report on the key topics, discussions, and insights that emerged during both workshops.

Presenter: VASSALLO, Daniele (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Space technology

Contribution ID: **33** Type: **not specified**

The future of the ESA Science Programme

Friday 11 July 2025 09:00 (15 minutes)

Presenter: COLANGELI, Luigi (ESA)

Session Classification: Space missions and instruments

Contribution ID: **34** Type: **not specified**

High Dynamic Range Photon-Counting UV Detectors

Friday 11 July 2025 14:30 (15 minutes)

We present the development and expected performance of an innovative photon-counting detector for far-ultraviolet, designed to overcome the dynamic range and lifetime limitations of traditional Microchannel Plate (MCP) based systems. The detector pairs new-generation MCPs, with ALD passivation, with custom readout electronics designed to maximize their potential.

Presenter: USLENGHI, Michela Clelia Angela (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Space technology

Contribution ID: **35** Type: **not specified**

CUBES and ANDES: ground-based technological enablers for the HWO

Friday 11 July 2025 10:30 (15 minutes)

Presenter: DI MARCANTONIO, Paolo (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Ground based synergies

Contribution ID: **36** Type: **not specified**

MAVIS: sharper than JWST, deeper than HST

Friday 11 July 2025 11:25 (15 minutes)

MAVIS (MCAO Assisted Visible Imager and Spectrograph) is a new facility instrument for the ESO VLT being built by an Australian (Astralis - lead), Italian (INAF) and French (LAM) consortium. MAVIS pushes the frontier of new instrument technologies to provide, for the first time, wide-field, diffraction-limited angular resolution at visible wavelengths. Enhancing the VLT Adaptive Optics Facility, MAVIS will use multi-conjugate adaptive optics (MCAO) to feed a 4k × 4k imager covering 30 × 30 arcseconds, as well as a powerful Integral Field Spectrograph (IFS). Angular resolution down to 18 milliarcseconds will be achieved at 550 nm (V band), making MAVIS a powerful complement to infrared-optimised facilities like JWST and ELT. The IFS will provide four spectral modes, with resolutions from 4,000 to 15,000 between 370-935 nm. This enables a wide variety of science cases, spanning themes that include the emergence of the Hubble sequence; resolving the contents of nearby galaxies; star clusters over cosmic time; and the birth, life, and death of stars and their planets. MAVIS builds on the success of MUSE Narrow Field Mode, extending to bluer wavelengths and higher spectral resolution (complementing BlueMUSE), larger field size and angular resolution for imaging capabilities, and dramatically higher AO-corrected sky coverage, including most of the sky. I will present an update on the MAVIS project and science, highlighting its complementarity to the suite of ESO capabilities and space facilities in the coming decade.

Presenter: CRESCI, Giovanni (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Ground based synergies

Contribution ID: **37** Type: **not specified**

Polarimetry Perspectives for HWO

Friday 11 July 2025 14:45 (15 minutes)

Presenter: Dr FINESCHI, Silvano (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Space technology

Contribution ID: **43** Type: **not specified**

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Author: FOSSATI, Luca (Space Research Institute, Austrian Academy of Sciences)

Co-authors: Dr NEINER, Coralie (Paris Observatory); Dr BOURET, Jean-Claude (LAM); Dr LE MIGNANT, David (LAM); Dr MUSLIMOV, Eduard (Oxford University)

Presenter: FOSSATI, Luca (Space Research Institute, Austrian Academy of Sciences)

Contribution ID: **44** Type: **not specified**

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Author: Dr CRESCI, Giovanni (Istituto Nazionale di Astrofisica (INAF))

Presenter: Dr CRESCI, Giovanni (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **45** Type: **not specified**

R&D for space-based High-Contrast Imaging in Europe

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Author: VASSALLO, Daniele (Istituto Nazionale di Astrofisica (INAF))

Presenter: VASSALLO, Daniele (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **46** Type: **not specified**

SETI and HWO

Friday 11 July 2025 10:10 (10 minutes)

SETI, the Search for ExtraTerrestrial Intelligence, started in 1959 when Giuseppe Cocconi and Phil Morrison (then both at Cornell) realized that radio communications between nearby stars was indeed possible even with the modest radio telescopes (30 meters in diameter) then available.

No ET Civilization was discovered up to 2025, but the amount of searched space is very small indeed.

By 2040, when HWO is expected to become operational, the number of explored stars will have increased much beyond the present 5000 stars.

In particular, the huge amount of data provided by the GAIA space mission will have been "digested"by the Astronomical Community by 2040. We thus suggest an increased cooperation between the Teams of GAIA and of HWO designers to get the best out of both Communities and thus reach Contact for the first time, changing the course of Human Thinking to something better than just wars among Humans.

Author: MACCONE, Claudio (Istituto Nazionale di Astrofisica (INAF))

Presenter: MACCONE, Claudio (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Ground based synergies

Contribution ID: **47** Type: **not specified**

High Dynamic Range Photon-Counting UV Detectors

We present the development and expected performance of an innovative photon-counting detector for far-ultraviolet, designed to overcome the dynamic range and lifetime limitations of traditional Microchannel Plate (MCP) based systems. The detector pairs new-generation MCPs, with ALD passivation, with custom readout electronics designed to maximize their potential.

Author: USLENGHI, Michela Clelia Angela (Istituto Nazionale di Astrofisica (INAF))

Presenter: USLENGHI, Michela Clelia Angela (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **48** Type: **not specified**

PCS at ELT as a precursor for HWO

Friday 11 July 2025 10:20 (10 minutes)

The Planetary Camera and Spectrograph (PCS) for the Extremely Large Telescope (ELT) is a new instrument proposed for the direct detection and characterization of exoplanets in the neighbourhood of the Sun. This goal is achieved by a combination of eXtreme Adaptive Optics (XAO), coronagraphy and spectroscopy.
PCS will allow to gather both images and high-resolution spectra, allowing the atmospheric characterization of the detected planets, including the search for biosignatures in the most favourable cases.
Italian contribution is relevant both on scientific and technological aspects.
While we are still in a preliminary phase (a three years research & development phase before Phase A is ongoing), we may expect that PCS will be able to directly detect rocky planets around the closests M dwarfs and to characterize their atmospheres, few years before HWO.
The number of accessible low-mass planets is expected to be more limited than HWO, but the similar science case would make the synergies between the two projects very fruitful in several aspects.

Author: DESIDERA, Silvano (Istituto Nazionale di Astrofisica (INAF))

Presenter: DESIDERA, Silvano (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Ground based synergies

Contribution ID: **49** Type: **not specified**

Atmospheric retrievals: from machine learning to quantum technologies

Friday 11 July 2025 14:20 (10 minutes)

The study of exoplanetary atmospheres traditionally relies on forward models to analytically compute an exoplanet's spectrum by fine-tuning numerous chemical and physical parameters. However, the high dimensionality of the parameter space often results in significant computational overhead. In this work, we introduce a novel approach to atmospheric retrieval, leveraging machine learning techniques accelerated by GPUs and TPUs, and ultimately, quantum technologies. This integration of novel technologies will be crucial for analysing data in the era when the Habitable Worlds Observatory (HWO) becomes operational. We propose a framework for extracting exoplanetary atmospheric features using Technologies like DCGANS, Transformers and quantum extreme learning machines (QELMs), which employ quantum systems as a black box for processing input data. For this last system, we demonstrate a fault-tolerant strategy suitable for near-term quantum devices and show its implementation on IBM Fez. The QELM architecture we present shows the potential of quantum computing in the analysis of astrophysical datasets and may, in the near-term future, unlock new computational tools to implement fast, efficient, and more accurate models in the study of exoplanetary atmospheres.

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Session Classification: Space technology

Contribution ID: **50** Type: **not specified**

Oxygenic phototrophs exposed to simulated exoplanetary conditions: possible biosignatures in different organisms

Thursday 10 July 2025 12:10 (10 minutes)

Oxygenic photosynthesis generates atmospheric and surface biosignatures, ideal targets for investigating the detectability of life beyond Earth. These are linked, respectively, to the oxygen release activity of oxygenic photosynthesis and to the absorption of their photosynthetic pigments, which on Earth generate a distinctive reflectance spectrum. As prime exoplanet targets for astrobiology are the ones orbiting in the habitable zone of M-dwarf stars, this poses the question whether such stars could sustain this remarkable metabolism, ultimately generating detectable biosignatures.
Most of oxygenic photosynthetic organisms rely indeed on harvesting Sun's visible light (VIS, 400-700 nm) to produce organic compounds and oxygen, while M-dwarfs'exoplanet receive a spectrum poor in VIS light and mainly enriched in far-red and infra-red light (FR, 700-750 nm, IR, 750-1000 nm), wavelengths that generally do not drive common oxygenic phototrophs. Interestingly, our planet offers terrestrial niches that can be considered exoplanets'light analogues, resembling the light generated by M-stars, found to surprisingly host some oxygenic photosynthetic organisms. Peculiar morpho-physiological adaptations can allow the use of very dim VIS light and FR photons, both in prokaryotes and eukaryotes. Some cyanobacteria can utilize constitutively FR light through chlorophyll d or acclimate to FR through mechanisms like Far-Red Light Photoacclimation (FaRLiP) [1, 2]. Some eukaryotic algae can harvest FR light by changing the organization of their light harvesting systems without synthesizing specific FR-absorbing pigments [3]. Even on plants, recent studies demonstrated that shade adapted understory species have evolved peculiar strategies to photosynthesize under very dim FR enriched light spectra [4]. In our laboratory, we developed a set up to simulate exoplanetary conditions in terms of anoxic atmosphere and irradiance, recently implemented with a custom-made UV lamp that simulates the flares reaching exoplanets orbiting M-dwarf stars. The set up allows to test the viability and growth of some of these FR-adaptable organisms also recording their oxygen evolution responses and reflectance spectra in real time, to evaluate the biosignatures that they would generate in an M-dwarf planetary system. The proposed talk will explore the photosynthetic responses in FR-enriched and simulated M-dwarf spectra, illustrating how the study of photosynthetic biodiversity coupled with laboratory simulations can help assessing the plausibility of oxygenic photosynthesis on exoplanets orbiting M-dwarfs and understanding what kind of biosignature this metabolism could possibly generate.

Author: LIISTRO, Elisabetta

Presenter: LIISTRO, Elisabetta

Session Classification: Exoplanet Science

Contribution ID: **51** Type: **not specified**

On the sinergy between HWO and ground-based high-resolutions spectrographs

Friday 11 July 2025 11:15 (10 minutes)

The atmospheric characterisation of nearby rocky exoplanets will soon become achievable thanks to the next generation of telescopes, such as the ground-based Extremely Large Telescope (ELT) and the proposed space mission Habitable Worlds Observatory (HWO).

This powerful synergy between ground- and space-based facilities will open new frontiers in the study of exoplanet atmospheres by combining reflected light measurements at low resolution from HWO with those at high resolution from spectrographs like ANDES@ELT. Together, these complementary observations will make it possible to constrain bulk compositions, temperature–pressure profiles, and key chemical tracers for nearby Earth-sized planets in the habitable zone.
Over the past 13 years, the Global Architecture of Planetary Systems (GAPS) program at the TNG has built an unparalleled legacy dataset: multiple transits (3–11 per target) for a selected sample of ~40 exoplanets, simultaneously observed in the visible and near-infrared with GIARPS (HARPS-N + GIANO-B). This unique resource serves as an essential benchmark to investigate atmospheric variability and refine retrieval techniques in preparation for the ELT era. Drawing on this expertise, our team has pushed forward the detection of atomic and molecular species in (ultra-)hot and warm gas giants. By combining our high-resolution data with archival low-resolution space spectra (e.g., HST, JWST), we demonstrate how a multi-resolution approach improves constraints on atmospheric structures and compositions.
This groundwork sets the stage for the next leap: merging the capabilities of ANDES and HWO to characterise terrestrial exoplanets in unprecedented detail, paving the way to robust constraints on potential biosignatures and for the detection of life beyond our Solar System.

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Presenter: GUILLUY, Gloria (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Ground based synergies

Contribution ID: **52** Type: **not specified**

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

Thursday 10 July 2025 11:50 (10 minutes)

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 Arχes 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.

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

Session Classification: Exoplanet Science

Contribution ID: **53** Type: **not specified**

Supernova science with the HWO

Thursday 10 July 2025 18:00 (10 minutes)

While primarily designed for the detection and characterization of exoplanets, the Habitable Worlds Observatory will also provide a transformative platform for time-domain astrophysics, particularly supernova science. Its combination of high-angular-resolution imaging, wide spectral coverage from the UV to near-infrared, and high-throughput spectroscopy will enable key advances in several areas, such as 1) the studies of supernova progenitors in nearby galaxies, 2) the search and discovery of high-redshift peculiar events like pair-instability events and the first stellar explosions, 3) the chemical composition and Fe-peak nucleosynthesis, and finally 4) to explore the synergy with multi-messenger astrophysics.

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Presenter: IZZO, Luca (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Extragalactic Astrophysics

Contribution ID: **55** Type: **not specified**

Pyramid WaveFront Sensors and contactless active mirrors: a research program for high contrast imaging

WaveFront sensing and control is considered an enabling technology for the the next generation space telescopes such as the HWO. We investigated the possible contributions of ground based Adaptive Optics for space telescopes and in particular the pyramid WaveFront Sensor and the concept of a contactless active primary mirror.
The PWFS, largely adopted on ground, is a pupil-conjugated sensor and is extremely sensitive at the low-mid spatial scales. We run a set of numerical simulations with the PWFS measuring the misalignment and phase steps of a JWST-like primary mirror, with natural guide stars in the magnitude range 8 to 14; we estimated a sensitivity far below 1 nm, while sampling at 1s cadence, in presence of photon and detector noise. In view of these results, the PWFS may help reducing the temporal stability requirements on the DM. In add, the PWFS signal may feed an advanced PSF reconstruction algorithm for contrast enhancement.
Concerning active mirrors: based on the technology of the adaptive secondaries (currently in use at LBT, VLT, e.g.), we developed a 40 cm mirror, 18 kg/m2, controlled by 19 voice coil actuators and capacitive position sensors, in a contactless control scheme. The optical surface floats at 300-1000 um from the mechanical support with no mechanical contact; such scheme potentially provides an intrinsic insulation from vibrations (and enhanced stability at no added cost) while reducing dramatically the mechanical spec of the support. The system is currently in the optical lab and we are assessing the rejection of external vibration and disturbances, while studying how to reduce its density to 14 kg/m2

Author: BRIGUGLIO PELLEGRINO, Runa Antonio (Istituto Nazionale di Astrofisica (INAF))

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Presenter: BRIGUGLIO PELLEGRINO, Runa Antonio (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **57** Type: **not specified**

Tracing Galaxy Evolution with Resolved Stars: The HWO Perspective

In this talk, I will review our current understanding of resolved stellar populations in nearby galaxies, with particular emphasis on the progress enabled by JWST. I will then discuss the advances expected from the ELT, focusing on the unprecedented spatial resolution achievable with the MORFEO-MICADO system. Finally, I will explore future prospects opened by HWO and its potential to push the study of galaxy evolution through resolved stellar populations into new regimes.

Author: ANNIBALI, Francesca (Istituto Nazionale di Astrofisica (INAF))

Presenter: ANNIBALI, Francesca (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **58** Type: **not specified**

PSF reconstruction from WFS data and other tools to make your images sharper and deeper

Bla bla bla

Author: PEDICHINI, Fernando (Istituto Nazionale di Astrofisica (INAF))

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Presenter: PEDICHINI, Fernando (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **59** Type: **not specified**

Unveiling the star formation mechanism with HWO

I will provide an abstract in the incoming weeks

Author: TRAFICANTE, Alessio (Istituto Nazionale di Astrofisica (INAF))

Presenter: TRAFICANTE, Alessio (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **63** Type: **not specified**

The future of the ESA Science Programme

An overview of the future plans of the ESA Science Programme

Author: Prof. COLANGELI, Luigi (ESA)

Presenter: Prof. COLANGELI, Luigi (ESA)

Contribution ID: **64** Type: **not specified**

Synergies between Ariel and the Habitable Worlds Observatory

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Author: MICELA, Giuseppina (Istituto Nazionale di Astrofisica (INAF))

Presenter: MICELA, Giuseppina (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **65** Type: **not specified**

Investigating the origin of stars with the Habitable World Observatory

Understanding the processes that lead to star formation is essential for addressing key questions in modern astronomy, from the origin of the Solar System to the evolution of galaxies. While a broad framework for star formation in the Milky Way has been established, several critical aspects remain unresolved. In particular, the influence of the
environment properties, such as stellar density and metallicity, is still not well understood. In this talk, I will highlight these open questions and discuss how the field is expected to evolve over the next two decades. I will also explore the potential contributions of the Habitable Worlds Observatory in advancing our understanding of star formation, and how its capabilities will complement those of
the ELT.

Author: SACCO, Giuseppe Germano (Istituto Nazionale di Astrofisica (INAF))

Presenter: SACCO, Giuseppe Germano (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **66** Type: **not specified**

The LIFE Mission - Characterizing other words and searching for life

In this talk, I will discuss the Large Interferometer For Exoplanets (LIFE), a space mission project rooted in Europe, which has been gaining significant international support and traction over the last few years. I will summarize the scientific vision for LIFE, provide an overview of ongoing technology development efforts, and give an outlook about the overall development process.

As a space-based nulling interferometer operating at mid-infrared wavelengths, LIFE will be able to directly detect hundreds of exoplanets - with an expected 30 to 50 of which of size and temperature similar to Earth - and measure their intrinsic thermal emission spectroscopically. The wavelength range and mission design of LIFE offers unique and distinct advantages compared to other future missions and projects. This allows LIFE to search for atmospheric biosignatures in Earth-twin exoplanets, but LIFE can also find atmospheric biosignatures from biospheres that differ significantly from that of Earth in their composition or stellar environment. Also, LIFE has the capabilities to search for imprints of technology in exoplanet atmospheres, so-called technosignatures. This versatility allows LIFE to become the world's leading mission in the search for life beyond the Solar System. With a target launch no later than 2040, LIFE's vision and ambition go beyond standard agency-led development processes, motivating us to explore new private-public partnerships.

Author: QUANZ, Sascha P. (ETH Zurich)

Co-author: TEAM, LIFE

Presenter: QUANZ, Sascha P. (ETH Zurich)

Contribution ID: **67** Type: **not specified**

Shaping the Future of Time-Domain and Multi-Messenger Astronomy with HWO

TBD

Author: PIRANOMONTE, Silvia (Istituto Nazionale di Astrofisica (INAF))

Presenter: PIRANOMONTE, Silvia (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **68** Type: **not specified**

Studying the intergalactic medium with a future space telescope

In this talk I will briefly review what are the advantages of studying the intergalactic medium from space and what would be interesting to do with a big telescope such as the HWO (in my biased view).

Author: D'ODORICO, Valentina (Istituto Nazionale di Astrofisica (INAF))

Presenter: D'ODORICO, Valentina (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **70** Type: **not specified**

New frontiers in cosmology in view of the Habitable World Observatory

I will present an overview of the frontiers and challenges for cosmology in view of the Habitable World Observatory

Author: MORESCO, Michele Ennio Maria (Istituto Nazionale di Astrofisica (INAF))

Presenter: MORESCO, Michele Ennio Maria (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **71** Type: **not specified**

Beyond the Habitable Zone: A Multiscale Approach to Exoplanetary Biosignature Detection for HWO

Thursday 10 July 2025 12:00 (10 minutes)

The search for promising candidates for life necessitates moving beyond the traditional Habitable Zone paradigm, employing a **multiscale approach** that integrates biological, chemical, and astrophysical perspectives. This presentation will demonstrate how our current understanding of extremophilic microorganisms, coupled with their environmental tolerances, can effectively characterize the life potential of exoplanetary atmospheres.

We introduce a novel **Multiparametric Life Score** (MLS), based on atmospheric pressure, temperature, and radiation conditions, which provides an initial assessment of atmospheric compatibility with known life forms. This framework offers a refined method for identifying high-priority targets for future observational campaigns, including those of the HWO.

Crucially, our future work involves enriching this model with metagenomic data from extremophiles. This will enable us to describe the **atmospheric biochemistry** that could arise in the most life-compatible atmospheres, ultimately highlighting the characteristic mix of prevalent molecules that define an 'atmospheric exobiome'. This predictive framework aims to guide the search for novel biosignatures, informing the design and scientific requirements of future missions like HWO and its advanced coronagraphic capabilities."

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Presenter: MARCELLINO, Marco (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Exoplanet Science

Contribution ID: **72** Type: **not specified**

HWO and its optics system: requirements, challenges and possible European contributions

The implementation of the HWO optics system presents several challenging aspects, as it must work under unprecedented requirements. In addition to achieving the exquisite angular resolution, one must address the problem of the mirror mass (with an areal density mass goal of approximately 10 kg/cm^2), a wide range of operational thermal conditions, and a broad reflection wavelength band. In the US, the development of appropriate technologies for both the mirror substrates, the actuation systems, and the coatings started a few years ago. Still, the final trade-off has not yet been completed. In this context, we'll discuss ideas for a potential European contribution to implementing the optical system.

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Presenter: PARESCHI, Giovanni (Istituto Nazionale di Astrofisica (INAF))

Contribution ID: **74** Type: **not specified**

Sinergie tra PLATO e HWO

IN questo breve talk presentero' lo status della missione PLATO e le possibili sinergie tra le due missioni

Author: PIOTTO, Giampaolo

Presenter: PIOTTO, Giampaolo

Contribution ID: **76** Type: **not specified**

Question and answer

Thursday 10 July 2025 14:55 (10 minutes)

Session Classification: HWO NASA