PORTAL

PhOtotrophy on Rocky habiTAble pLanets

DURATION
15/01/2021 - 15/04/2025

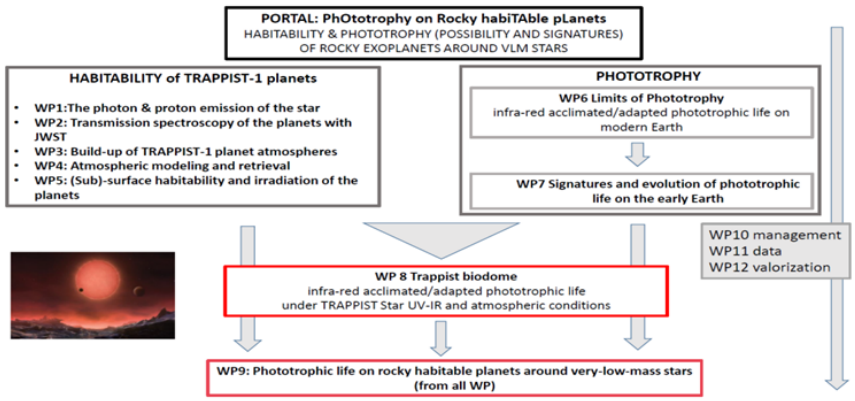
BUDGET
951 058 €

PROJECT DESCRIPTION

Star light represents an efficient source of energy that is abundantly used by life on Earth and is at the basis of trophic chains, so it could play also a key role in the development and sustainability of other biospheres elsewhere in the Universe. Among the thousands of detected exoplanets, a few dozen are potentially habitable and a detailed atmospheric characterization should be within reach of upcoming telescopes. A thorough assessment of the habitability of exoplanet around late-type M-dwarfs is critical for a deep understanding of the universality and limits of Life. Because the luminosity of these cold stars is much smaller than that of the sun, rocky planets have to orbit very close to them to be habitable. Since the spectrum of M-dwarfs peaks in the infrared, phototrophic life on the surface of their planets needs to be able to harvest infrared photons while protecting itself against very strong fluxes of XUV photons and stellar winds. On Earth, phototrophic organisms have evolved metabolisms to scavenge photons in the spectrum of visible light, but also in the infra-red range, and strategies for protection against UV radiations. Phototrophy appeared more than 3.4 Ga ago, when the anoxic Earth atmosphere was lacking an ozone layer, and its surface was exposed to strong UV radiations. Later oxygenic photosynthesis had a major impact on atmosphere composition and oceanic chemistry from at least 2.4 Ga ago, which contributed to the diversification of complex life (eukaryotes). Phototrophy thus can have a major impact on planets and life evolution.

The project "PhOtotrophy on Rocky habiTAble pLanets" (PORTAL) will address the potential habitability of rocky planets in orbit around very low-mass stars, and the possibility to detect life on such planets. The **objectives** are (1) to determine characteristics about physical and irradiative conditions at the surface of the planets in the habitable zone of the nearby dwarf star TRAPPIST-1 from observational data and theoretical modelling, and (2) to investigate for those constraints the possibilities of phototrophy in the infra-red range and the detectability of their signatures, in samples from the early Earth and modern extreme habitats, in simulated exoplanet conditions in a new TRAPPIST biodome, and on rocky exoplanets in orbit around TRAPPIST-1.

Methodology: PORTAL is multidisciplinary, combining expertise in astrophysics, geophysics, geology, paleobiology and microbiology. WP1-5 (habitability of TRAPPIST-1 exoplanets), WP6 (IR photosynthesis on modern Earth), and WP7 (photosynthesis on early Earth) will be addressed in parallel to foster synergy, and to provide data for WP 8 (TRAPPIST biodome) and WP9 (possibility of phototrophy on rocky habitable exoplanets around very low-mass stars). WP8 needs data from WP -7 but will start on year 1 to build the equipment, and will use preliminary parameters already available, that will be adjusted as new data become available. WP9 will need data from WP1-8. For each WP, risk assessment is made and will be evaluated regularly.



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Impacts and valorization

Scientific knowledge: publications and presentations at international meetings on the characterization of the habitability of TRAPPIST-1 exoplanets, new models for TRAPPIST-1 exoplanets' atmospheres, new biosignatures of phototrophic life to search for in the early Earth record and in the solar and extraterrestrial systems, new understanding of the evolution of phototrophy in prokaryotes and eukaryotes, and new basic knowledge in biology and biochemistry on the limits of photosynthesis in the IR range.

New facility: a TRAPPIST biodome adaptable to other planetary conditions for future astrobiological projects, which also serves as a research infrastructure for the European and international community, and as a teaching and public outreach tool.

New databases: open access data for new projects, collaborations, and ongoing and future space missions about solar and extrasolar planetary systems, which are part of the long-term strategy of the European Space Agency (ESA COSMIC VISION 2015-2025), and belong to the priority themes of the European Commission Horizon 2020.

Major impact on society: the possibility of ET life in the universe; the evolution and risks to habitability of rocky planets including Earth

Outreach and dissemination to the general public, schools and university students: public conferences, podcasts, activities with artists, SCI-FY evenings, poster competition, public exhibitions ("the TRAPPIST biodome", "a river of time"), planetarium activities, a ULiege Astrobiology course (MSc, PhD students), news and social media, website.

Collections: increase of their universal value: the Belgian Coordinated Collections of Microorganisms (polar cyanobacteria) supported by BELSPO, samples acquired using the Antarctica Belgian base infrastructure, early Earth fossil collections (coordinator lab), samples from a "world heritage field site craddle of life" obtained through a ICDP project in South Africa.

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LINKS

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