

ExoPhot: A project for measuring the exoplanetary photosynthetic activity

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ExoPhot





CAB María de Maeztu Challenge: Remote search and characterisation of exoplanets, including atmospheric studies

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EXCELENCIA

DE MAEZTU

MARÍA





- Photosynthesis:
 - o Existing pigments on Earth
 - Simulated pigments

- Exoplanets:
 - Host stars
 - Exoplanetary atmospheres

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ExoPhot



- Photosynthesis:
 - Existing pigments on Earth
 - o Simulated pigments



García de la Concepción et al. 2022 *Phys. Chem. Chem. Phys.*, 2022,**24**

- Exoplanets:
 - Host stars
 - Exoplanetary atmospheres

Article

ExoPhot. The photon absorption rate as a new metric for quantifying the exoplanetary photosynthetic activity fitness

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Fundamental questions:

- Can photosynthesis exist in exoplanetary systems?
- Is there a "photosynthetic feasibility zone"?
- Can we quantify that feasibility?
- What types of stars would host those systems?
- What kinds of planetary atmospheres would they require?
- What kinds of photopigments would be found?



Photosystems /photopigments

Stars (spectral type)

Optimum Spectral Overlap $max \int f(\sigma, T, F) d\lambda$ (Darwinian principle)

Exoplanets (atmosphere)

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Mixing all ingredients:

Spectral Absorption Rate Γ_{λ}

How many photons are absorbed per unit of time?





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Spectral absorption rate calculation of a Sun-like star (G2 V) at the top of the planet atmosphere, $F(\lambda)$, transmittance of an Earth-like atmosphere, $T(\lambda)$, and absorption cross section of chlorophyll a, $\sigma_{abs}(\lambda)$.



Spectral absorption rates of Earth-like exoplanets in the HZm for:

- 5 photopigments
 - Chl a
 - Chl b
 - BChl a
 - BChl b
 - Phot0
- 4 different atmospheres
 - Earth-like
 - highly oxidizing
 - weakly oxidizing
 - reducing
- 3 different spectral types
 - A5V
 - G2V
 - M8V



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ExoPhot / Future



A Titanic Endeavour ahead



100s photopigments (terrestrial and hypothetical, chemical reactivity with atmosphere, evolution, ...)



Dataset of stellar models (types A to L, several regions of habitability zone HZ, stellar activity, tidal locking, ...)



1000s planetary atmospheres (different compositions & exoplanets sizes, see/ice effects, automation in cloud, ...)



Processing and analysis of data (local and cloud algorithms, automation in big data setting, ...)



Future mission concepts (feasibility, instrumentation requirements, ...)



In the European space agency → the European space agency

ExoPhot Team





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The ExoPhot project. Presenting a metric for measuring the photosynthetic fitness in an exoplanetary environment

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