Absorption efficiencies of light-harvesting complexes in photosynthetic organisms exposed to the photoenvironment of exoplanets

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visible

infrared (high albedo!)

🌟 vegetation has a unique spectral feature
→ how about planets orbiting F, G, K, M stars?

🌟 purple bacteria absorb longer wavelength radiation than plants → M stars!

-purple bacteria
-antenna complex
-photosynthetic pigment

🌟 we investigated the light absorption ← quantum chemistry calculations
FGK stars: Soret bands contribute to the efficiencies just around 4000 Å break (← heavy metals in stars).

M stars: Qy bands contribute highly to the efficiencies.
Quiescent and Flaring Lyman-\(\alpha\) Radiation of Host Stars and Effects on Exoplanet Atmospheres

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Host’s stars and habitability

Florian Gallet (Genève), Corinne Charbonnel (Genève/IRAP) and Louis Amard (Genève/LUMP)

1) Introduction

✓ About 2000 exoplanets discovered within different configurations
✓ Thanks to increase of precision of modern techniques size and mass of detected planets have dramatically decreased
✓ Earth like planets => habitability?
  o First step: habitable zone (HZ) and continuously habitable zone (CHZ)
✓ We aim at:
  o highlighting the impact of stellar parameters on HZ and CHZ
  o add more constraints on HZ and CHZ location
  o link HZ location to stellar activity evolution

2) Reference grid of stellar models

STAREVOL
  o mass range 0.5 – 2 $M_\odot$
  o 4 metallicity values
  o impact of rotation-induced mixing
  o rotation

3) Model

✓ Habitable zone (Kopparapu et al. 2013, 2014):
  \[
  d = \left( \frac{L}{L_\odot} \right)^{0.5} \frac{S_{\text{eff}}}{S_{\text{eff}}^0} = \frac{F_{\text{IR}}}{F_{\text{INC}}} \]
  1-D radiative-convective climate model

  $S_{\text{eff}} = S_{\text{eff}}^0 + aT_\star + bT_\star^2 + cT_\star^3 + dT_\star^4 \quad T_\star = T_{\text{eff}} - 5780$

  $R_{\text{in}} = \text{runaway greenhouse, net positive feedback of greenhouse effect}$

  $R_{\text{out}} = \text{maximum greenhouse, Rayleigh scattering due to CO}_2 \text{ reduce greenhouse effect}$

✓ Stellar structure evolution grid: Amard et al. (in prep.)

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4) Key results

Table 1. Size of the HZ as a function of stellar mass.

<table>
<thead>
<tr>
<th>ΔHZ</th>
<th>0.5 M☉</th>
<th>1 M☉</th>
<th>1.5 M☉</th>
<th>2 M☉</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔHZ_{mean} (AU)</td>
<td>0.27</td>
<td>0.86</td>
<td>2.05</td>
<td>3.25</td>
</tr>
<tr>
<td>ΔHZ_{min} (AU)</td>
<td>0.2</td>
<td>0.65</td>
<td>1.2</td>
<td>1.85</td>
</tr>
<tr>
<td>ΔHZ_{max} (AU)</td>
<td>1.39</td>
<td>3.46</td>
<td>5.9</td>
<td>6.63</td>
</tr>
</tbody>
</table>

5) Conclusion

- **Systematic** study of HZ and CHZ
  - grid available
  - online tool scheduled

- **Strong** effect of mass and metallicity
  - limits
  - shapes

- **NO** rotation effect on HZL and CHZL

- **HZL** minimum when stellar activity at its lowest
  - Impact on planetary formation?

→ Need to include
  - star-planet tidal interaction (dissipation processes)
  - magnetic interaction/protection
  - ...

Contact

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Habitable Planets and Dynamics in Stellar Binaries
Habitability of Exoplanets:
What can we learn in the next 10 years?

– Julien de Wit –

MassSpec’s potential

Stars too bright for JWST

Host star’s effective temperature [K]

Distance [pc]

Earth with EChO

super-Earth with EChO

Earth with JWST

mini-Neptune with EChO

Earth with 20-m
What Can the Habitable Zone Gallery Do for You?

Dawn M. Gelino¹ & Stephen R. Kane²

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Why Create the HZG?

- To provide an interactive method and table to visualize the orbits and Habitable Zones (HZs) and sort for planets which spend substantial time within the HZ
- To provide tools, graphics, and movies which can be easily imported into presentations to facilitate communication of these concepts in both public and scientific contexts
- To investigate the habitability of exoplanets and potential exomoons whose energy budget varies with a cyclic nature

Use Cases

- Using figures for talks/grants/papers
- Characterization of exoplanets and their moons
- Easy determination of and orbit visualization for known planets spend substantial time in their HZs
- Planetary environment studies
- Target selection, visual aids in a variety of contexts, and general demographic investigations
- See Kane & Gelino 2012, PASP, 124, 323 for more details

http://www.hzgallery.org

- Sortable table of parameters for each planet including:
  - % of time spent in conservative HZ and optimistic HZ
  - temperatures for 2 different atmosphere models at 2 different locations: well mixed & hot dayside for periastron and apoastron locations

- Includes up to 3 images for each system scaled for: 1) Planets exterior to the HZ, 2) Planets in the HZ, 3) Planets interior to the HZ
- The Gallery and Movies pages are searchable!!

- Shows real-time predicted change in temp (well mixed model) and separation from star which is particularly useful for eccentric orbits
- Includes circumbinary planet movies!

- Dependence on the effective stellar flux received by the planet on stellar mass. Green = planets which spend > 50% of their orbital phase within the HZ. Red and blue = planets interior and exterior to the HZ respectively. The dashed crosshairs show the location of Earth.
- Other summary plots on the site include animated yearly depictions of the planet mass and orbital eccentricity versus the orbital period of exoplanets which enter their HZs.