

Exoplanets

Lecture 12
MFF UK
Winter 2020/2021

Outline

- Habitable Zone
- Biomarkers
- Discussion

The definition of the Habitable Zone

- James F. Kasting - 1993

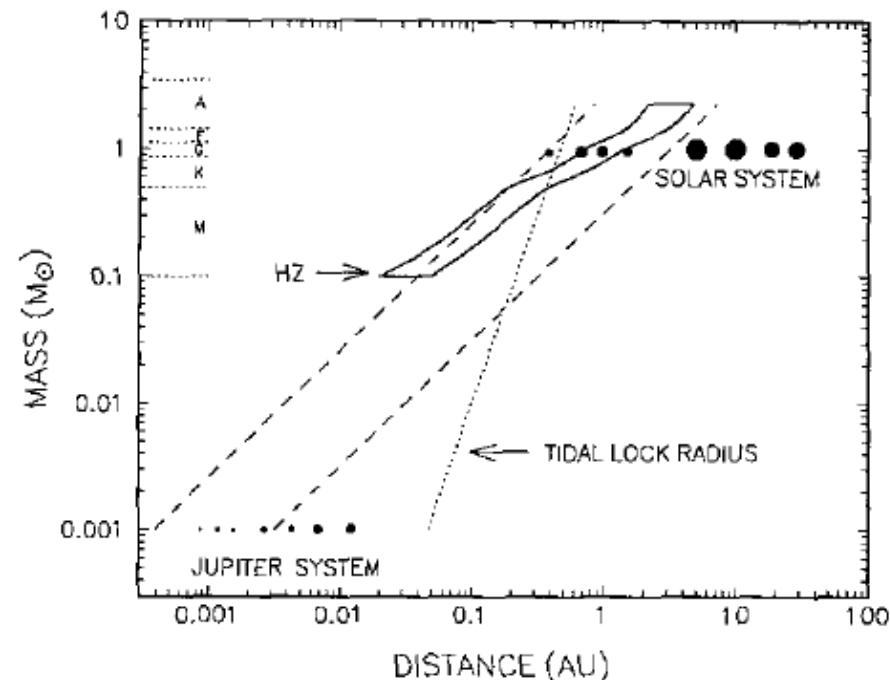
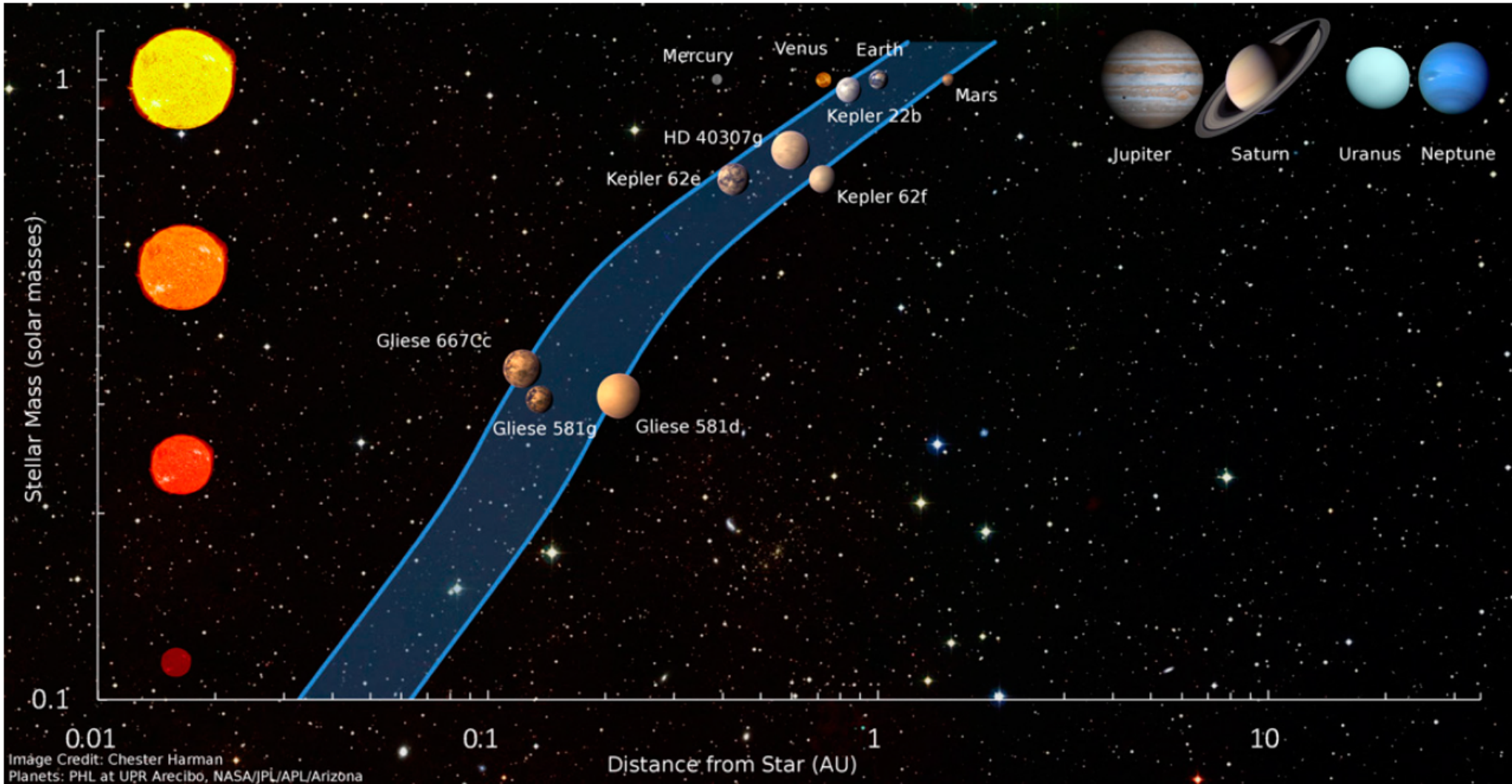


FIG. 16. Diagram showing the ZAMS habitable zone (solid curves) as a function of stellar mass (intermediate habitability estimates used). The long-dashed lines delineate the probable terrestrial planet accretion zone. The dotted line represents the distance at which an Earth-like planet in a circular orbit would be locked into synchronous rotation within 4.5 Gyr as a result of tidal damping. Note that all Earth-like planets within the HZ of an M star would be within this radius.

The habitable zone



Extending the HZ

- H₂ rich Super Earth atmospheres and planets with volcanic activity extend the HZ
- Ramirez et al. 2017, <https://arxiv.org/pdf/1702.08618.pdf>

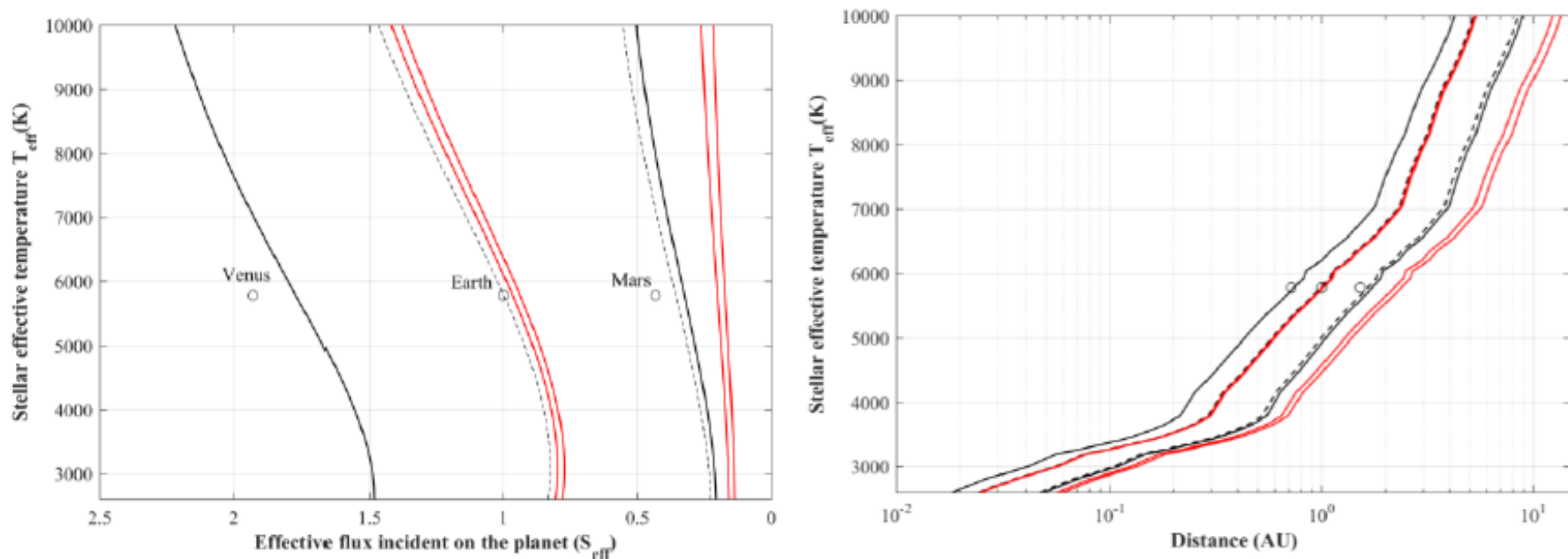
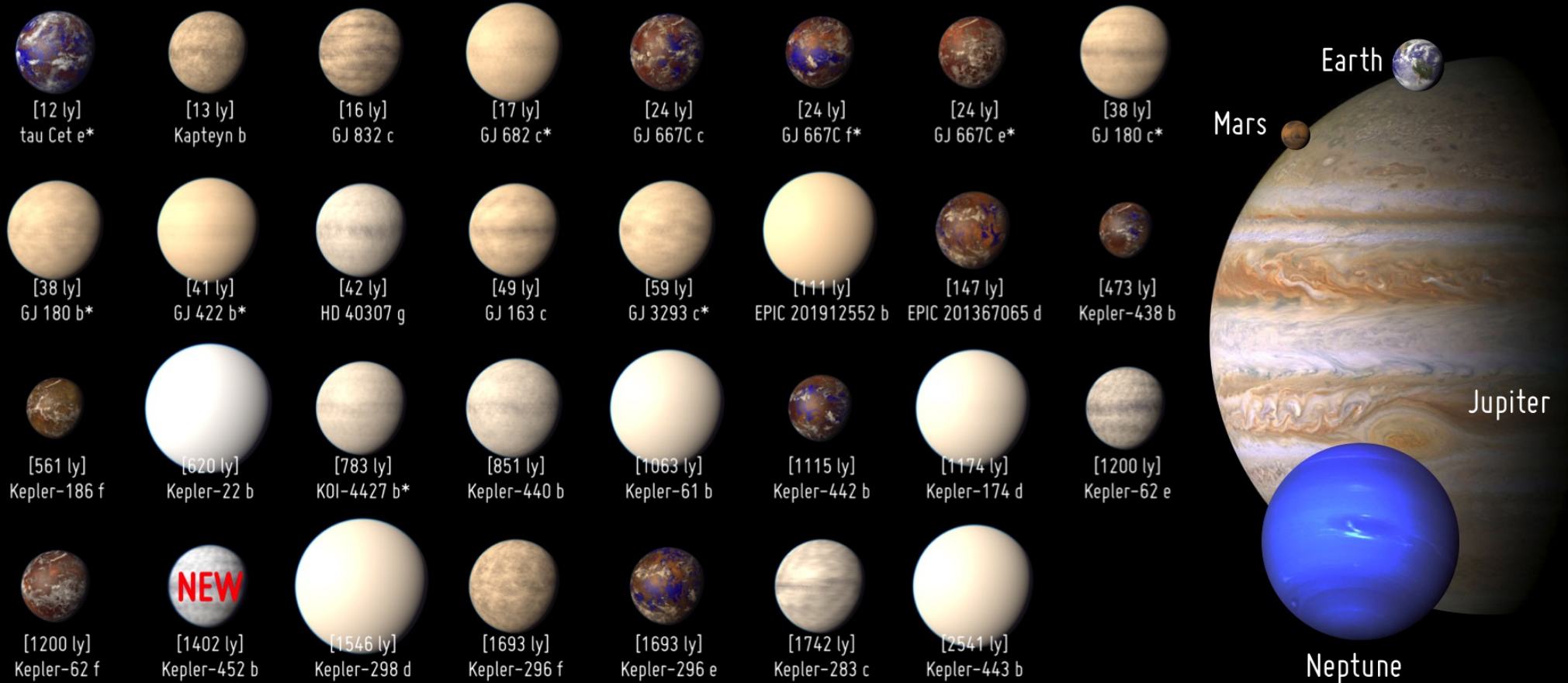


Figure 2: Effective stellar temperature versus (left) incident stellar flux (S_{eff}) and (right) orbital distance for the classical (dashed), empirical (solid black), and volcanic hydrogen (solid red) habitable zone. The red curves contain 30% and 50% H₂, respectively. As shown in Kopparapu et al. (2013), Earth appears near the classical inner edge because of the generic model assumption of 100% relative humidity. With subsaturation, Earth is well within the classical HZ (e.g., Leconte et al. 2013)

Vzorek 2015/2016 (dnes 53)

Potentially Habitable Exoplanets

Ranked by Distance from Earth (light years)



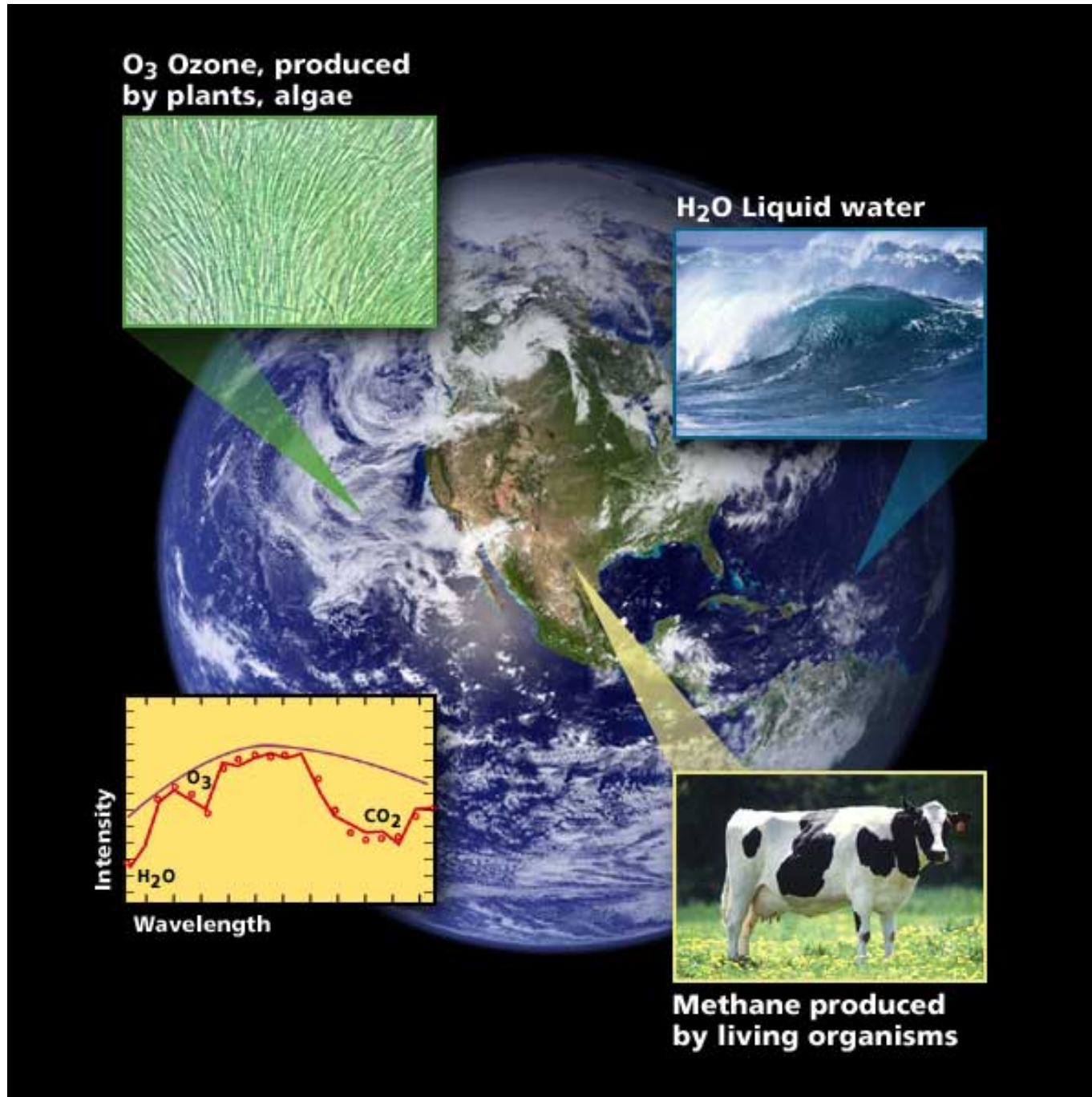
Artistic representations. Earth, Mars, Jupiter, and Neptune for scale. Distance is between brackets. Planet candidates indicated with asterisks.

CREDIT: PHL @ UPR Arcibo (phl.upr.edu) July 23, 2015

Habitable planets today

- <http://phl.upr.edu/projects/habitable-exoplanets-catalog>

Biosignature



Spectrum of the Earth

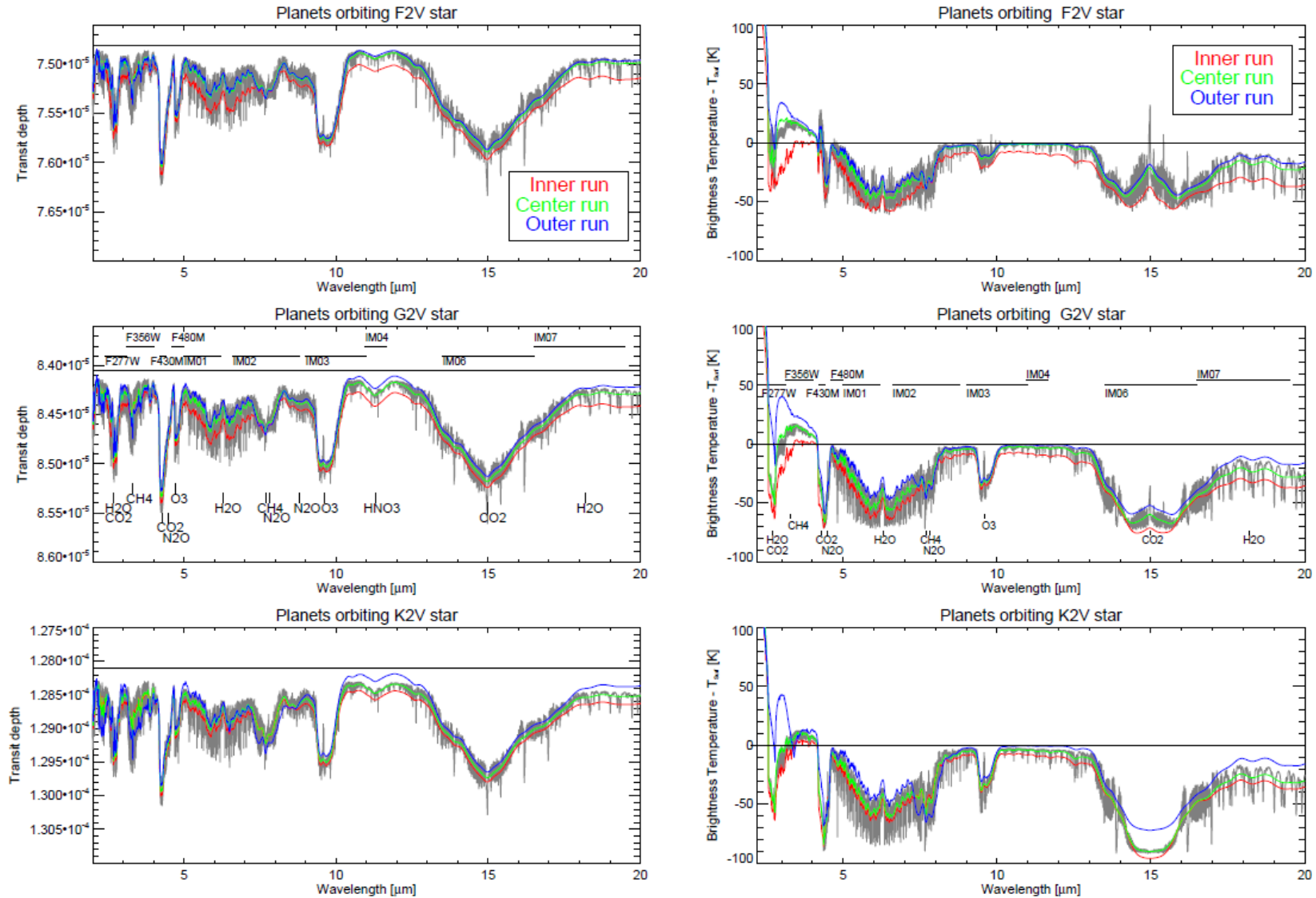
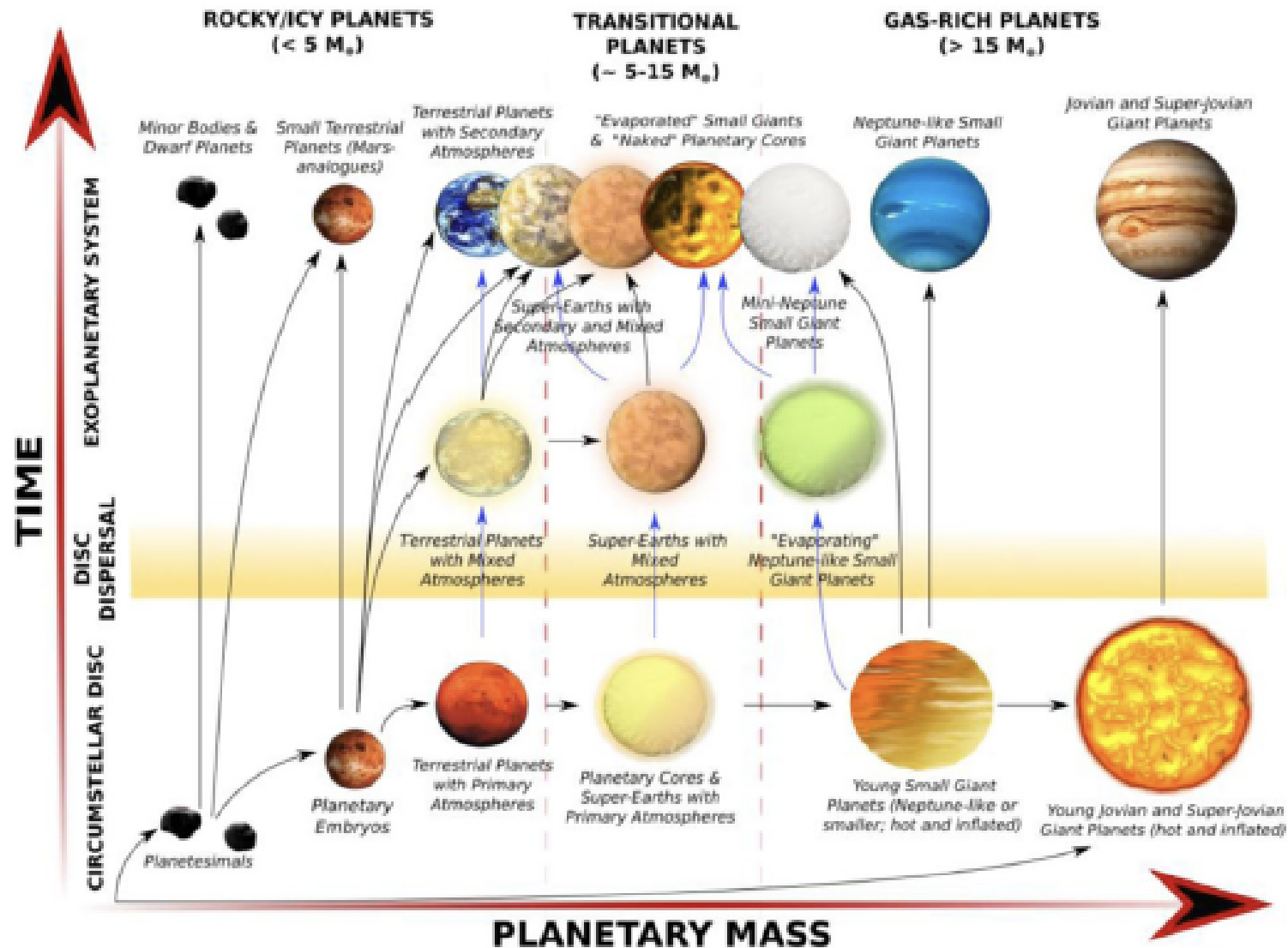
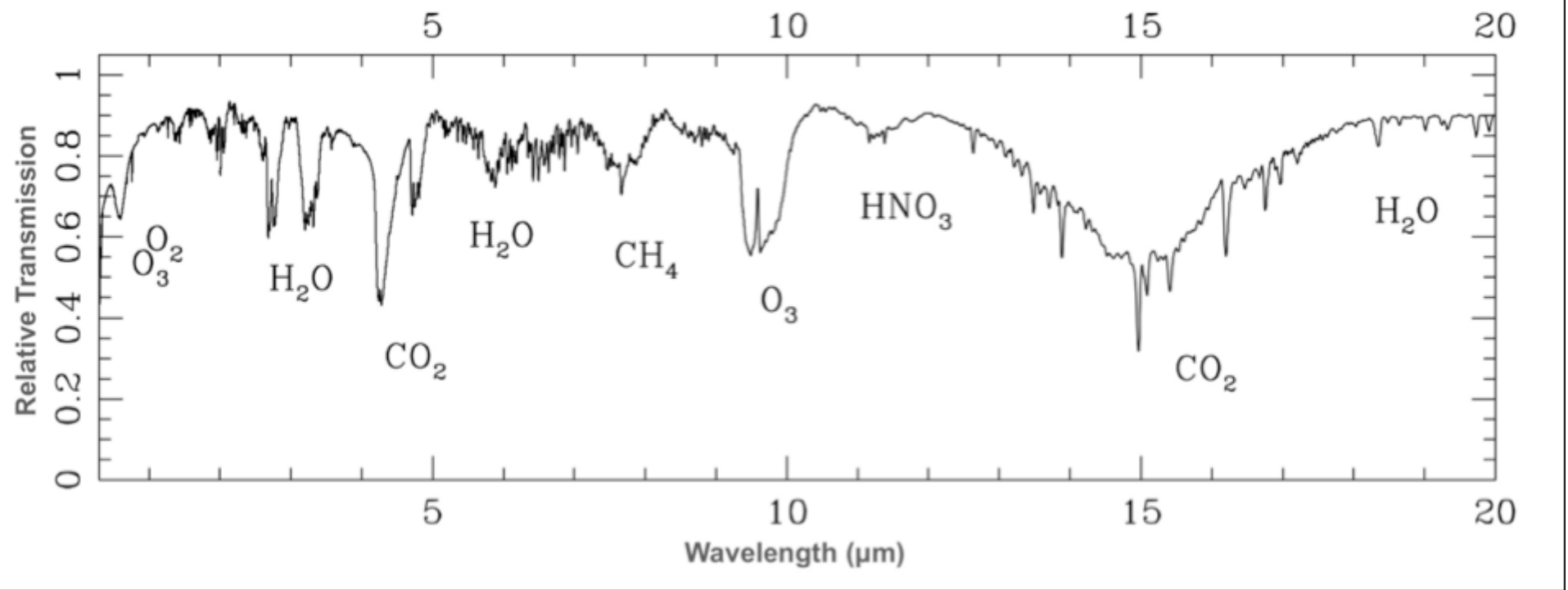


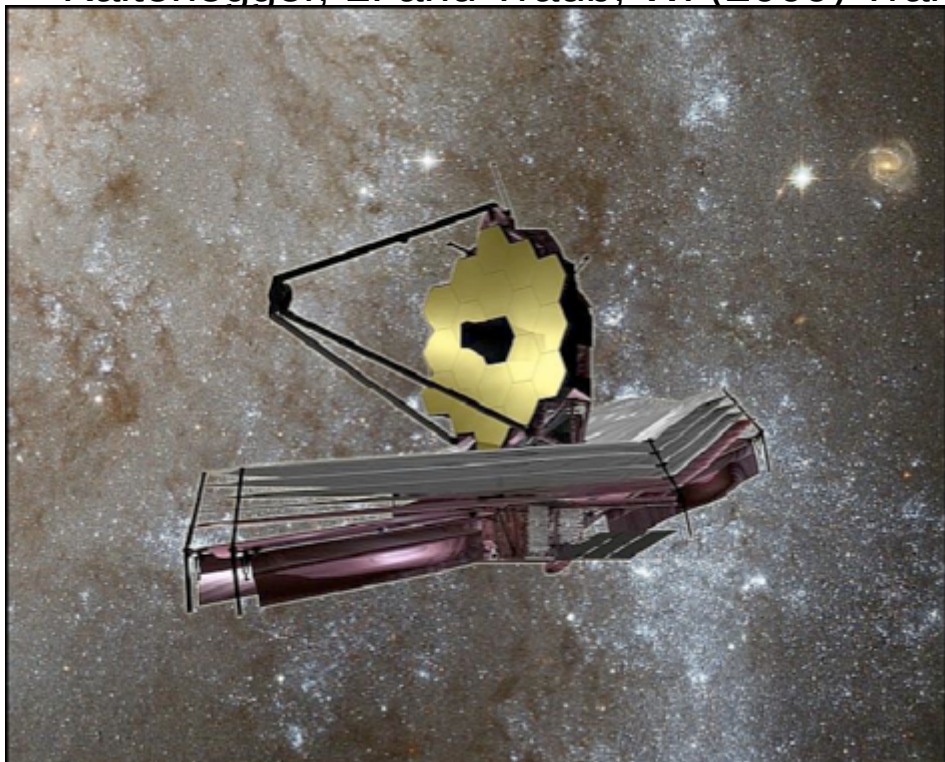
Fig. 4. Transit depth during primary eclipse (left) and brightness temperature difference with respect to the calculated surface temperature spectrum during secondary eclipse (right) for the scenarios considered. The spectral resolution is $R = 100$. Each center run with $R = 3000$ is shown in grey. The geometric transit depth (see Sect. 3.3) is indicated by a horizontal line for transmission spectra. The brightness temperature spectra include the reflected stellar component in the near-IR. Furthermore the bandpass of the filters considered in this work are shown.

Atmosféry klíč k životu jak ho známe ze Země



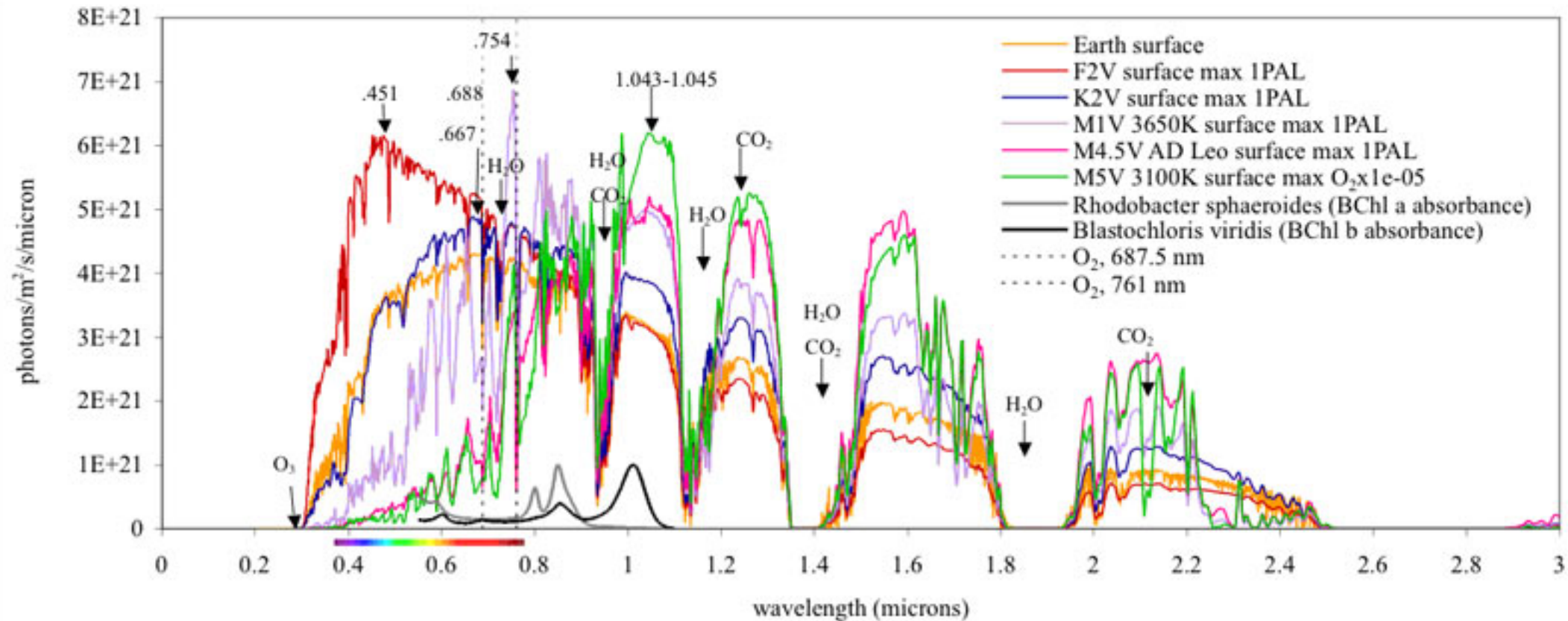


Kaltenegger, L. and Traub, W. (2009) Transits of Earth-Like Planets. *Astrophysical Journal*



JWST
Launch 2018
Ideal for characterization of small
planets in infrared
Image NASA

Různé barvy exoplanet?



Credit: <http://www.giss.nasa.gov/research/news/20070411/>

Exam questions

- Please find one paper from exoplanetary field of your choice, what you find the most interesting.
 - You will present us the paper and describe why you chose the particular paper.
- Imagine you would obtain a 1million EUR research grant. Please prepare a project description on some topic of exoplanetary research
 - It can be project, instrument etc..., please describe the science motivation, project plan, expected results and why you chose the particular topic – PPT presentation with a few slides please