Life on Trappist-1-like Planets

Impossible, Possible or Likely?

Joe Gale, Institute of Life Sciences

Amri Wandel, Racach Institute of Physics

The Hebrew University of Jerusalem
Israel

ESA NL 2017

Some Life Significant Data of Trappist -1

Small – 0.12 Rsun. 39ly from Sun.
Radiation flux – 0.05% of Sun. Subject to XUV flares. Age: 5-10Gy.

Cool – 2,550^{o}K – Most radiation in NIR;
e,f, and g planets of Trappist-1 are in the "Habitable Zone".

Six of the seven detected planets are close to star (0.1 – 0.35AU), which makes them **Tidally locked.**

Planets receive 0.25 – 4.0 of the EMR flux incident on Earth.
Of this, only ~ 10% is within the PAR waveband (400-700nm).

XUV radiation on Trappist-1 - Continuous and Flaring

XUV from Trappist-1, is many times that incident on Earth. Modeling suggests that the water and oceans may not be entirely eroded.

Given a suitable atmosphere and a magnetosphere, absorbing/diverting XUV and particulate radiations, life clement conditions may be maintained.

Alternatively - Life evolving in water below a depth of 10cm would be protected by the absorption of XUV. Water transmits PAR but little NIR.

Red Dwarf stars have longevity many times that of Sun-like G-stars. Only in their early lives do they have strong XUV flares. (Age of Trappist-1 – estimated as 5-10Gy).

A recent, more promising Red Dwarf Star Planet
(Astronomy and Astrophysics, October, 2017)

11 ly from Solar system

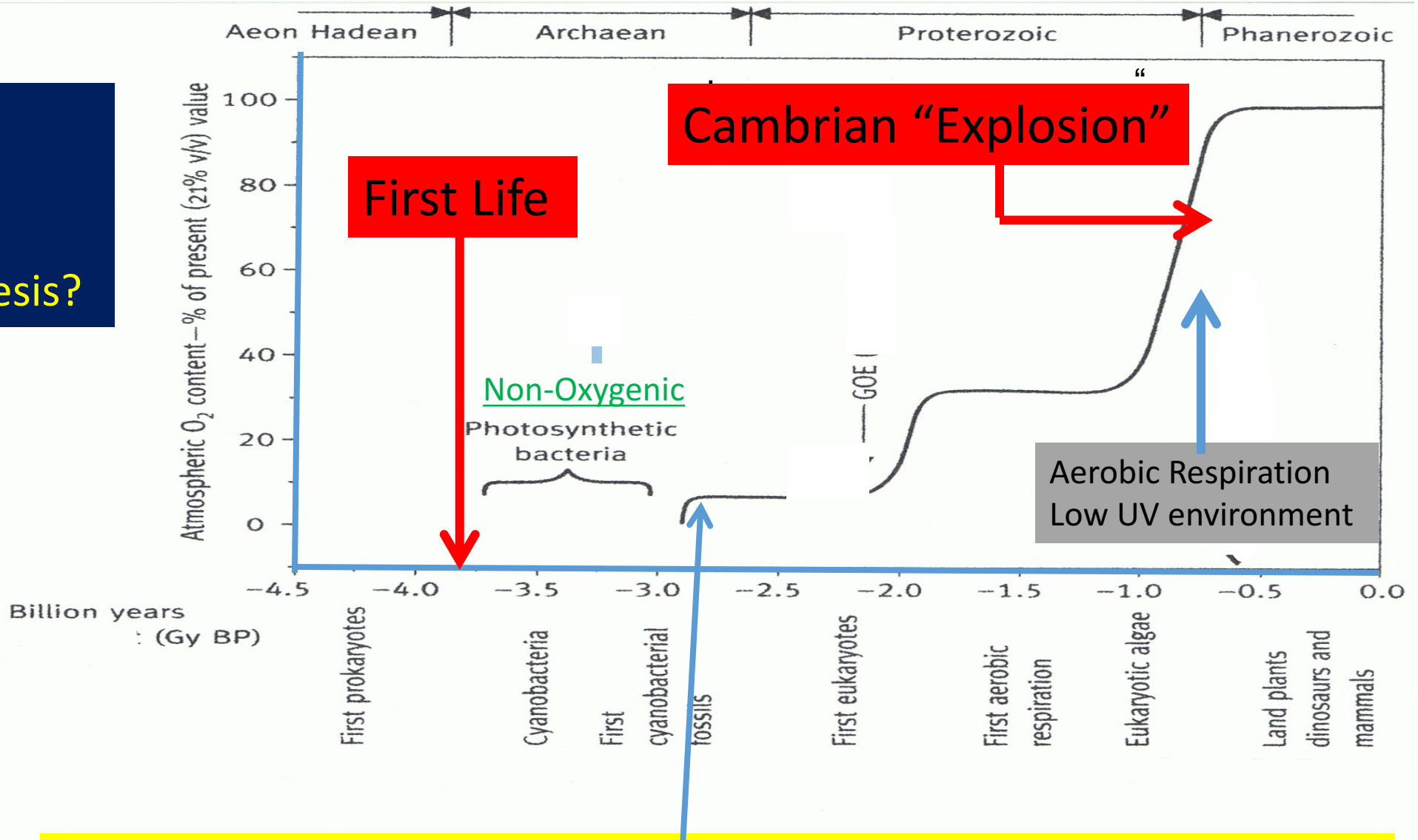
Orbits in 9.9 days at 0.05AU.

Surface temperature -60 to 20 C°

The RDS has very low XUV flaring (cf Trappist-1 or Proxima centauri)

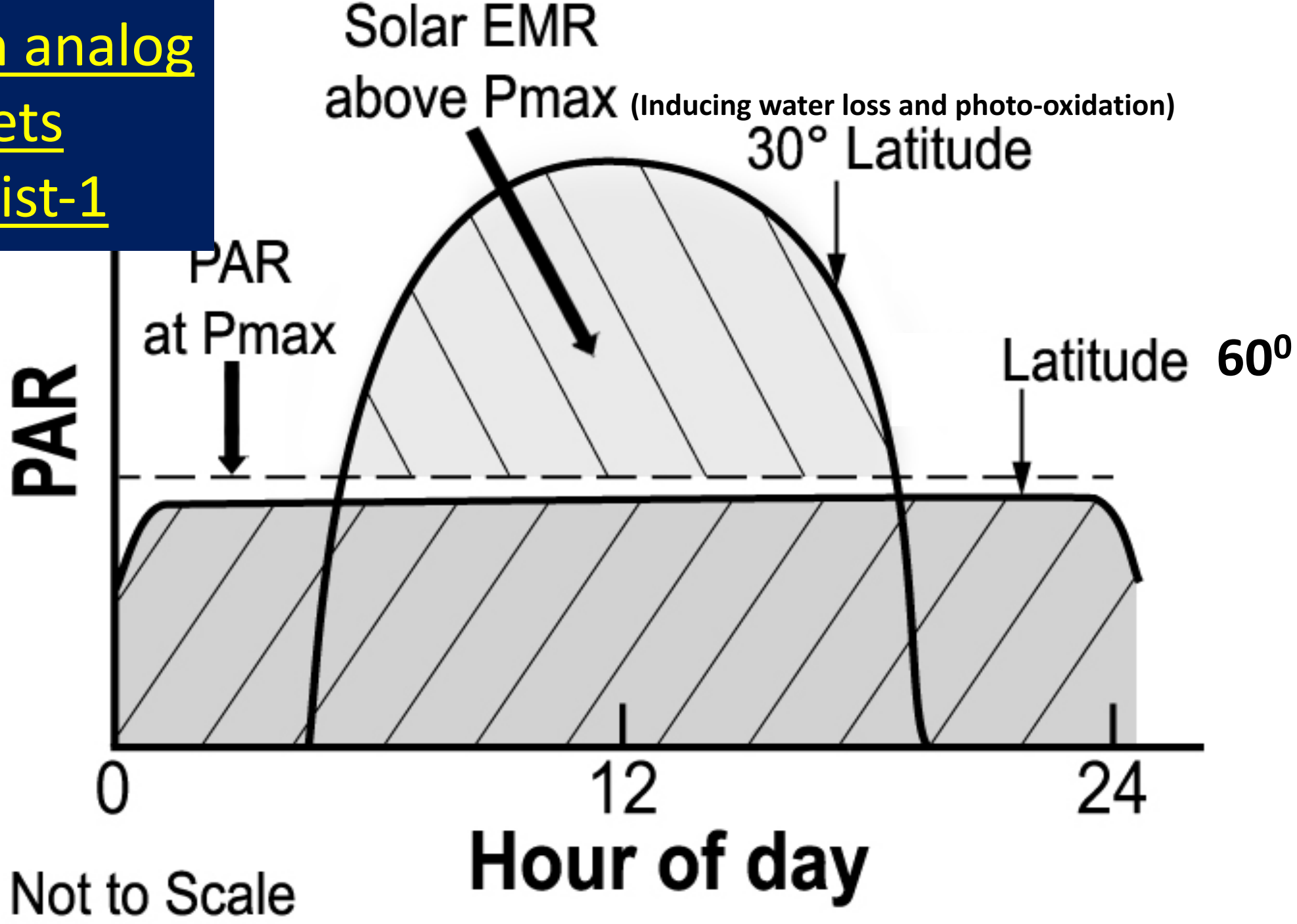
.

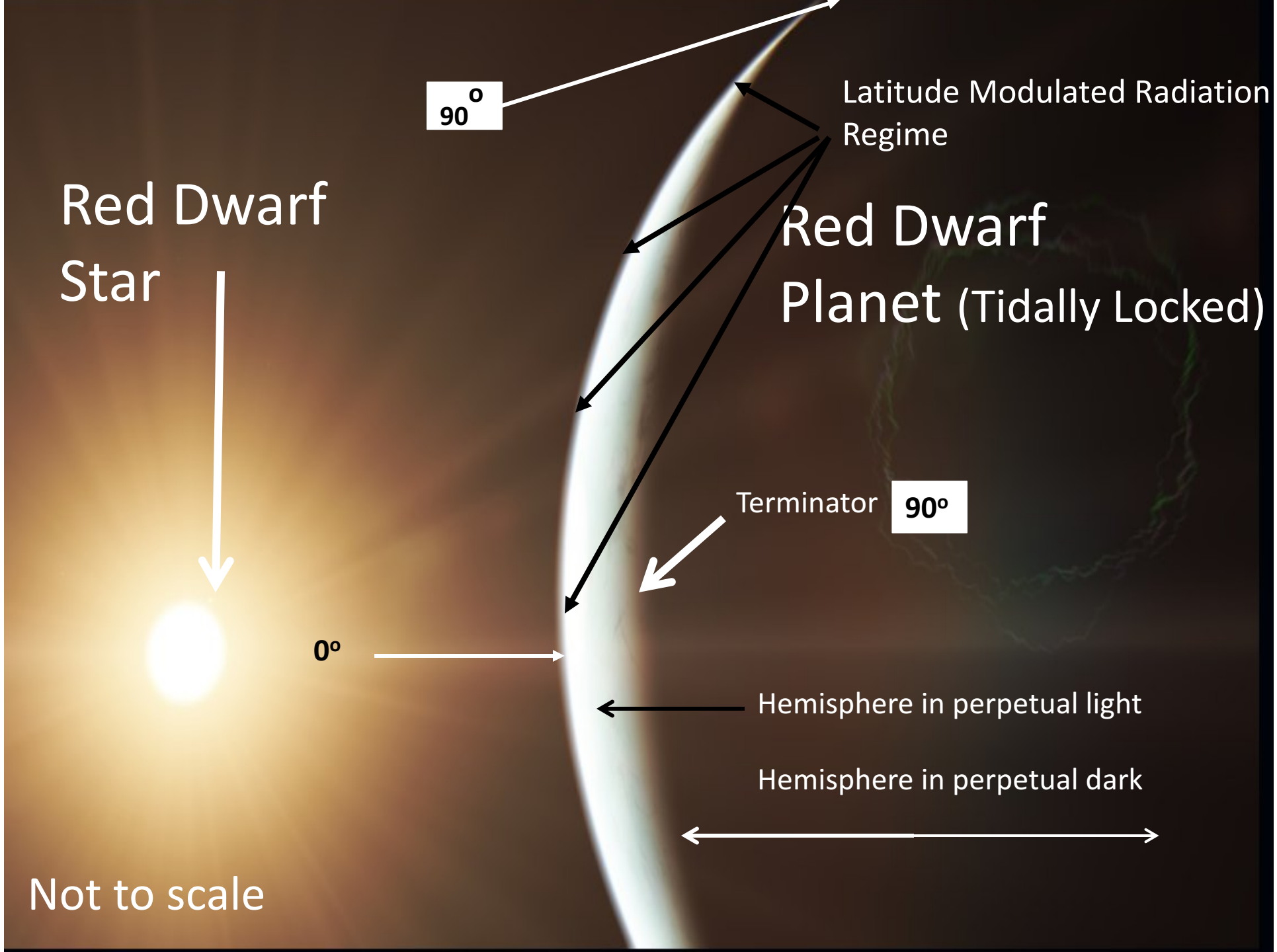
What's so interesting in Oxygenic Photosynthesis?



Oxygenic Photosynthesis and the Evolution of Earth's Atmosphere and Complex Life

An Earth analog for Planets of Trappist-1




90°
Latitude Modulated Radiation Regime
Red Dwarf Star
Red Dwarf Planet (Tidally Locked)
Terminator
90°
0°
Hemisphere in perpetual light
Hemisphere in perpetual dark
Not to scale

Calculation of PAR available on Trappist-1-d planet

At a distance of 0.2AU, radiation incident = 1.14 of that on Earth- of this only 10% is PAR (400-700nm) (versus 30% of Earth incident radiation) or 0.114/0.30 = 0.38 of PAR on Earth (calculation without atmosphere).

On a Solar year comparison, at the sub-stellar point, tidally locked Trappist-1d would receive four times the PAR incident on Earth. At latitude 75^{o}, PAR dose would be the same as on Earth.

Vegetation on Trappist-1d, could avoid over-exposure to EMR radiation, by location, somewhere between the sub-stellar point (latitude 0^{o}) and the light terminator at 90^{o}.

Oxygenic Photosynthesis could evolve to use NIR between 700-1,000nm. About 15-20% of the radiation of Trappist-1 is within this waveband.

<u>Conclusion:</u> vs Earth - Sufficient radiation for Oxygenic Photosynthesis.

Conclusions on the likelihood for Life supporting conditions on Trappist-1 and other RDS planets

Life and Oxygenic photosynthesis could evolve.

By analogy to Earth, the evolution of Complex Life in a high Oxygen environment is possible (but not necessary) .

Such life could be very different to that on Earth

(for example: alternative Genetic Code; No Circadian Rhythms)

The product of the above and the huge number of other planet bearing RD (and other) stars, results in a high statistical probability of there being other abodes of Life, even Complex Life, in the Milky Way.

Intelligent Life???

Ernst Mayer's, 1990 argument as to the low chance of there being another intelligent civilization (summary)

- In 4 Gy of evolution on Earth only one life form appeared.

- Multi cellular complex life appeared only after 3.5Gy.

- Intelligence evolved in only one species of one line of complex life.

- In only one of about 26 civilizations did science and technology develop. This was very recent and may be self-destructive..

Knowing today, that Carl Sagan was right in his (1990) estimate (guess) of the number of planets in the Milky Way -

- Back to the Enrico Fermi Paradox (~1950)

“Where is everybody? ”