

Viability and Detectability of Photosynthesis on Earth-Like Planets Orbiting Nearby Stars

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Based on current understanding of how photosynthesis arose and developed on Earth, we consider what factors would limit or encourage the viability of photosynthetically energized organisms on Earth-like planets (ELP's) orbiting nearby ms stars with a range of surface temperature. Assuming that the ELP originally had an atmosphere similar to that of the early Earth and orbited within the parent star's habitable zone, the main factors are: (1) an adequate photon flux incident on the organism in the photosynthetically active region (400 to 700nm on Earth); and (2) the need to avoid UV-B radiation - prior to the production of an atmospheric UV screen of ozone - which would damage the organism's DNA. Significant photosynthesis with the generation of molecular oxygen could take place with an incident photon flux at the organism of at least ten times that on today's Earth. If the parent star is hot enough for there to be appreciable levels of UV radiation, photosynthetic organisms can seek lower UV light levels in the ELP ocean with the benefit of the greater attenuation of UV-B radiation than of the 400-700nm radiation. In the case of cool stars where the flux of photosynthetically active photons may be too low, a major change in the photosynthetic apparatus would be required from the two-photon photosystem of terrestrial photosynthesis, which energises the electron transfer needed in photosynthesis, to a three- or four-photon photosystem which can make use of lower energy photons. The implications for the viability and spectroscopic detectability of photosynthetic organisms on ELP's will be discussed.