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Thermodynamic constraints on photosynthesis in different extraterrestrial environments

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A universal property of life is that it needs a source of free energy to sustain itself. Although life on Earth likely originated from geologic sources of chemical free energy, most organisms in the present world are phototrophs. In general, photosynthesis is a process that transforms the shortwave low entropy solar radiation into useful (chemical) energy and long-wave radiation. At present, chemical energy is generated at a rate of 215TW by photosynthesis on Earth. In order to quantify the possibility for phototrophic activity on exoplanets, we calculate the entropy and exergy of radiation in different environments. We show that increased atmospheric thickness and greenhouse gas concentration can reduce the exergy of the radiation on the planets surface.