Possible photosynthesis around M dwarfs using the database of excited states

*Yu Komatsu[1]

1. Astrobiology Center / National Astronomical Observatory of Japan

Assuming the life outside the Earth, the way to obtain its essential energy is crucial. In near future observations, extrasolar planets around M dwarfs will be good targets. In such an environment, it is interesting to consider the possible photosynthesis, but it has a lot of uncertainties.
Photosynthesis has changed the earth environment in the history. To extend its global effect to photosynthetic organisms outside our Solar system, identifying photosynthetic biosignatures from planetary spectra such as oxygen or surface vegetation (the vegetation red edge), is a promising tool. Even though clarifying the surface environment of exoplanets is challenging, the remote sensing detects the vegetation on the Earth.
In this study, we investigate possible photosynthesis applicable to the M dwarf environment using the quantum chemistry to accumulate the basis for future detection. As we only know the photosynthesis on the Earth, we observe intensively natural (and artificial) photosynthesis and explore the possibility in redder photoenvironment. By quantum chemistry calculations, the database is being constructed on excited states of natural photosynthetic pigments like chlorophylls and carotenoids. Since the electronic structures determine the light absorption properties, starting with natural photosynthetic pigments in a variety of conditions, artificial pigments are calculated with minor difference like the central metal, side chain or solvent as a result from another possible evolution around M dwarfs. After constructing the database, key components to absorb the longer wavelength radiation are analyzed by the dimension reduction such as primary component analysis, one of the techniques in the machine learning. The results will be discussed in the poster.

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