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A search for infrared emission from extrasolar Earth-like planets: Spectral signature of life

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Is our planet an oasis of life in an otherwise dead universe?
Significant advances have occurred in the field of extrasolar planet research during the past decade.
The definitive goal of the search for extrasolar planets is the direct detection of radiation from Earth-like planets orbiting nearby stars and characterization of their atmospheres for evidence of habitability and life.
Future space missions such as Terrestrial Planet Finder will ultimately offer the opportunity to obtain spectra of extrasolar planets that are situated within the habitable zones of stars and thus search for signs of life.
Accordingly, it is required to develop the database for interpreting those spectra, both for evidence of habitable conditions and life.
The mid-infrared spectroscopy is the best suited method to characterize atmospheric conditions and to detect the gaseous components such as ozone, carbon dioxide, and methane.
These molecular species are abundant in the Earth's atmosphere, and could be attributable to primitive life in extrasolar terrestrial planets.
However, it remains unknown whether we could characterize the atmospheric composition of extrasolar planets on the various meteorological conditions from the observed spectra.

In order to explore the possibility of diagnosing existence of life from mid-infrared spectra, we have calculated synthesized global infrared spectra for hypothetical terrestrial planets.
We performed calculations of the high-resolution mid-infrared spectra of Earth-like planets taking into account of global distribution of clouds, viewing angles, seasonal variation in solar insolation and surface temperatures, and consequently, the infrared radiation emitted to space.
In the calculation of terrestrial planets with cloudy atmospheres, we adopted the distributions and properties of cloud in the present Earth.
In addition, we examine the spectral characteristics with a global atmosphere for the anoxic atmosphere of the early Earth, the ancient Earth just after formation of the ozone layer, and the present Earth.
This is because the ancient Earth has displayed significantly different atmospheric signatures, which is strongly influenced by life.
In this contribution, we will compare the derived spectral features of terrestrial planets between the past and the present and discuss the detectability of the atmospheric constituents of extrasolar terrestrial planets with cloudy atmosphere.

Keywords: extrasolar Earth-like planets, infrared observations, model calculations