[JJ] Evening Poster | P (Space and Planetary Sciences) | P-AE Astronomy & Extrasolar Bodies

[P-AE20]Exoplanet

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Exoplanetary science, which began with the discovery of a hot Jupiter in 1995, has reached a major turning point by the discovery of countless super-Earths by the Kepler mission. More recently, planets that are similar in size to the Earth and also receive similar amounts of stellar radiation (namely, located in the so-called habitable zone) have been discovered around nearby stars such as Proxima Centauri and TRAPPIST-1. As a result, not only theoretical, but also observational studies on the atmospheres and surface environments of Earth-like exoplanets have been started. Moreover, the number of planets discovered around early-type and late-type stars has become large enough that the occurrence rate and orbital distribution of planets around a wide variety of host stars have become clear. Thus, new observational insights, which become the basis of pan-planet formation theory, are now gathering. While exoplanets have been mainly targeted for astronomy until recently, it can be said that earth planetary science is finally becoming a research field to make a central contribution. In this session, we aim to share cutting-edge research results in exoplanetary science which is in such a transition period.

[PAE20-P07]The effect of irradiation from a G-type companion star on tidal locked planets around M-type host star in a binary system

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The Habitable zone (HZ) is the orbital region where liquid water can exist on the planetary surface. Planets in the HZs around M dwarf stars are attracting a lot of attention because M dwarf stars account for about 3/4 of stellar population and the small stellar size makes characterization of planets easier. Recent discoveries of planets in the HZs around M dwarfs within 12.5 parsecs of the Earth, TRAPPIST-1e, Proxima centauri b, and LHS 1140b, also promote our attention.

The HZ around an M dwarf is close to the central star because of its lower luminosity, so planets in the HZ are likely to be tidally locked (Kasting et al. 1993). As a result of the synchronous rotation, planets tend to have the warm/hot dayside and the cold nightside. If the local temperature becomes so low that the major atmospheric constituent condenses out, the loss of the greenhouse effect and the heat transport would cause further cooling and the planet would undergo a transition into a cold state with a thin atmosphere. The phenomenon is called “atmospheric collapse” and could be a serious difficulty for their habitability (Joshi et al. 1997).

When an M dwarf has a much brighter stellar companion such as a G-type star, it can periodically irradiate the cold night side of the tidally locked planet orbiting around the M dwarf; in reality, binary systems comprised of an M-type star and a G-type star are not so rare because more than half of G stars in the solar neighborhood have companions and the companions tend to be M dwarf stars (Duquennoy &Mayor 1991). In such systems, the irradiation from G-type star changes the distribution of the planetary temperature and may prevent the planet from undergoing atmospheric collapse.

In order to investigate this scenario, we study the climate of a land-covered or an ocean-covered planet in the binary system as a function of changing the binary separation and the planetary surface pressure. We calculate the surface temperature distribution of the planet by using 2 dimensional Energy Balance Model (e.g., North 1975). The model includes time variation of the irradiation from the G-type companion star, planetary heat capacity, heat transport, and greenhouse effect of the planetary atmospheres. We compare the surface temperature maps with and without G-type companion star and discuss the condition in which the companion star influences the habitability of the planet around an M dwarf star.