

Detectability of oxygen exosphere of Earth-like exoplanet by 1.7-m UV space telescope

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Many Earth-sized planets have already been discovered, and several Earth-like planets have been detected in the habitable zone of low-mass stars near the solar system. Transit spectroscopy is an effective method for observing atmospheres, but it requires extremely high precision to observe the thin lower atmospheres of small terrestrial planets, and at present no atmospheres of terrestrial exoplanets have been detected. On the other hand, low-mass stars have very strong XUV radiation even in the habitable zone, which may cause the upper atmospheres of terrestrial planets to extend to more distant regions with high density. In this study, we investigate the possibility of detecting the upper atmospheres of terrestrial exoplanets by transit spectroscopic observations with an ultraviolet space telescope. Assuming that TRAPPIST-1e has a lower atmosphere similar to that of the Earth, we estimated the upper atmosphere density distribution in a strong XUV radiation environment using 3 different models and estimated the UV (O I 130 nm) absorption by oxygen atoms in the upper atmosphere. The calculated transit depth based on the model by Johnstone et al. (2019) is about 45%, which would be detectable (3σ) in 9 transits using a 1.7-m ultraviolet telescope in combination with the spectrograph we are developing. On the other hand, the transit calculated based on another model by Nakayama et al. (2022) has a depth of about 1.5%, which is not detectable. In this presentation, we will introduce the atmospheric density profiles that vary with different models, their detectability, and the instrument under development.

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