P304a 自転傾斜角を持つ系外惑星の大気循環構造と熱光度曲線

大野 和正 (東京工業大学), Xi Zhang (University of California Santa Cruz)

Planetary obliquity, defined as an angle between a planet spin axis and an orbital normal, has a large impact on climate on exoplanets. The obliquity is also an important clue to explore the formation processes of planets. One of the possible approaches to constrain the obliquities of exoplanets is the thermal light curve observation because tilted planets should have distinct thermal structures. However, the thermal structure is strongly associated to the atmospheric dynamics, which has been poorly understood for tilted exoplanets.

In this study, using a 2D atmospheric circulation model, we investigate the atmospheric temperature distributions and circulation patterns of tilted exoplanets for various obliquities, eccentricities, and radiative timescales. We find that the climate on tilted planets could be classified into five regimes according to the radiative timescale, rotation period, orbital period, and obliquity. The circulation patterns of tilted exoplanets are drastically reshaped when the obliquity is larger than $\sim 30^\circ$ or $\sim 60^\circ$, depending on the radiative timescales. This is because planet receives more insolation at the poles than that at the equator, results in distinct thermal and dynamical structures from non-tilted planets. We calculate the synthetic thermal light curves based on the simulation results, and find that tilted planets potentially yield the flux peak after the secondary eclipse. This negative peak-offset is also caused by eccentricity in some specific configurations. We find that it is possible to solve this degeneracy when the secondary eclipse occurs after the periapse passage timing. Our results would be useful to constrain the exoplanetary obliquity with current and future observations such as JWST.