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Coupled thermal and orbital evolution of super-Earths: effect of temperature-dependnecy of mantle rheology

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With the rapid development of observational instruments and techniques, 18 "super Earths" (which is defined as a planet of which mass is less than $10M_{Earth}$) have been detected already. Ongoing and oncoming space transit surveys (CoRoT, Kepler and JWST) will detect more and more planets of these sizes. The detection probability of transit method is proportional to inverse of semi-major axis of planet, and thus closer planets are more easily detected. In fact, most of detected super Earths are orbiting with relatively small semi-major axis around their host star.
In such a situation, the tidal interaction with host star is a very important heating mechanism for the planetary interior, while the situation is not the case of planets in our Solar system (except for the satellites of Jupiter and Saturn). Thus, these close-in super Earths are good targets to understand the mechanism of tidal dissipation inside rocky planets.

In this context, we have simulated coupled thermal- and orbital- evolution of extra solar super Earths due to tidal dissipation inside them taking into account temperature-dependency of rheology of rocky mantle. The tidal dissipation affects the thermal state of planetary interior, whereas the tidal dissipation rate is highly affected by thermal state of planetary interior due to temperature dependency of rheology of rocky mantle. Especially, the viscosity of rocky mantle is highly depending on the temperature, which controls the dissipation rate. Therefore, the thermal evolution and orbital evolution is coupled through this tidal dissipation. Thus, we took into account such temperature dependencies of rock rheology and examined how it affects the evolution. We will show there are some regimes in a-e plane where the thermal-orbital evolution is clearly changed.

Keywords: super Earths, tidal dissipation, exoplanets