Geophysical Research Abstracts
Vol. 12, EGU2010-9759, 2010
EGU General Assembly 2010

CoRoT-7b: Convection in a Tidally Locked Planet

Lena Noack (1), Vlada Stamenkovic (1), Frank W. Wagner (1), Frank Sohl (2), and Doris Breuer (2)
(1) Joint Planetary Interior Physics Research Group of the University Münster and IfP DLR Berlin, Germany (lena.noack@dlr.de), (2) Dept. of Planetary Physics, DLR Berlin, Germany

The number of terrestrial extrasolar planets found in the past few years is increasing rapidly. Some have masses ranging from 2 to 10 Earth masses, and the habitability of these planets is widely discussed in the planetary community. Due to observational limitations we will mostly be able to observe planets that are very close to its host star, resulting in a potentially tidally locked orbit. Our goal is to investigate if such planets can be habitable at all. But to do so, we first have to understand the convection behaviour of such planets.

In this work we model the mantle convection of the recently discovered exoplanet CoRoT-7b [1], which is a planet believed to be tidally locked. The extreme intense insolation in the vicinity of its host star heats the day-side of CoRoT-7b, leading to surface temperatures about 2000 Kelvin higher than on the night-side [1]. CoRoT-7b is about 5 times more massive than the Earth and predominantly composed of dry silicate rock similar to Earth's Moon. A central iron core, if present, would be relatively small [2] with a core mass fraction of no more than 15 wt%.

The mantle convection is modelled in a spherical shell [3] using a temperature- and pressure-dependent viscosity. We use a radioactive heat source density similar to present Earth. Coriolis forces are neglected and we assume that CoRoT-7b has no atmosphere.

The results show that the lower mantle above the core-mantle boundary is in a more sluggish convection regime as a consequence of the viscosity increase with pressure. Depending on the strength of the viscosity increase, even a so-called low-lid [4] can form and conductive heat transport dominates from the core to the upper part of the mantle. The thermal state of such a deeply situated, conductive lower mantle of CoRoT-7b is not much influenced by the strongly laterally varying surface temperature.

However, the temperatures of the upper convecting mantle are found to strongly vary from one side of the planet to the other with lateral temperature differences up to several hundred Kelvin in the downwellings. The temperature in the upwellings on the other hand seems to be unaffected by the surface temperature variation.

The most prominent feature due to the strong lateral surface temperature variation is the difference in the style of convection between the two hemispheres. At the night-side, a stagnant upper layer forms above the convecting mantle whereas at the day-side, the surface takes part in the convection, showing larger convective cells as compared to the night-side. Hence, CoRoT-7b, if it does not have an atmosphere thick enough to balance the surface temperature across the surface, is in a stagnant-lid regime at the night-side and in a mobile regime at the day-side.

References

[1] A. Léger, D. Rouan, J. Schneider, et al. (2009), A&A.
[2] F.W. Wagner, F. Sohl, H. Hussmann, H. Rauer, and M. Grott (2010), to be submitted.
[3] C. Hüttig and K. Stemmer (2008), PEPI.
[4] V. Stamenkovic, L. Noack, D. Breuer, and T. Spohn (2010), to be submitted.