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Interior structure models and fluid Love numbers of exoplanets in the super-Earth regime

Clemens Kellermann, Andreas Becker and Ronald Redmer
Institute of Physics, University of Rostock, Germany

Abstract

The increasing number of discovered exoplanets provides us with new planetary classes, such as super-Earths and mini-Neptunes. In order to model their interior structure the mean density of a planet is an important input. Based on this quantity we can decide whether extensive gaseous layers or rocky mantle materials have to be considered.

In this work we calculate three-layer models with one or two adiabatic outer layers of volatile material and two or one isothermal, solid inner layers consisting of magnesium oxide (MgO) or iron (Fe), respectively, as well as the resulting Love numbers k_2. This quantity results from the planet's internal density profile and, if also measured, can be used to constrain the possible layer compositions and sizes.

To examine the effect of planet mass, layer sizes and surface temperature on internal structure and Love number we perform a parameter study. Furthermore, we apply the results to analyze several known exoplanets with measured densities in the regime of super-Earths and mini-Neptunes. We find that an observational constraint on k_2 would be particularly useful to narrow down the planetary Fe/MgO mass ratio.