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Effects of tidal heating in Proxima Centauri b's thermal evolution

Enrique Sanchis and Lena Noack
Freie Universität Berlin, Institute of Geological Sciences, Malteserstr. 74-100, 12249 Berlin, Germany

The recent discovery of a terrestrial planet orbiting Proxima Centauri, our closest neighbor (an M5.5V star of 0.1 M_{Sun} mass and only 1.3 pc distance to the Sun), offers an excellent planet laboratory to study the most important theories of planet evolution and composition. The planet (Proxima b) is orbiting the star in its habitable zone at a separation of only ~0.05 AU and an orbital period of ~11 days, and most recent studies suggest a non-zero eccentricity of about 0.17. With a mass of >=1.2 M_{Earth}, Proxima b is expected to have a rocky composition, which might resemble the Earth. It is therefore an excellent target to characterize terrestrial planets similar to Earth, avoiding the inherent biases of only studying the terrestrial planets of the solar system.

Due to its close orbit and expected eccentricity, Proxima b most likely suffers from severe tidal heating, which can have an extreme incidence in the planet's habitability and the survival of an atmosphere. In this work, we perform a comprehensive analysis of the incidence that different distribution patterns of tidal heating can have on Proxima b's interior and thermal evolution. To accomplish this goal, we consider various possible geometries of the planet, from the simplest case, homogeneous distribution of the generated heat, to the more complicated cases, with an inhomogeneous distribution pattern that depends on the planet's interior structure (a stratified sphere, an incompressible homogeneous planet, or a two-layer structure with a differentiated core). The different models considered alter how tidal heat is distributed throughout the planet's interior, which can highly affect its overall thermal evolution.

Furthermore, due to its proximity to the central star, Proxima b may as well be in synchronous rotation with Proxima Centauri. This can cause an extreme surface temperature variation between the hemisphere that permanently faces the star and the opposite hemisphere. In this work, the effect that synchronous rotation may have on Proxima b's interior is also thoroughly investigated.