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

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Exoplanets in the Habitable Zone (HZ)

Proxima Centauri b



<u>Our goal:</u>

Study the incidence of the spatial distribution of tidal heating on the thermal evolution of Proxima-b

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Tidal Heating

- > If non-zero eccentricity or obliquity
- > Global tidal dissipation rate in a synchronously rotating body:

$$H = Im(k_2) \frac{(\omega R_p)^5}{G} \left(\frac{21}{2}e^2 + \frac{3}{2}\sin^2 I\right)$$



Distribution of tidal heat



Modeling of Proxima-b's interior

CHIC grid convective code (Noack et al.)

We study different cases of how is tidal heating distributed:

- > Homogeneous distribution of tidal heating
- > Radially-dependent distrib. in homogeneous body
- > Radially-dependent distrib. in a two-shell body
- > Lateral- & radially-dependent distrib. in a two-shell body



Also the effect of using a reference or local viscosity and shear modulus

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Mantle depletion for different distributions of tidal heat after 2Gyr



But, when computing tidal heat more accurately...



When computing tidal heat more accurately...



Strong generation of melt



Thermal evolution of the interior changes!

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Synchronous rotation

If synchronous rotation around a star Surface temperature variation



In Proxima-b, expected surface temp. variations of ~130-150 K ! (Sergeev et al. 2020)

Preliminary results:



Summary

Tidal heating and synchronous rotation needs to be considered in Proxima-b when studying its thermal evolution and its habitability

- > In a first glance, tidal heating distribution has a minor incidence in the evolution.
- > BUT! In fact in the most realistic simulations, strong impact on the thermal evolution.
- > Synchronous rotation: considerable effect on the interior.

Next: expand study to other cases!

- > lo: strong tidal heating, locked (but) to Jupiter
- > Trappist-1 planets: tidal heating in at least the 5 planets

Inner Solar System Order energie 25 h Marteury Vegtus Egith

Credit: NASA/JPL/Caltech

synchronous rotation unknown but likely

> Corot-7b: zero-eccentricity (no tidal heating?) but most likely synchronous rotation