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Induction heating of the interior of Proxima Cen b

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Our closest neighbour star, Proxima Centauri, has been shown to have at least one orbiting planet, Proxima Cen b. This planet has a minimum mass close to Earth's mass and is likely rocky in its composition. Unlike the Sun, Proxima Centauri possesses a very strong magnetic field of at least a few hundred Gauss, which may have been even higher in the past. Although at present the star has a slow rotation period of ˜83 days, it may have rotated much faster in the past. If the stellar rotation axis and the dipole axis are inclined with respect to each other, the planet experiences constant change of the magnetic flux caused by stellar rotation and orbital motion. Due to finite conductivity of the planetary interiors, this leads to generation of eddy currents and electromagnetic induction heating of the planetary mantle.

Here we study the electromagnetic induction heating in the interior of Proxima Cen b over time, and its effect on the evolution of interior, surface and atmosphere of the planet. We consider both the present-day parameters of the star as well as stellar evolution, and study the possible induction heating in the past. We calculate different evolutionary tracks for Proxima Centauri and investigate the evolution of its rotation period and magnetic field. We calculate the heating in planetary interiors over time for different magnetic fields and rotation evolutions of the star. We implement the local magnetic induction heating effect in our mantle convection simulations depending on the composition, the mantle electrical conductivity, and the inclination between stellar rotation axis and dipole axis.

Our results show that the induction heating may have been substantial in the past, leading to formation of local magma oceans in the planetary mantle and to extreme volcanism during substantial periods of planetary history. This implies a very different evolution history of Proxima Cen b in comparison to the Earth and raises important questions about its claimed habitability potential.