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Characterizing super-Mercuries via state-of-the-art interior models

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Abstract

In the solar system, Mercury appears as a peculiar body, both on its physical parameters (low mass and highest uncompressed density) and its composition, making it unique among terrestrial planets. It is namely characterized by an enrichment in iron compared to solar abundances, and by reducing chemical conditions, yielding different formation materials than on the Earth or other terrestrial bodies [1]. Observations from the MESSENGER data, coupled to laboratory experiments and models of internal structure allowed to converge towards a precise characterization of Mercury [2, 3]. Beyond the general enrichment in iron of the planet, the general view that Mercury stores a significant fraction of silicon in its core (rather than sulfur, which restrains to the mantle) starts to be widely accepted.

Exoplanets resembling Mercury are identified from their high inferred bulk density. In this work, we investigate the internal structure and composition of a set of exoplanets that potentially present the same characteristics as Mercury (see Figure 1). We use the model of planetary interiors from [4], designed for terrestrial planets up to a few Earth masses, that we improve with finer core and mantle descriptions. This allows us to study planetary compositions that, in our solar system, are specific to Mercury. Current studies of these potential "super-Mercuries" only characterize such bodies as iron-rich planets, with a metallic core made either of pure iron or of an iron-sulfur mixture [5]. By considering the incorporation of silicon in the core of these exoplanets, we aim at determining how similar to Mercury they are, according to their measured fundamental parameters.

We thus show that, as for Mercury, the presence of silicon in the core of these planets allows them to present a bulk Fe/Si ratio closer to the stellar value, compared to the case with an Si-free core. In that latter case, the planetary Fe/Si ratio can reach ∼7 times the stellar value. In contrast, an Si-rich core lowers both Mg/Si and S/Si ratios of the exoplanets, because the silicate mantle only represents a small fraction of their mass. These deviations from the stellar abundances could be consequences of a particular formation mechanism of Mercury-like bodies, not only specific to our solar system. With a constantly increasing number of super-Mercuries, statistical studies on this family of exoplanets could allow to distinguish between the different formation scenarios invoked for Mercury. If Mercury-like bodies are common among exoplanets, the giant impact scenario [6] might not be the most favorable scenario, compared to a possible volatilization of the silicate mantle.

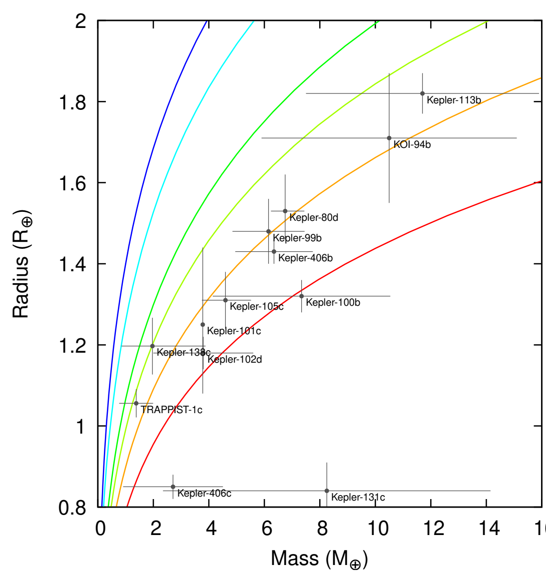

Figure 1: Position of potential super-Mercuries in the mass-radius diagram. The curves are mass-radius relations computed for a given set of planetary compositions (from top to bottom: 100% water, 50% water-50% silicate mantle, 100% silicate mantle, Earth-like, Mercury-like, and 100% metallic core).

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References

[1] Nittler, L. R., Starr, R. D., Weider, S. Z., et al. 2011, Science, 333, 1847

[2] Hauck, S. A., Margot, J.-L., Solomon, S. C., et al. 2013, Journal of Geophysical Research (Planets), 118, 1204

[3] Brugger, B., Mousis, O., Deleuil, M., & Deschamps, F. *In prep.*

[4] Brugger, B., Mousis, O., Deleuil, M., & Deschamps, F. 2017, ApJ, 850, 93

[5] Santerne, A., Brugger, B., Armstrong, D. J., et al. 2018, Nature Astronomy, 2, 393

[6] Benz, W., Anic, A., Horner, J., et al. 2007, Space Science Reviews, 132, 189