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plaNETic: Inferring the interiors of observed super-Earths and sub-Neptunes using neural networks

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Despite over 5800 exoplanet discoveries to date, determining the internal compositions of these planets remains challenging. This is due to an intrinsic degeneracy: many interior compositions can fit the observed mass and radius values of each exoplanet. This difficulty is especially pronounced for small planets, with radii between the ones of Earth and Neptune. However, studying the composition of exoplanets can give us insights into planet formation and evolution processes, as exoplanet interiors are shaped by the properties of the protoplanetary discs in which they formed, as well as their formation locations, orbital migration, and evolution histories.

Traditionally, interior models have been combined with Bayesian inference to explore the range of an observed planet's possible compositions, but this is a computationally expensive and slow process. To this end, we developed the plaNETic code (Egger et al. 2024), an open-source framework that accelerates interior characterisation by replacing the computationally expensive forward model with a fast surrogate model. More specifically, plaNETic uses a feed-forward neural network for this purpose, that was trained on a dataset of 15 million planetary interior models generated using the BICEPS planetary structure model (Haldemann et al. 2024). In this way, the internal structure of an observed planet can be inferred quickly but still reliably. The framework has already been successfully applied to a range of observed systems, including a recent detailed analysis of the TOI-469 planets (Egger et al. 2024).