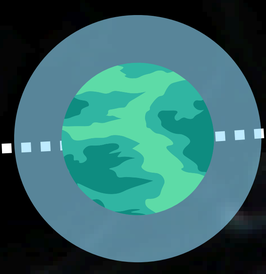
Why so light? Exploring TOI-244 b and the growing population of low-density super-Earths

A. Castro-González,[1] O. D. S. Demangeon,[2] J. Lillo-Box[1], and the ESPRESSO team

[1]Centro de Astrobiología, CSIC-INTA, ESAC campus, Villanueva de la Cañada, Madrid, Spain
[2]Instituto de Astrofísica e Ciências do Espaço, Universidade do Porto, CAUP, Portugal

acastro@cab.inta-csic.es



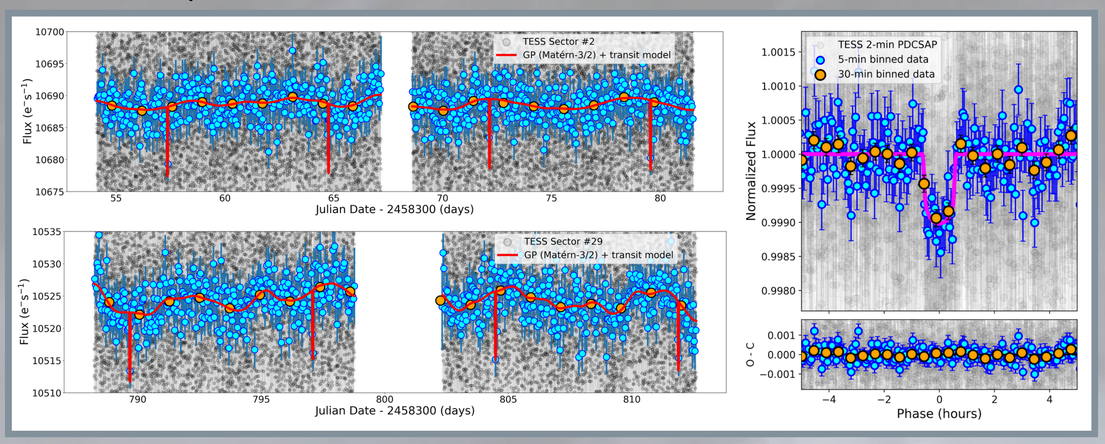
Small planets located at the lower mode of the bimodal radius distribution are generally assumed to be composed of iron and silicates in a proportion similar to that of the Earth. However, recent discoveries are revealing a new population of low-density planets inconsistent with that description.

Earth-like density

Low density

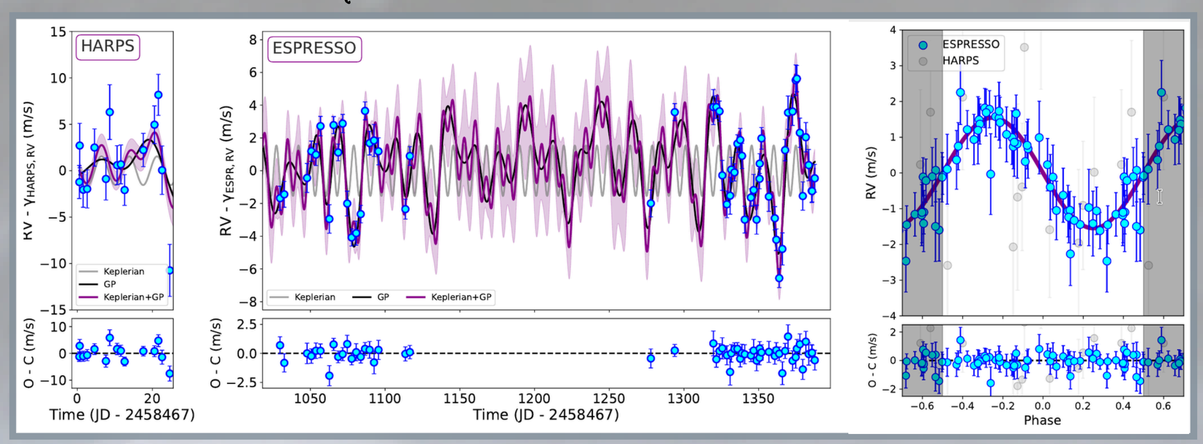
The **bright** (K = 7.97 mag), **nearby** (d = 22 pc) **M-dwarf** star TOI-244 (GJ 1018) was found to have a super-Earth candidate in a **7.4-day orbit** by the Transiting Exoplanet Survey Satellite (TESS). We observed TOI-244 with the ESPRESSO spectrograph to confirm and characterize its candidate and search for additional non-transiting planets.

Transits



Transit model and a **Gaussian Process** (Matérn-3/2 kernel) to deal with the **correlated noise** within the TESS data.

Radial velocities



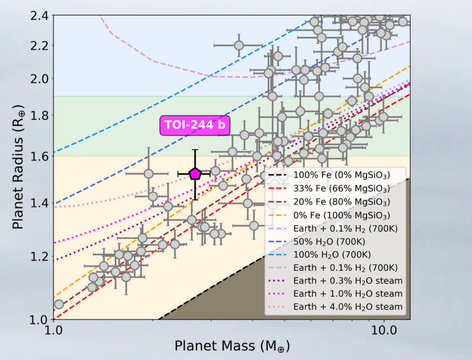
Keplerian model and a **Gaussian Process** (Quasi-periodic kernel) to model the RVs and FWHMs with **shared hyperparameters**.

Joint analysis → $R_p = 1.52 \pm 0.12\ R_\oplus$ (8% precision), $M_p = 2.68 \pm 0.30\ M_\oplus$ (12% precision), $P_{orb} = 7.397225 \pm 0.000026$ days.

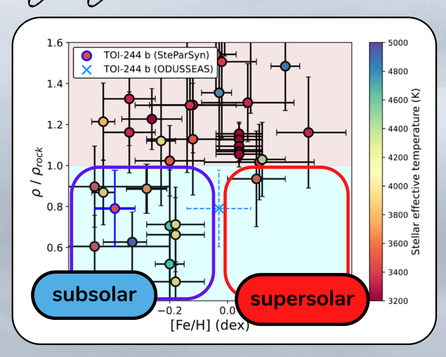
Internal structure

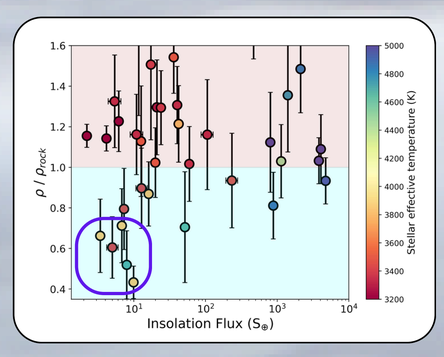
TOI-244 b has a lower density than expected for an Earth-like composition and a pure silicate composition. Therefore, a possible scarcity of iron in its core would not be enough to explain it.

TOI-244 b **cannot have a H/He atmosphere**, and instead, our internal structure analysis favours **the existence of a 480 km thick hydrosphere** on a rocky planet.



Emerging trends





We find that **low-density super-Earths** (LDSEs) **tend to be hosted by metal-poor stars AND to receive low insolation fluxes** ($S < 10\ S_\oplus$). These trends support the **steam atmosphere hypothesis since metal-poor stars were formed in water-rich environments**, whose retention seems to only be possible **under low irradiation conditions.** SEE MORE:

- We have confirmed and characterized the planet TOI-244 b, a new member of the emerging population of low-density super-Earths
- Based on its mass, radius, received insolation flux, photoevaporation and Jeans scape analysis, we find that TOI-244 b might have a **480-km thick hydrosphere** of **steam** and **supercritical** water
- Based on **observed trends**, we propose that the population of low-density super-Earths **could all have steam water atmospheres**
- The **confirmation** or **refutation** of this hypothesis will be **possible very soon** through observations of the planetary atmospheres

I'm happy to talk and collaborate to further study those LDSEs!

CENTRO DE ASTROBIOLOGÍA · CSIC - INTA ·

TOI-244 work