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Here comes the GJ 486.

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Abstract

At a distance of only 8.1 pc, GJ 486 b is the third closest transiting planet. The relatively bright, very weakly active, M-dwarf host star, its visibility from both Earth hemispheres, and the short orbital period and warm expected surface temperature make this planet one of the best targets for planet atmosphere emission and transit spectroscopy with *Webb* and future ground-based extremely large telescopes. Caballero et al. (2022) slightly improved the precision and accuracy of the planet mass and radius determination, with which they developed different planet interior and atmosphere scenarios. There are a few differences with respect to previous work that made this analysis unique. Instead of estimating the stellar radius from luminosity and model-dependent spectral synthesis, they directly measured the angular radius of the planet host star with MIRC-X at the CHARA Array. They reduced the input data error contribution by gathering extremely precise radial-velocity data collected by CARMENES and MAROON-X and transit data obtained by *TESS* and, presented there for the first time, *CHEOPS*. The selected joint radial-velocity and transit fit model with a Gaussian process was supported by an independent photometric monitoring with small and medium-size telescopes for determining the stellar rotation period. As a novelty in M dwarfs, they determined Mg, Si, V, Fe, Rb, Sr, and Zr abundances of the stellar host, which constrained two of the three considered planet interior scenarios. They also considered different planet atmosphere scenarios and their detectability with forthcoming *Webb* observations with NIRSpec and MIRI after taking into account different possibilities on composition and planet surface temperature and pressure. In the most probable combination of scenarios, GJ 486 b is a warm Earth-like planet of $R \sim 1.343\,R_\oplus$ and $M \sim 3.00\,M_\oplus$ with a relatively low-mass, metallic core surrounded by a silicate mantle with dissolved water, and an upper layer probably composed of a mixture of water steam and carbon dioxide.

1 Introduction

Instead of developing what is concisely summarised in the abstract just above or what is reported and discussed extensively in the discovery publication by Trifonov et al. (2021) [1] and the follow-up publication by Caballero et al. (2022) [2], here I just sum up the unpublished novelties on the rocky planet GJ 486 b (plotted with a black star symbol in Fig. 1)

in the last few months, for avoiding overlapping of forthcoming works. Environmentally-aware and busy readers may welcome this approach to avoid the never-ending repetition of content in conference proceedings and refereed papers.

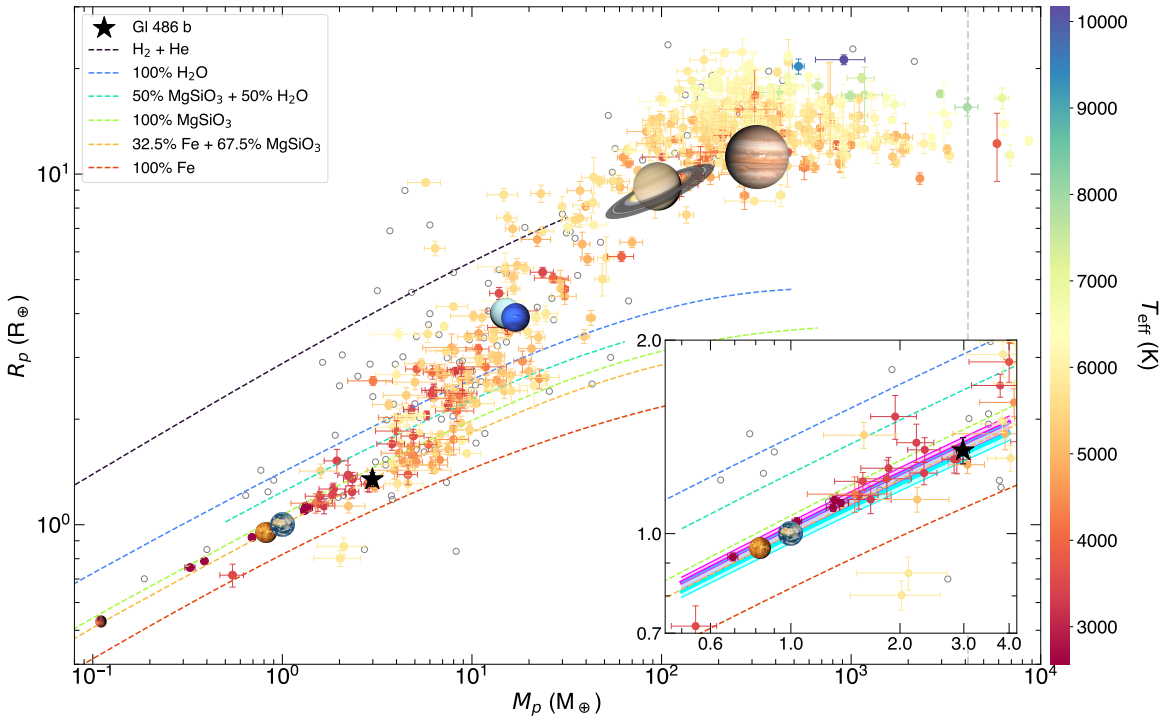

Figure 1: Mass–radius diagram of all transiting exoplanets with mass determination (from RV or transit time variations) known in Summer 2022, in comparison with the Solar System planets. Filled circles with error bars colour-coded by their host's $T_{\rm eff}$ are planets with mass and radius uncertainties of less than 30%, and open grey circles are the others. The filled black star is GJ 486 b. Dashed coloured curves are theoretical models, as specified in the legend. The Earth-like model is orange. The grey vertical dashed line is the deuterium burning mass limit at 13 $M_{\rm Jup}$ ('planet'-brown-dwarf boundary). The inset zooms in around the smallest planets and add mass-radius relationships informed by stellar abundances with median and 1σ error regions following nominal relative abundances of Fe, Mg, and Si of the host star without (pink) and with (cyan) empirical correction based on well-characterised super-Earths. The original figure, references, and details were provided by Caballero et al. (2022) [2].

2 What?

On the one hand, *TESS* revisited the star with its Camera 1 during Sector 50 observations between late March and late April 2022; these data are public. Besides, *CHEOPS* made three

additional visits in early March and early April 2022; these data have a one-year proprietary time (PI: J. A. Caballero). The early-April *CHEOPS* visit, simultaneous to *TESS* observations, will be very useful for direct spacecraft data comparison purposes; this is, however, a secondary objective. The new dataset, which virtually doubles the number of transits and enlarges the time baseline of the precise photometry by several orders of magnitude, is ideal for investigating transit time variations in the GJ 486 system. To date, previous searches (radial velocity, high resolution imaging, space astrometry) have, though, failed to find any additional planetary companion besides GJ 486 b [2]. As a bonus, together with the previously used CARMENES and MAROON-X radial velocities, the new precise photometry dataset will help further improving the stellar-to-planet radius ratio and other planetary parameters. All this analysis is being done by a team in Spain.

On the other hand, a team in the Netherlands is implementing an exhaustive planet modelling that includes both the structure, composition, and dynamics of the interior and a grid of global circulation models for different hypothetical atmospheres, while another team in Spain has proposed to use PIONIER at the ESO's Very Large Telescope Interferometer for covering the current observational gap in spatial frequency and, thus, determine a precise and accurate radius of the host star. New improved parameters of both the star (via interferometric data) and planet (via new *TESS* and *CHEOPS* data) will be excellent inputs for additional planet characterisation and modelisation works.

All this work in preparation is on time for the forthcoming publication of the analysis of the NIRSpec/*Webb* transmission spectra taken on 25 and 29 December 2022 with the filter F290LP, which are already available at the *Webb* archive (`jwst.esac.esa.int/archive`), and under analysis by a team in the USA. If you are interested in developing new projects on the GJ 486 planetary system on, for example, a wider grid of global circulation models with very different atmosphere compositions, structures, and dynamics, or the generation of magnetic fields in the liquid planet outer core, which may interact with the stellar magnetic field, feel free to contact the author of this proceeding.

3 Who?

Last but not least, the host star GJ 486 and the exoplanet GJ 486 b were one of the 20 star-planet pairs for which the International Astronomical Union offered all countries to name in the 2022 edition of the NameExoWorlds competition (`nameexoworlds.iau.org`). Other offered planetary systems pairs were, for example, GJ 1214, HD 95086, and WASP-69; all of them had, as well as GJ 486, been scheduled for observations by *Webb*.

In recognition of the United Nations Decade of Indigenous Languages (2022–2032), speakers of Indigenous languages were encouraged to propose names drawn from those languages. The Universidad del País Vasco/Euskal Herriko Unibertsitatea and the Centro de Astrobiología (CSIC-INTA) presented a proposal in Spain to name "Gar" and "Su" to the star GJ 486 and the planet GJ 486 b, respectively. In Basque[1], Gar means "flame", the luminous

[1]In Spain, in addition to Spanish, there are three co-official languages: Catalan/Valencian, Galician and Basque. All of them are Romance languages that evolved from Vulgar Latin, except for Euskara, which is a

gas coming from a burning object, while Su means "fire", a dual being (as it is good – it provides protection – but it can also be dangerous) as the selected planet. In Basque mythology, the fire of the hearth is the genie of the house and is asked for favours. Further details can be found at exoterrae.eu/gar+su. At the time of writing these lines, NameExoWorlds 2022 is in phase 2, namely national vetting process.

4 Why?

Finally, one may wonder why such a peculiar title for the proceeding of an oral contribution, "Here comes the GJ 486". Any reader with some musical rudiments will quickly realise of the reason when is told the titles of the other two contributions of the author in the same meeting: "A Day in the *LIFE*", on the *Large Interferometer For Exoplanets*, and "Radio Clásica's Longitud de Onda Club Band", the fifth item of the series "Music and astronomy". Actually, GJ 486 b has a soundtrack, which is the instrumental version of the CARMENES song[2] and that you can listen here.

Acknowledgments

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References

[1] Trifonov, T., Caballero, J. A., Morales, J. C. et al. 2021, Science, 371, 1038

[2] Caballero, J. A., González-Álvarez, E., Brady, M. et al. 2022, A&A, 665, A120

unique linguistic case spoken in the north of the Iberian Peninsula and the south of France even before the arrival of the Indo-European languages. In fact, scientists have recently found a bronze piece with the oldest inscription in Basque, dating back to the 1st century BC.

[2]Contrary to what one might expect, it is not a song by the The Beatles, but by Antonio Arias and José A. Caballero.