Water absorption in the transmission spectrum of the water-world candidate GJ 9827d



CRAQ meeting 2023 11 mai 2023

Pierre-Alexis Roy

with **B. Benneke**, **C. Piaulet**, M. Gully-S., **S. Delisle**, I. Crossfield, L. Kreidberg, C. Morley, T. Greene, Y. Brande, K. Hardegree-U.







Water absorption in the transmission spectrum of the water-world candidate GJ 9827d



CRAQ meeting 2023 11 mai 2023

Pierre-Alexis Roy

with **B. Benneke**, **C. Piaulet**, M. Gully-S., **S. Delisle**, I. Crossfield, L. Kreidberg, C. Morley, T. Greene, Y. Brande, K. Hardegree-U.







The solar system: Size of the planets



What is the size of the planets outside of the Solar System?



Fulton and Petigura, 2018

Most abundant exoplanet type is missing from the solar system



What is the size of the planets outside of the Solar System?



Fulton and Petigura, 2018

Sub-Neptunes are often regarded as "H2-rich super-Earths"



However, for small sub-Neptunes, new studies are challenging this view



Luque and Pallé 2022

A population of water-rich world ?

However, for small sub-Neptunes, new studies are challenging this view

TOI-1452b

Kepler-138d



Or even LHS 1140 b, as of yesterday!

Cadieux et al. in prep.

A population of water world candidates



Piaulet et al. 2023 (in prep.)

A population of water world candidates



Piaulet et al. 2023 (in prep.)

The next step...

We have not yet identified volatiles in the envelope of a water world candidate

A population of water world candidates



Piaulet et al. 2023 (in prep.)

GJ 9827 d - a 2 R_{\oplus} water-world candidate



Size = 2 R_{\oplus} Mass = 3.5 M_{\oplus} Temperature = 650 K

What is the nature of GJ 9827 d?



A deeper look into GJ 9827d with HST



We obtained **11 transits** of GJ 9827d with HST/WFC3 over 3 years



An absorption feature in the transit spectrum

A precision of ~ 22 ppm per 10nm bin



Cannot distinguish between water-world and mini-Neptune compositions



Roy et al. 2023 (in prep.)

Cannot distinguish between water-world and mini-Neptune compositions



Roy et al. 2023 (in prep.)

Water-dominated or H2-dominated with water

Cannot distinguish between water-world and mini-Neptune compositions



Roy et al. 2023 (in prep.)

Clouds needed for H2-rich

But is this feature really from the planet, or is it the star?

But is this feature really from the planet, or is it the star?



Rackham et al. 2019

But is this feature really from the planet, or is it the star?

Yes, it's the planet!



Roy et al. 2023 (in prep.)

First detection of water in the atmosphere of a water world candidate



Roy et al. 2023 (in prep.)

What is the nature of GJ 9827 d?



What is the nature of GJ 9827 d?





upcoming as part of the water world survey in JWST cycle 2!!!





upcoming as part of the water world survey in JWST cycle 2!!!

Merci beaucoup!





