Warm Neptunes: GJ 1214 b

Transit Observations

Warm Neptunes: GJ 1214 b

Planetary reflectance/emission

JWST observations by Kempton et al. 2023

Warm Neptunes: GJ 1214 b

Planetary reflectance/emission

Metallicity between 1000-3000 x Solar
Bond Albedo 10-20%

Warm Neptunes: GJ 1214 b

Consistent metallicity retrievals
Emission more constraining

Transit flatness and dis-equilibrium effects

See also Ohno et al. 2025

Transit flatness and dis-equilibrium effects

See also Ohno et al. 2025

Sulfur contribution

Organosulfuric hazes?

Very likely from laboratory experiments (Vuitton et al. 2021)

Temperate: TOI-1759b

Temperate Exoplanets: TOI-1759 b

TOI-1759 b

Temperature Profile

Dis-equilibrium has an important role
in the atmospheric composition

Haze/Cloud Properties

Haze dominates the visible transit spectrum

Molecular features observable in the near IR

Comparative Planetology of Temperate exoplanets

S. Paraskevaidou, PhD

K2-18b

Conclusions from JWST results

Observations **demand** more **detailed studies** of haze/cloud interplay.

First indications for **both** haze and clouds in hot-Jupiters (WASP-39b).

GJ 1214 b consistent with **1000-3000 x Solar** metallicity and **10-20%** Bond albedo.

Detection of **clouds** more difficult as we move to cooler atmospheres (TOI-1759b), because clouds are located deep in the atmosphere and may be **obscured by hazes**.

Organosulfuric products could play an important role for the atmospheric composition.

Open Questions

How important is ion chemistry at such high temperatures?

What is the role of more exotic species,
e.g. S-based (Vuitton et al. 2021), Si-based?

What are their optical properties?

What is the relative contribution of photochemical hazes and condensates in the observed spectra?

Forthcoming observations by JWST, ARIEL and other missions will help us understand better exoplanet hazes.

Laboratory measurements will help in the interpretation.

Machine Learning

Neural Networks

· Use the forward model to generate the microphysical dataset that will work as an input for the NN (70% to the training and 30% to the validation phase).

· "Feed" the NN enough simulated vertical profiles in order to make it learn the relationship between the particles in the atmosphere and learn the correspondence between physics and distribution profiles without following the actual formulas and procedures.

The predictions of the logarithmic mixing ratios that follow are for 1x atmospheric metallicity and for isothermal temperature profile (T = 300-1400 K), Kzz =10⁶cm²s⁻¹, charge=0, constant planet mass/radius.

Neural Networks

Solid: NN model predictions
Dashed: Forward model

Neural Networks

SOLID LINES: NN model predictions
DASHED LINES: Forward model

· The NN model is slightly biased towards temperature extremes (300K and 1400K).
· The model is capturing the bulk vertical structure of the atmosphere very accurately.