

L 98-59 d: Atmosphere on a rocky planet?

Deeper understanding of rocky planet atmospheres through Atmospheric Retrievals of super-Earth L 98-59d using JWST

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The Planet

- L 98-59 d is a super-Earth orbiting a nearby M-dwarf. Planet properties:

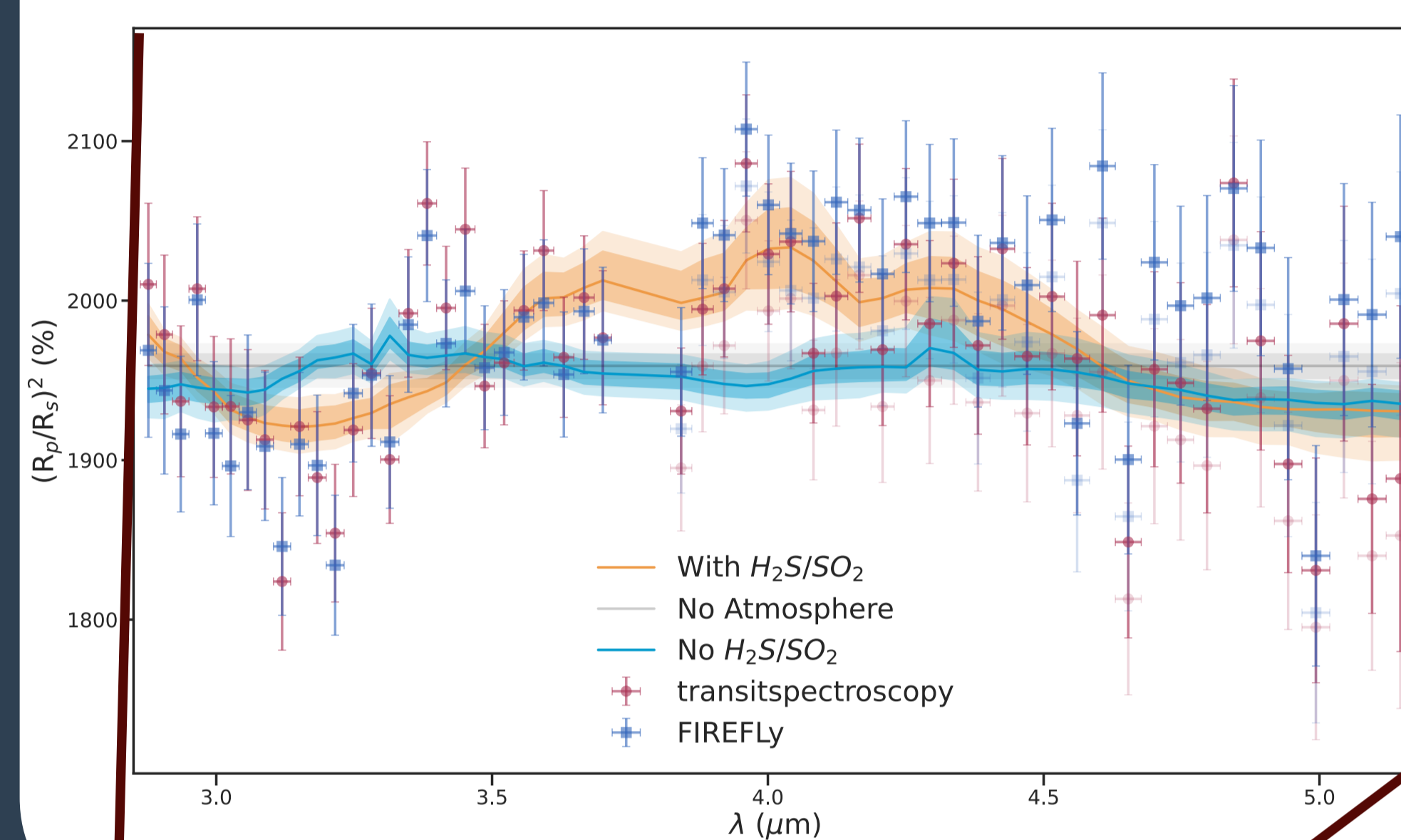
$$M = 1.94 M_{\oplus} \quad R = 1.52 R_{\oplus}$$
$$P = 7.45 \text{ days} \quad T_{\text{eq}} = 416 \text{ K}$$

- 1 transit observed^[1] using JWST NIRSpec G395H instrument by the GTO 1224 program
- Bright host star makes it an ideal target for transmission spectroscopy
- Orbits in the Venus Zone^[2] of host star
- Possible candidate for sustaining active volcanism via tidal heating^[3]

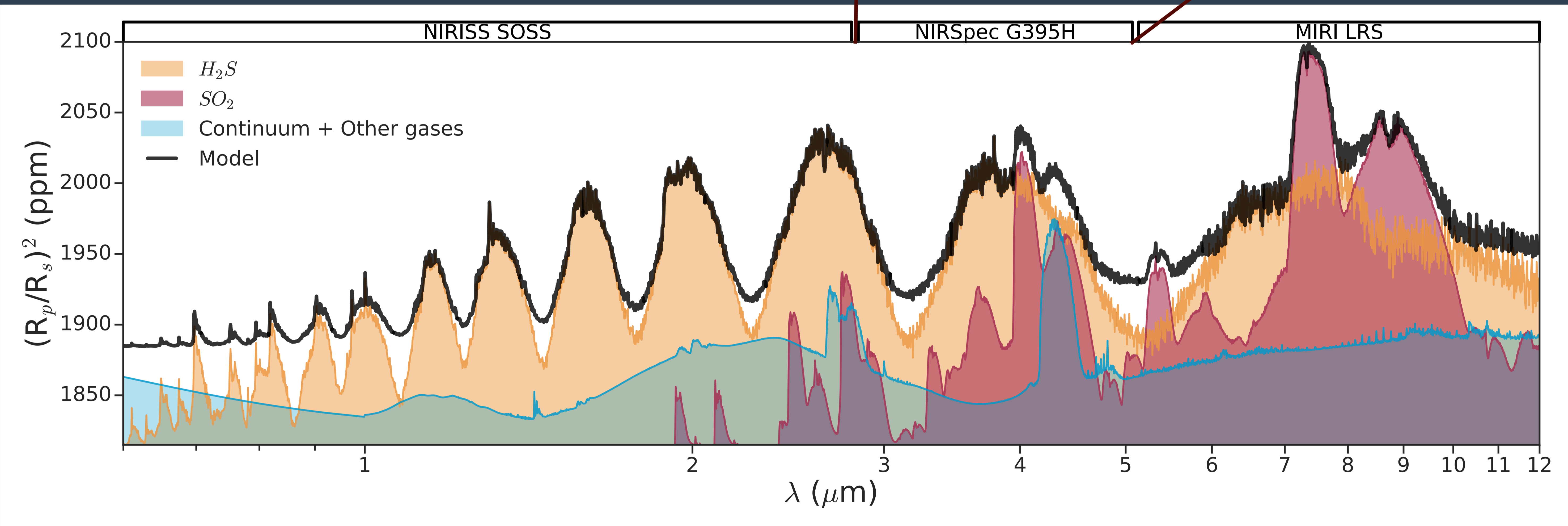
The Atmosphere

We performed atmospheric retrievals with **NemesisPy**^[4] using an atmosphere made of:

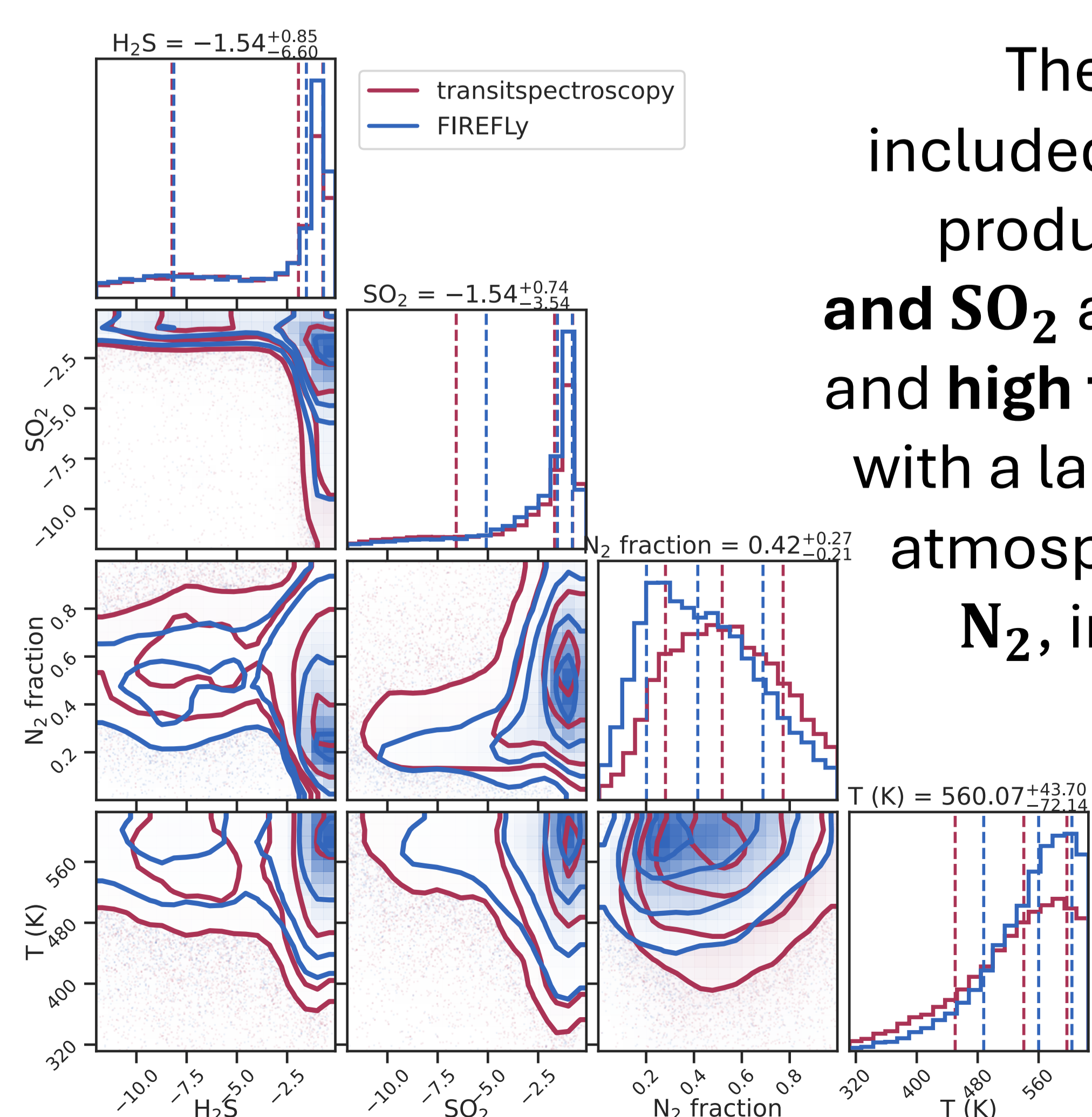
- Mixture of **H₂/He** and **N₂** as background
- Several trace gases including **H₂S** and **SO₂**
- Isothermal TP** profile + parametric clouds
- Parametric stellar inhomogeneities



An atmosphere with H₂S and SO₂ is preferred at ~3.7σ to one without those gases, and to one with no atmosphere



The Retrieval



The retrieval that included H₂S and SO₂ produced **high H₂S and SO₂** abundances^[5] and **high temperature**, with a large part of the atmosphere made of **N₂**, in addition to **H₂/He**

Conclusions

The spectrum indicates:

- Presence of a **hybrid**^[6] atmosphere
 - H₂S** and **SO₂** are the main spectrally active gases
- More observations are required to confirm the presence of H₂S and SO₂, possibly with:
- NIRSpec G140H: 0.97 – 1.82 μm
 - NIRSpec G235H: 1.66 – 3.05 μm
 - NIRISS SOSS: 0.6 – 2.8 μm (already taken by GO 4098 program)

References

- [1] Gressier+, Submitted, ApJL [2] Kane+, 2014, ApJL
[3] Seligman+, 2024, ApJ [4] Yang+, 2023, MNRAS
[5] Banerjee+, Submitted, ApJL [6] Tian+, 2024, ApJ