Impact of Infalling Dust on Hot Jupiter Transmission Spectra

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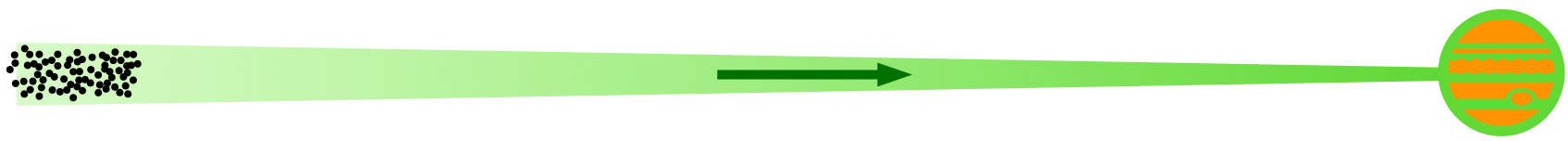
From Debris Disks to Hot Jupiter Atmospheres

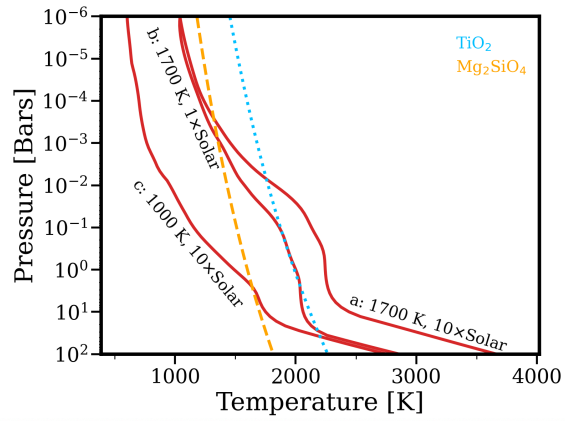


- **Debris disks** around mature stars produce μm-size dust through collisions (Wyatt+07)
- **Poynting-Robertson drag** causes this dust to drift inward, creating a steady $\dot{M}$
  - **Observations** show ~20% of nearby stars have hot-dust excesses, with inferred dust levels ~1000x higher than Solar system (Absil+13,21, Ertel+14,20)
- **Close-in, massive planets** efficiently accrete inspiraling dust compared to smaller or more distant planets
  - **Orbital simulations** show accretion fractions can reach 10-50% under favorable conditions (Arras+22)

How Infall Impacts Cloud Formation and Transmission Spectra

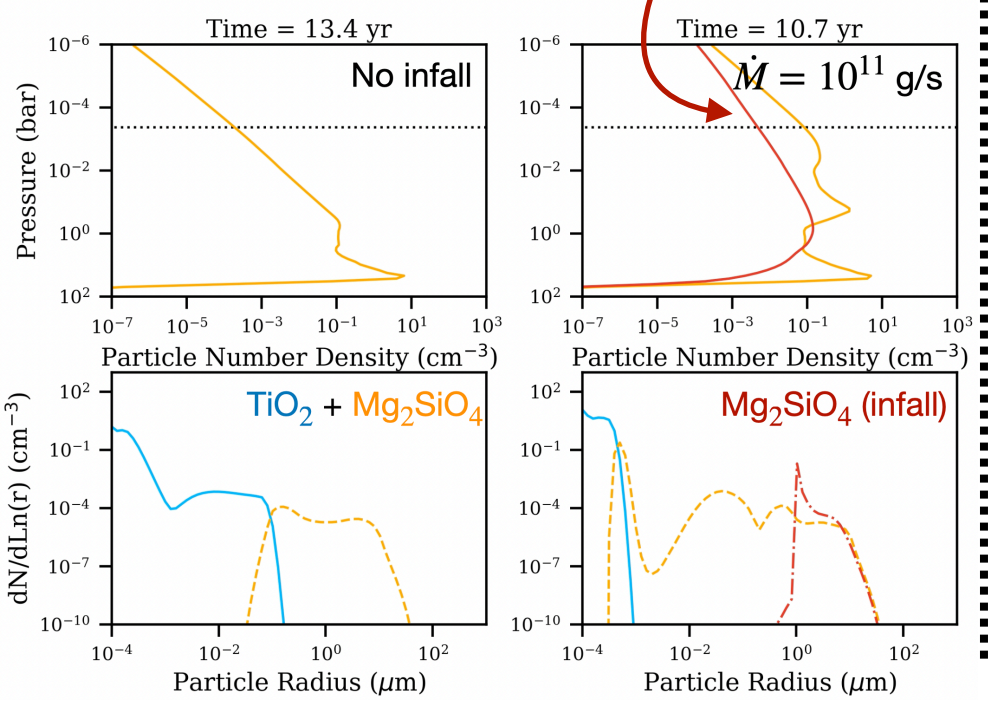
- **PICASO** computes 1D pressure-temperature profiles (Batalha+19, Mukherjee+23)
- **CARMA** simulates cloud microphysics and particle evolution (Gao+18, Powell+18)

→ Mock transmission spectra with dust/cloud effects

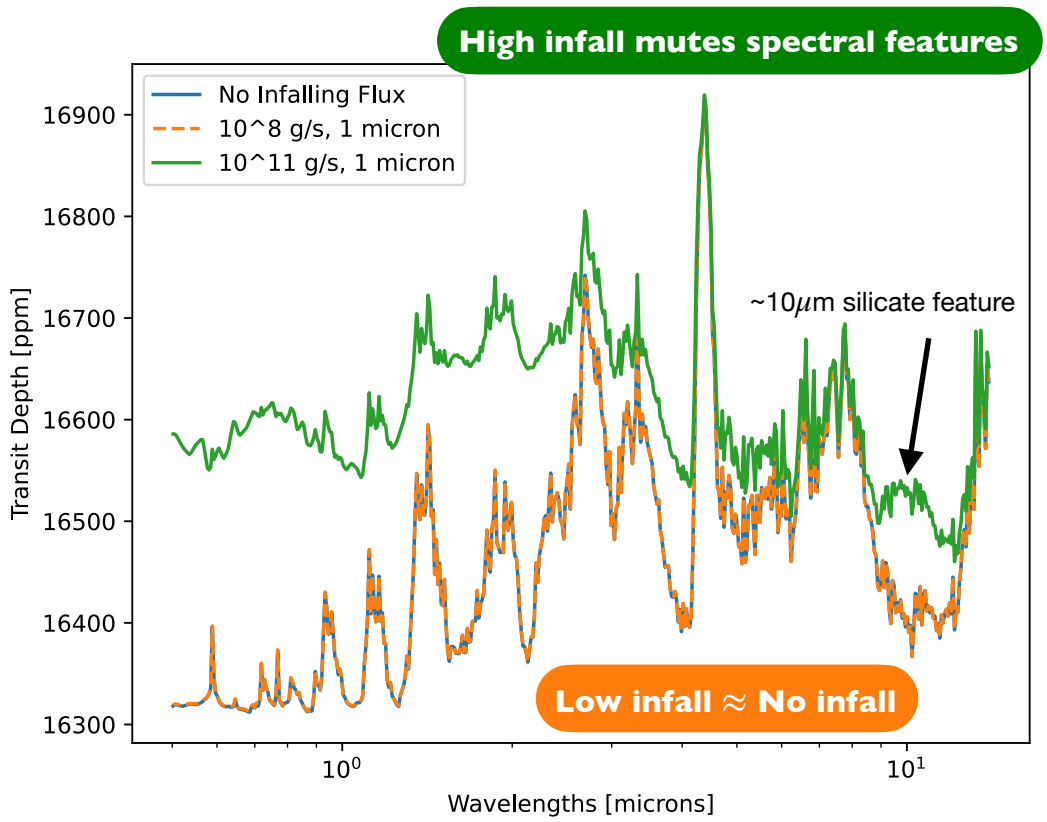


Model c shows the strongest effect

Infall forms high altitude clouds



High infall mutes spectral features



Takeaways

- **What we found:** dust infall can alter Hot Jupiter clouds
- **Why it matters:** transmission spectra muted by ~30%, if the Hot Jupiter is in a dusty system

Beyond Hot Jupiters

- For **young giant planets and brown dwarfs ($\lesssim$3 Myr)**, preliminary results suggest infalling dust can alter **emission** spectra, potentially explaining reddening
- Future studies could examine **more detailed infall scenarios**, including accretion heating, spatial deposition (latitudes, longitudes), magnetic fields and 3D dynamics

Paper in prep — coming this fall

References

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