# WASP-69b's Escaping Atmosphere is Confined to a Tail Extending at Least 7 Planet Radii

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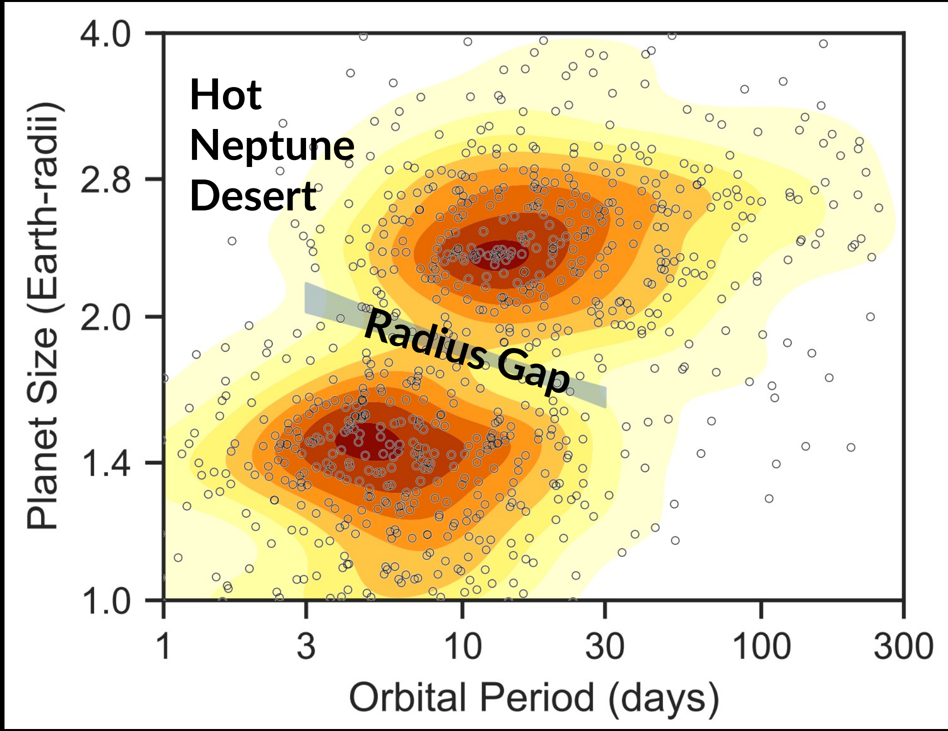
# Demographics Suggest Exoplanets Lose Mass as They Evolve

- **Most Sunlike stars host a planet between the sizes of Earth and Neptune with a period under 100 days**
- **'Hot-Neptune Desert' - Very few close-in Neptunes**
- **'Radius Gap' separates super-Earths and sub-Neptunes**

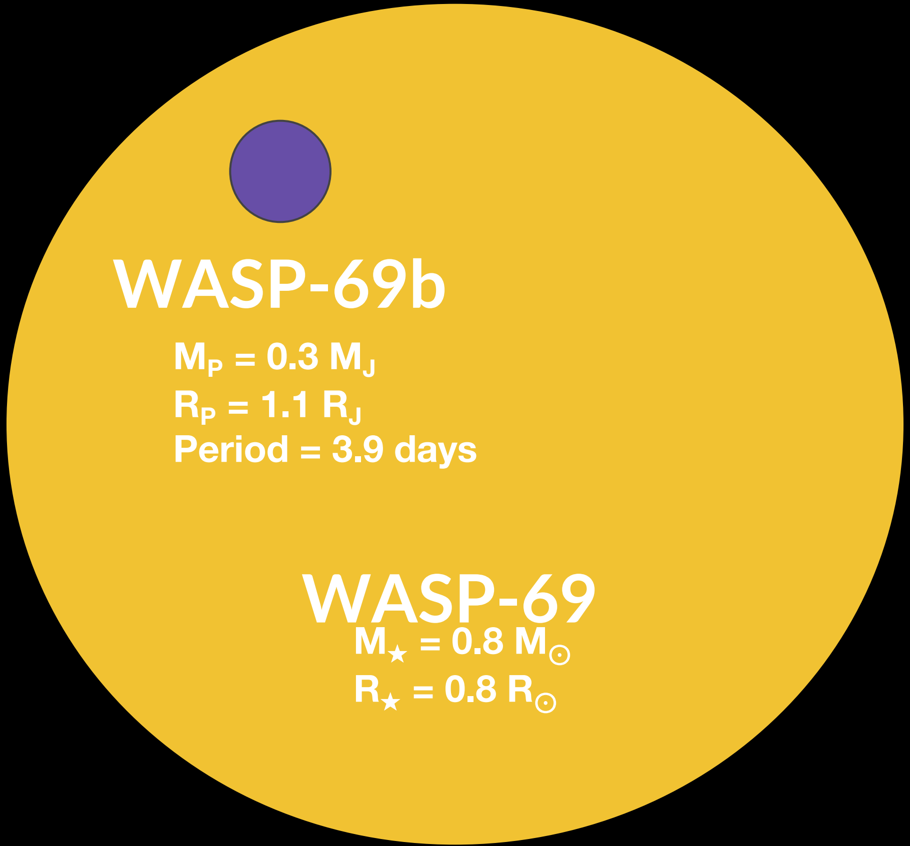



Petigura et al. 2022

# We Want to Detect This Mass-Loss in Real-Time

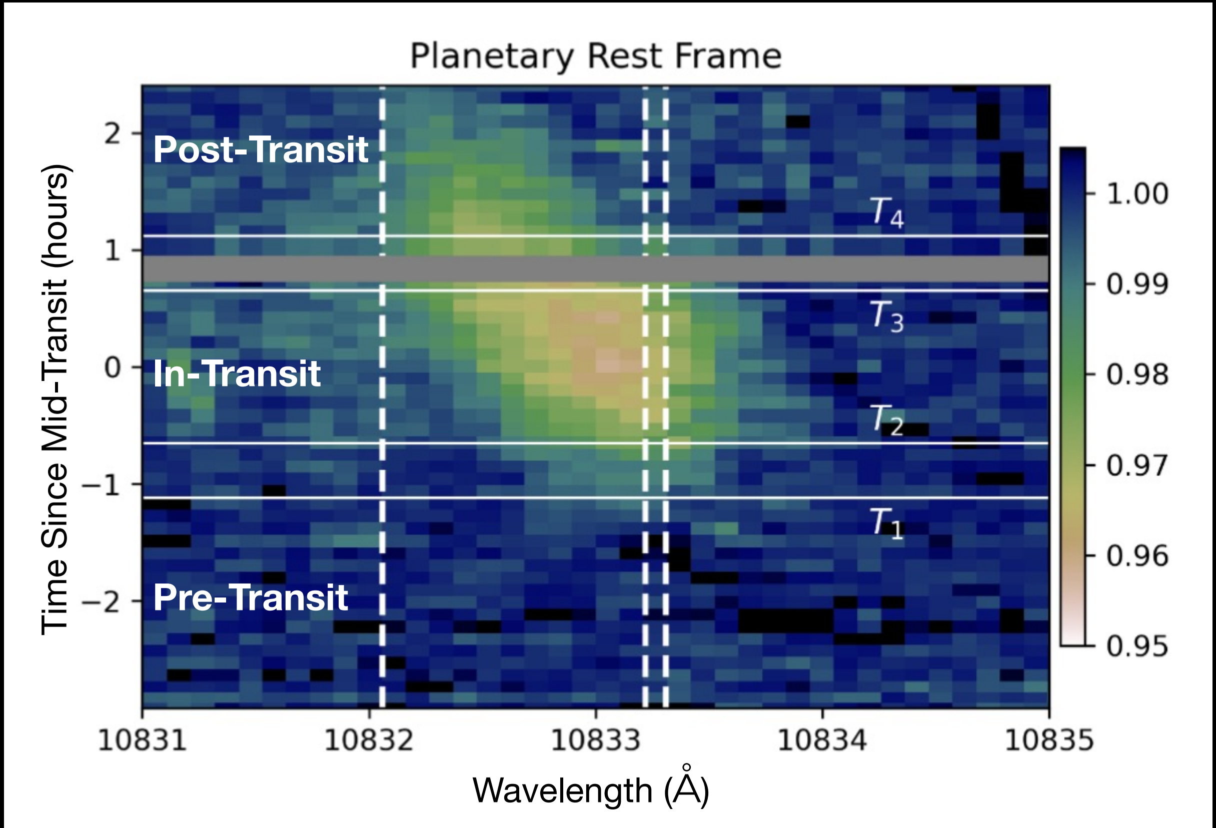
**Photoevaporation - Stars bake nearby planets, causing their atmospheres to heat up and escape**

**Hot-Jupiters are unique testbeds for observing photoevaporation**



# WASP-69b Helium Absorption

- **Strong in-transit absorption (the helium is escaping)**
- **Absorption continues post-transit for >2 hrs, accelerating at -23 km/s**
- **Mass-loss rate estimate: 1 Earth mass per Gyr**




**Tyler et al. ( 2023)**

# Interpretation – Diagram to Scale

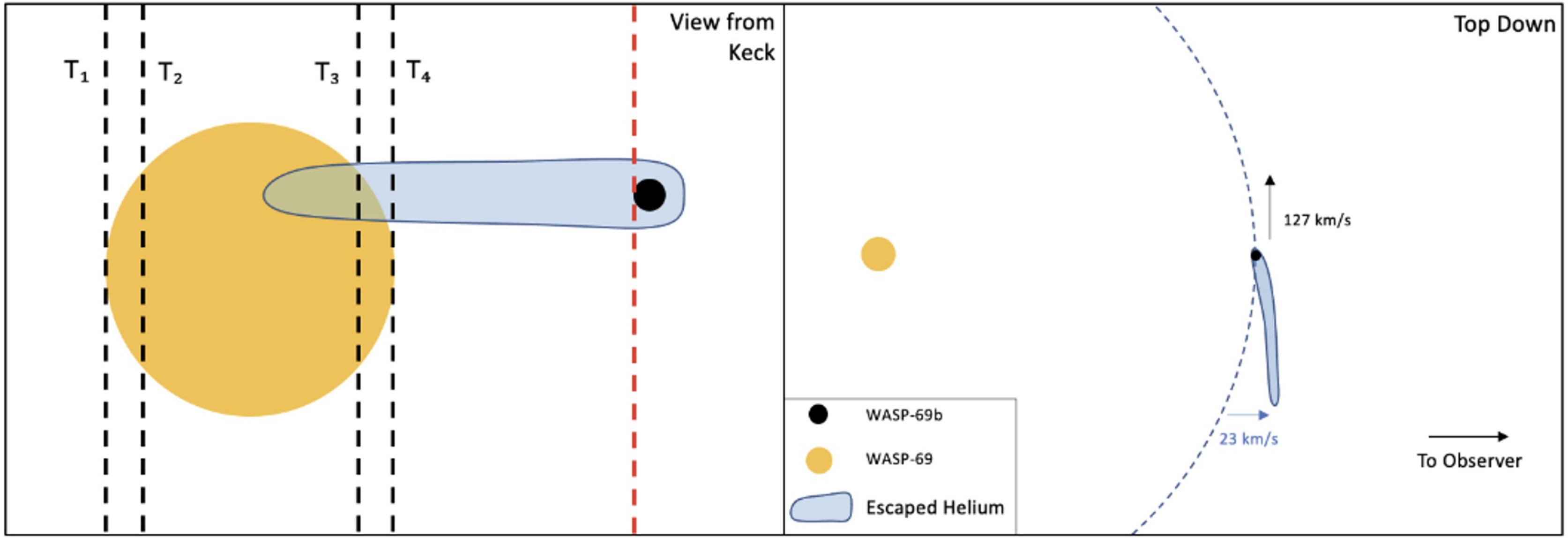



**Figure 6.** Transit chord and top down view of the WASP-69 system presented to scale. Left: Transit chord view from Keck. The four contact points, $T_1$, $T_2$, $T_3$, and $T_4$ are represented with vertical black dashed lines and the absorbing He I is light blue. The red dashed line represents the final predicted position of the planet corresponding to the last observation in the spectral time series after traveling over 7 $R_p$ (1.28 hrs) beyond the disk of the star from the perspective of the observer. Right: Top down view of the system. The He I tail can be seen accelerating towards the observer on the lower right of the panel.

Tyler et at. 2024

# Stellar Wind Shapes Planetary Outflow Into a Comet-Like Tail

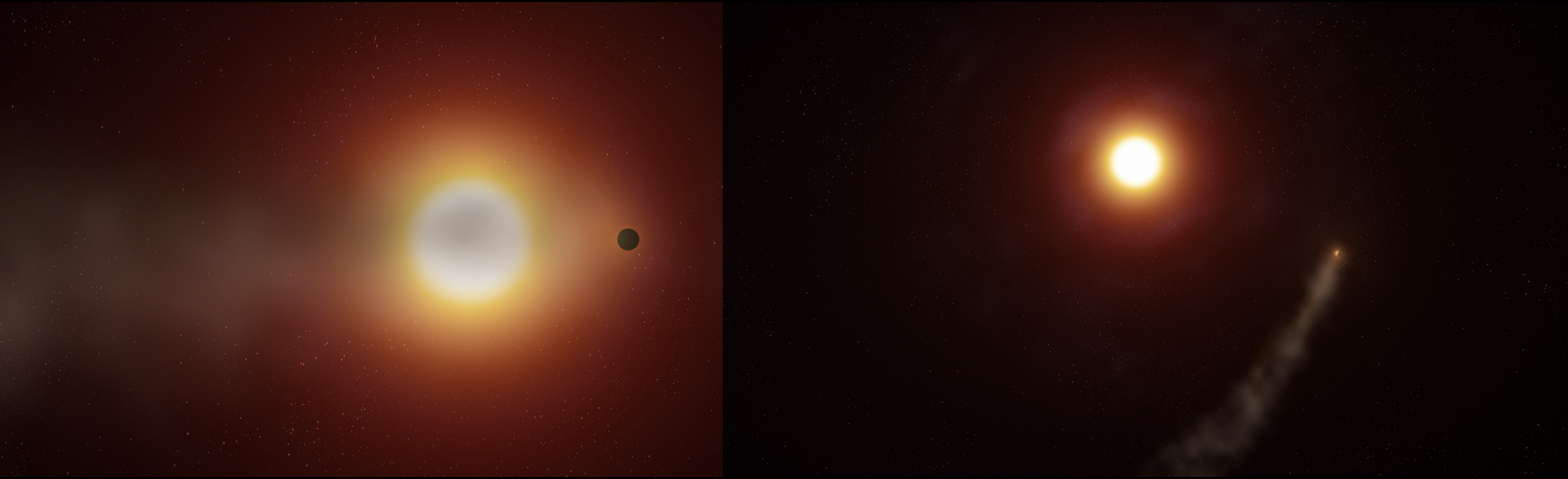
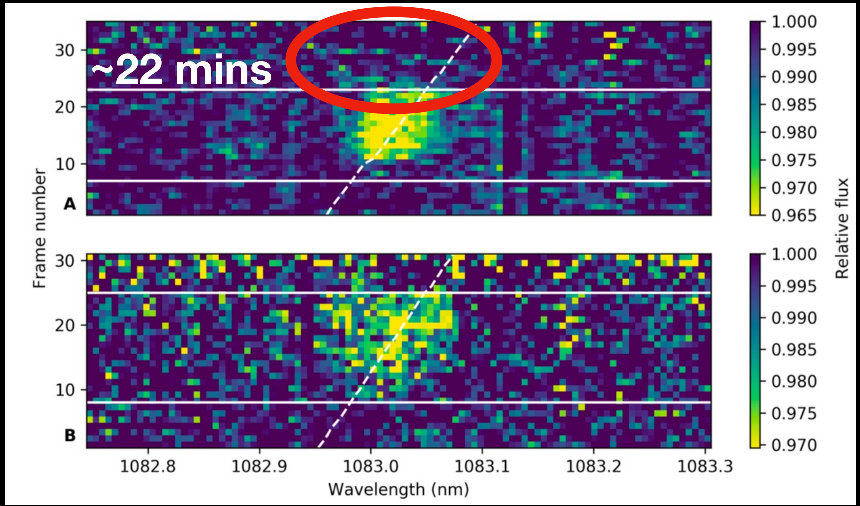


Image Credit: Adam Makarenko/W. M. Keck Observatory

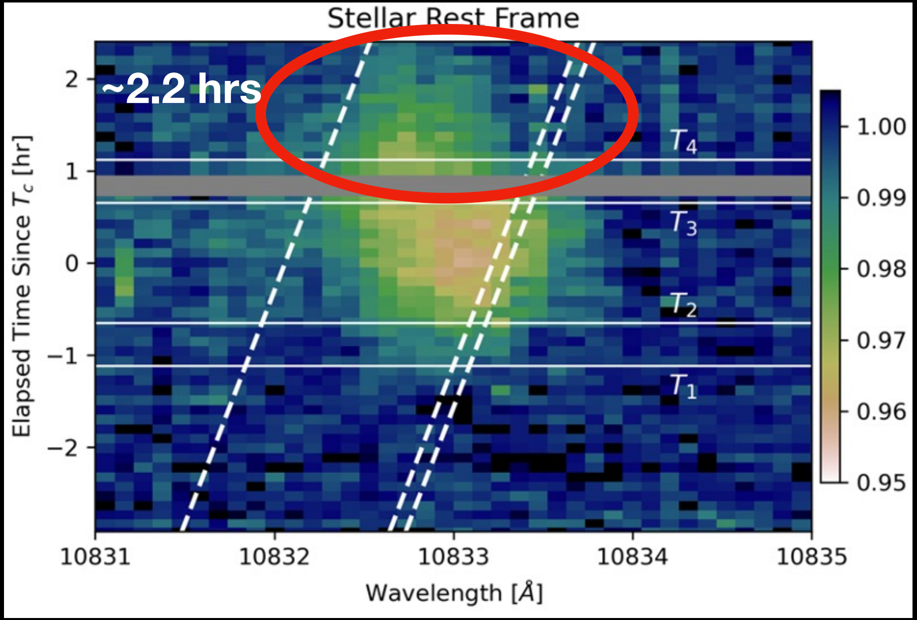
# The Tail Is Significantly Longer Than Previously Thought

**CARMENES – 3.5m telescope (previous observations)**




**Nortmann et al. 2018**

**NIRSPEC – 10m telescope (this work)**




**Tyler et al. 2023**

# WASP-69b Takeaways

- **Helium tail ≥ 7.5 planet radii**
- **Mass-loss rate of 1 Earth mass per billion years**
- **Variability likely stems from different instruments (signal-to-noise) – potential stellar variability**
- **Highlights importance of multiple observations**

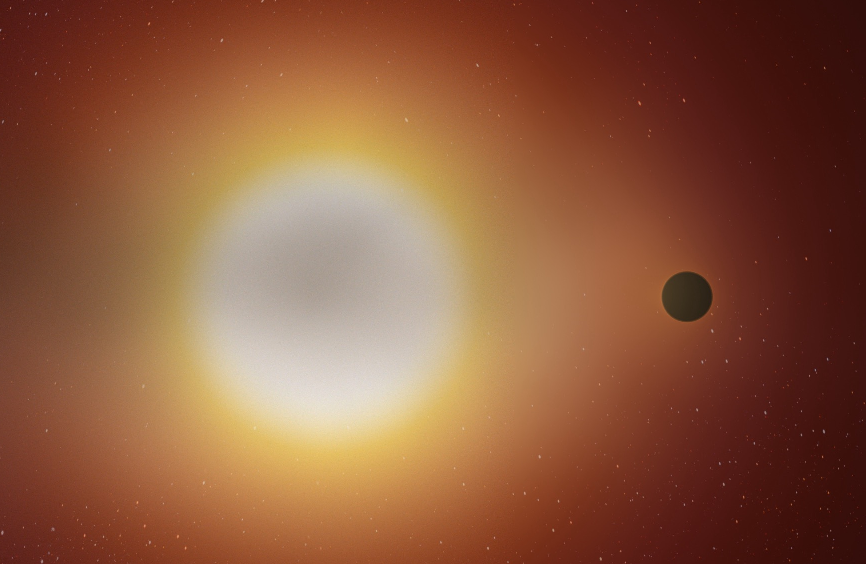


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**Image Credit**: Adam Makarenko/W. M. Keck Observatory