Transit Spectroscopy Using Medium-Band Filters with the **7-Dimensional Telescope**

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7-Dimensional Telescope (7DT)

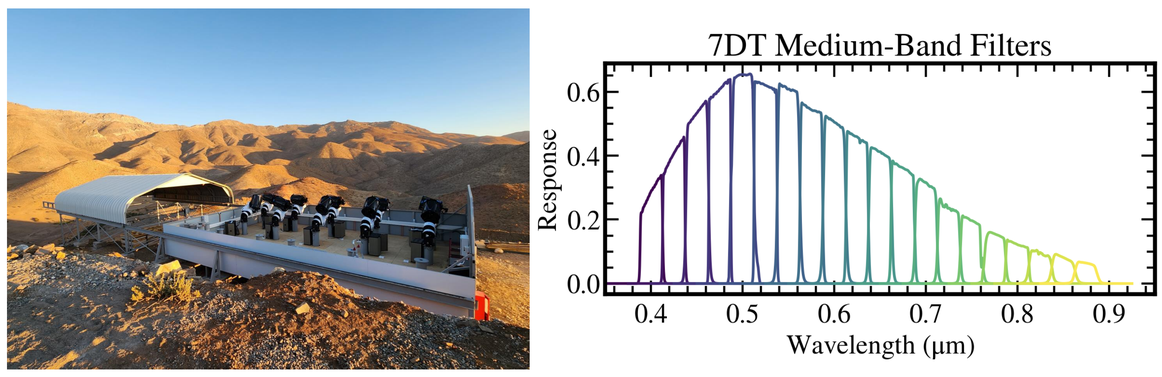
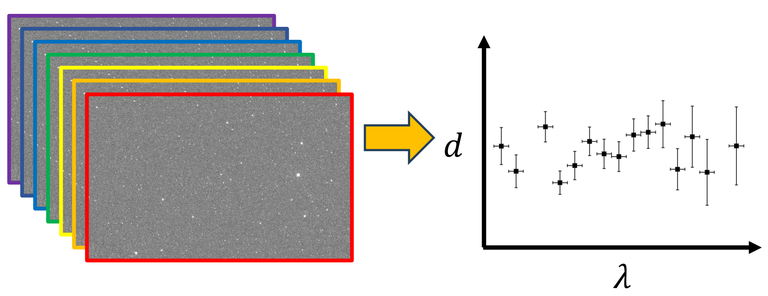


Fig 1. Left: 7DT when it was under construction. Right: 7DT medium-band filters.

- An array of **20 wide-field telescopes** with 50cm apertures (c.f. Kim et al. 2024).
- Equips **medium-band filters** ($\Delta\lambda = 25nm$) and g, r, i filters.
- Observation with 20 medium-band filters -> Similar to low-resolution IFU!

Simultaneous **transit observation with multiple telescopes** with **different filters** -> ***Transmission spectrum***

Spec mode
Each unit telescope observes a transit event using different **medium-band filters**



Color mode
Multiple unit telescopes observe a transit event using **broadband filters (g, r, and i).**

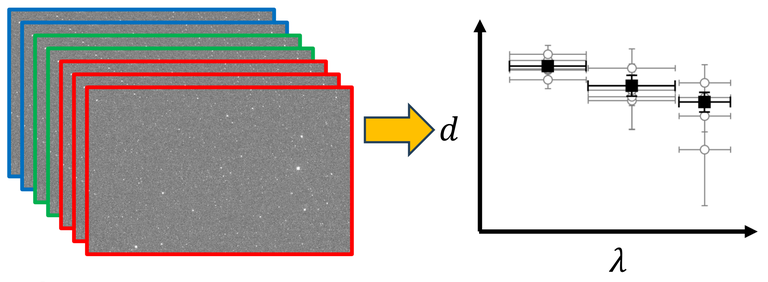


Fig 2. Observing modes of 7DT.

Validation Target: WASP-74 b

- Orbits a F9-type star with $V = 9.7$.
- A bloated hot Jupiter ($T_{eq} \sim 1900K$).
- Most of the references show consensus on **dominant scattering features** from hazes.
  -> However, the measured **scattering slopes are different!**

Observation & Lightcurve Fitting

- Commissioning observation conducted with ~10 telescopes.
- 2024.07.02: m450, m500, m550, ..., m850
- 2024.08.31: m400, m475, m525, ..., m775

- Lightcurve construction with an ensemble of reference stars.
- Lightcurve fitting with Juliet (Espinoza et al. 2019)
- Linear detrending using the airmass of each frame.

Fig 3. Examples of lightcurve fitting. We measured transit depths independently for all the observed medium-band filters.

Transmission Spectrum & Retrievals

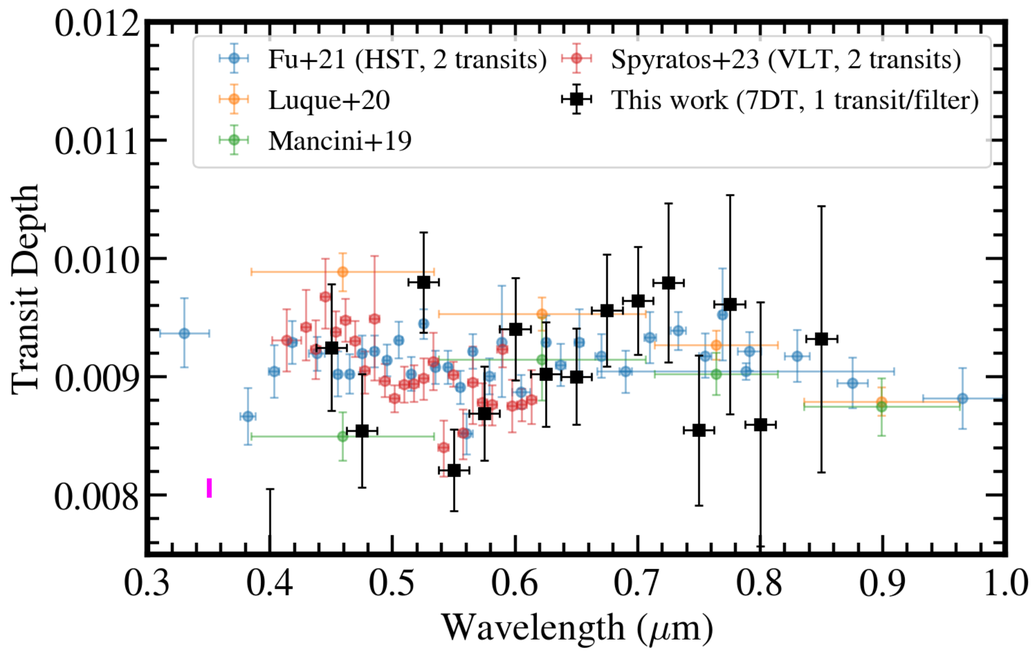


Fig 4. Transmission spectrum of WASP-74 b.

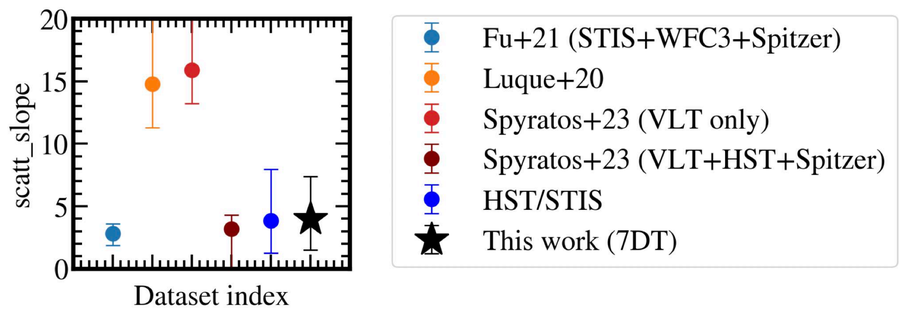


Fig 5. Scattering slopes retrieved from PLATON.

- The spectrum is **consistent** with the references!
  -> Even with one transit observation per filter.
- **Efficient and stable** transit observation.
  -> Even when some units are under significant systematic effects, we can obtain a spectrum with other units.
- **Retrieval**: using PLATON (Zhang et al. 2019; 2024).
- The scattering slope is more consistent with Fu et al. 2021.
  -> **Simple Rayleigh scattering?**

Conclusion & Plans

- 7DT can efficiently obtain a low-resolution transmission spectrum with medium-band filters.
- **Color mode** observation
  -> Robust transit spectroscopy with one visit.
  -> Self-calibratable as we measure a band with multiple units.
  -> Prospect for confirming and monitoring transit events!

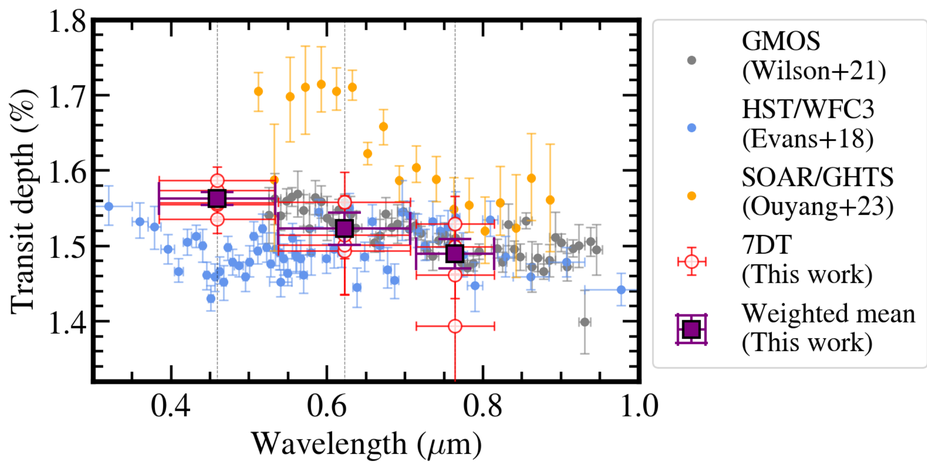


Fig 6. Transmission spectrum from color mode observation of WASP-121 b.

We welcome collaborations!

References

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