National Aeronautics and Space Administration

Commissioning Results from PARVI

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Background: The radial velocity (RV) technique via Doppler spectroscopy is the most effective demonstrated technique to measure masses of exoplanets. RVs have historically been measured at visible wavelengths where Solar type stars are brightest and rich with spectral features. The PAlomar Radial Velocity Instrument (PARVI, PI: Gautam Vasisht) measures RVs at near infrared wavelengths which provides several advantages vs. visible spectrographs.

PARVI

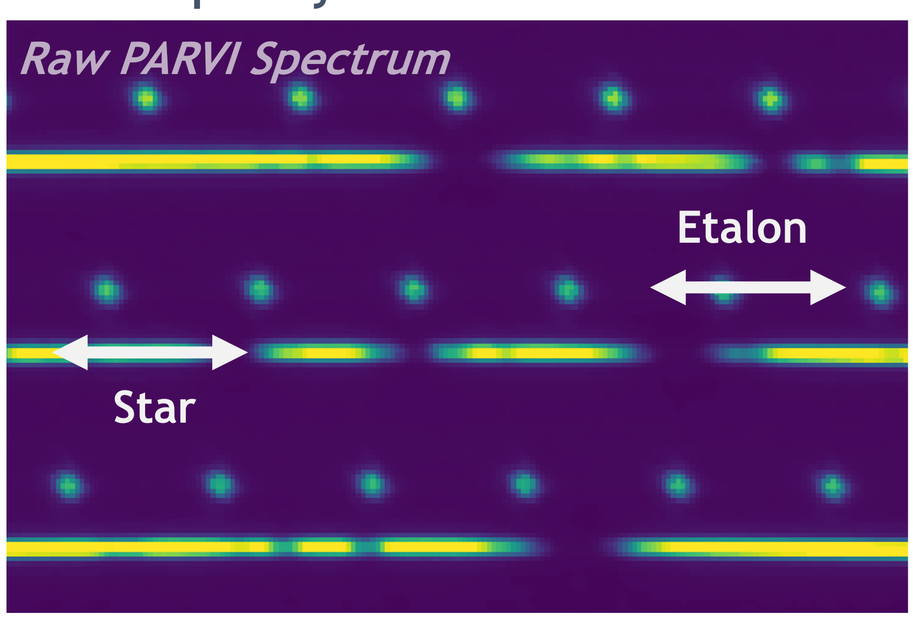
- λ ~ 1.1-1.8 μm, R=λ/Δλ~80,000
- Palomar 5 m telescope + P3K AO system
- Single-mode fibers for PSF stability & smaller instrument design

Significance to NASA:

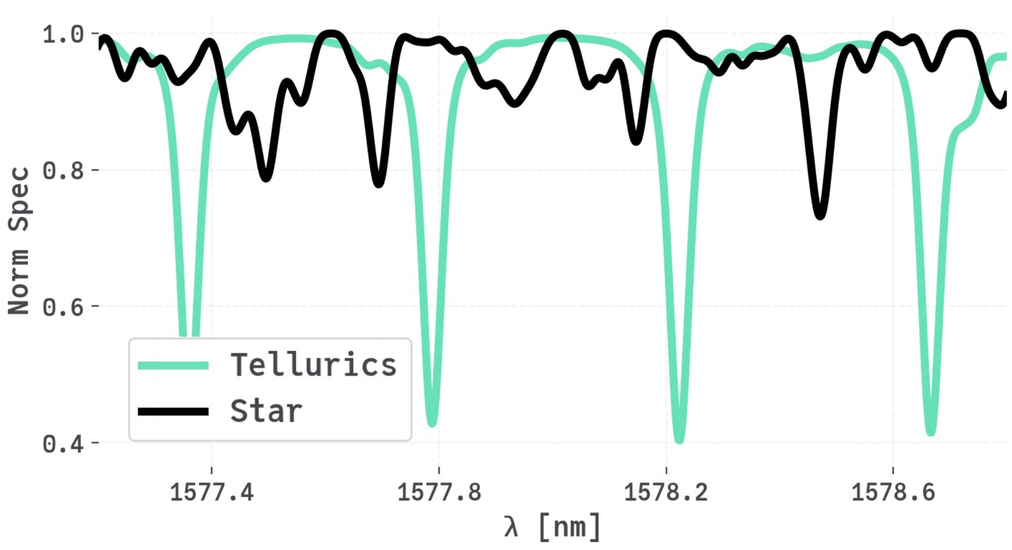
- RVs provide mass, orbital element, and ephemeris measurements for foreseeable Habitable Worlds Observatory mission targets.

Data Pipeline

- Processed in *Julia* lang for performance
- Extract spectra (2D ->1D) column by column
- Wavelength solution - *λ(pixel)* - determined by laser frequency comb + etalon

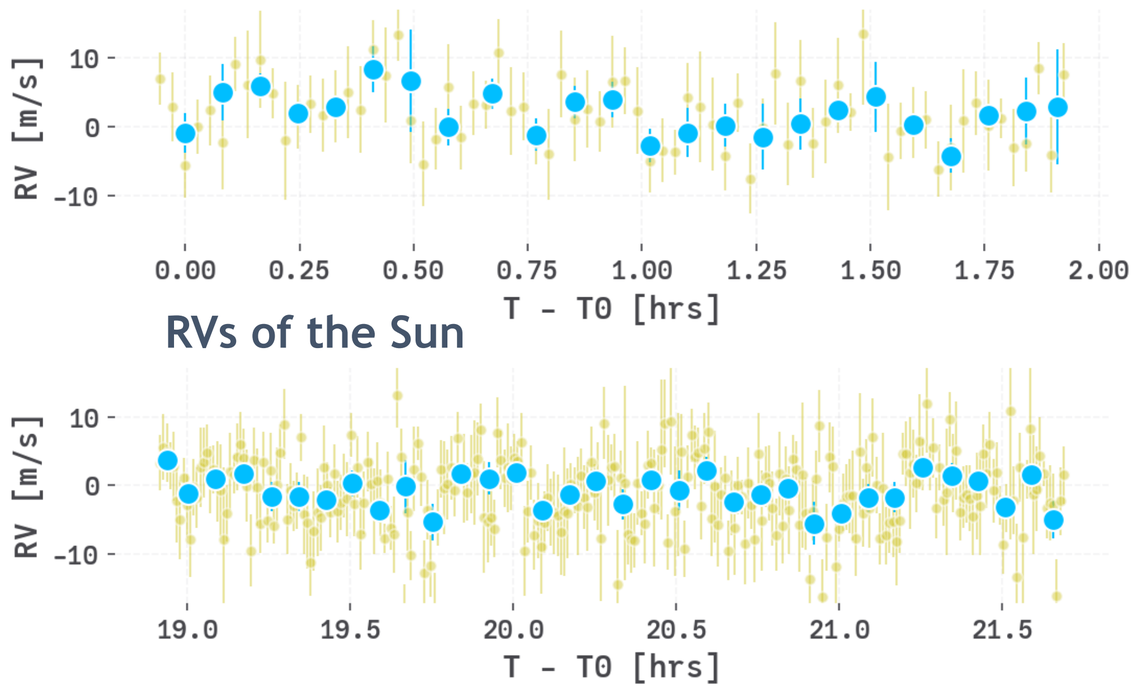


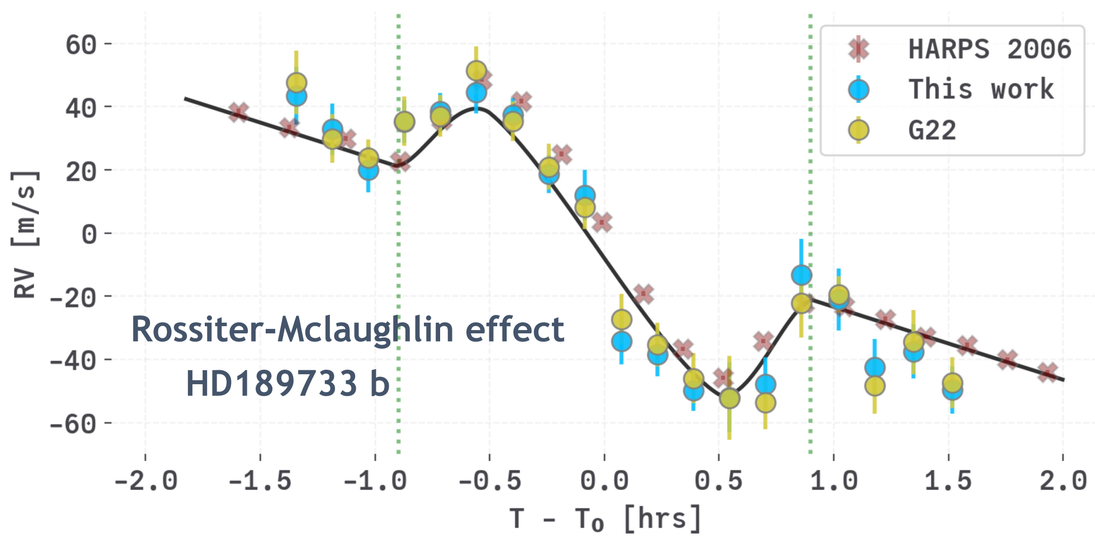
- The inaccuracy of theoretical stellar spectral models necessitates a data-driven approach to disentangle stellar from telluric features.



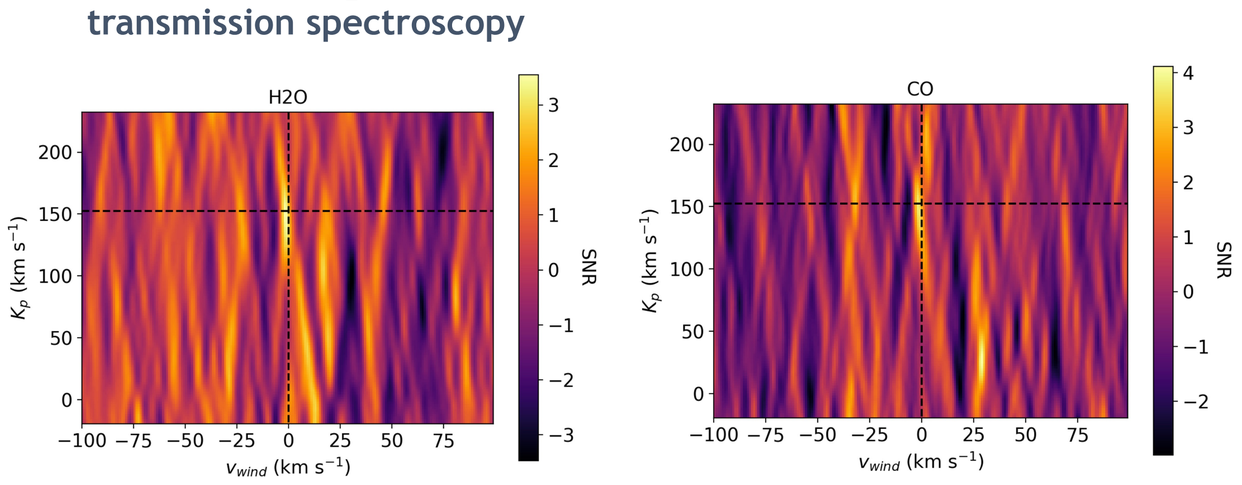
Results

- Commissioning observations focused on bright & well-studied quiescent stars.
- PARVI has demonstrated intra-night RV precision of σ~5 m/s for G, K & M stars.
- Long-term stability is subject to ability to isolate stellar spectrum from tellurics.
- *Ongoing:* Extend wavelength calibration to J-band to improve RV precision by ≳ 40%





Detections of H_2O & CO in the atmosphere of HD189733 b via transmission spectroscopy



Publications:

1. Commissioning observations of HD 189733 with the PAlomar Radial Velocity Instrument. Bryson Cale et al. 2023. JATIS.

2. Data Reduction Pipeline and Performance for the PAlomar Radial Velocity Instrument. Rose Gibson et al. 2022. JATIS.

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