

Near-Infrared Transit Explorer (NITE)

The M dwarf habitable zone Earth finder.

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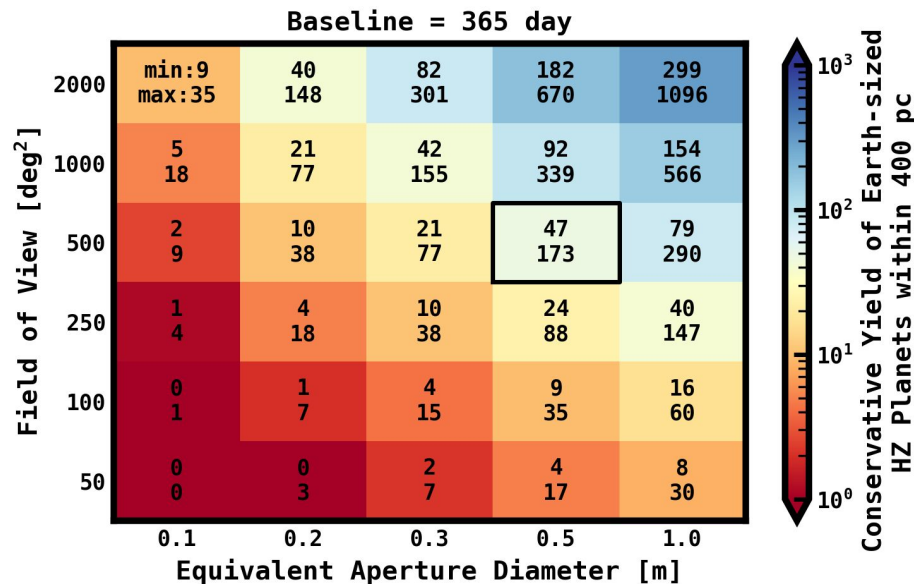
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Steven Giacalone (Caltech)
Emily Gilbert (Caltech/IPAC-NExScl)
Thomas Greene (Caltech/IPAC)
Christina Hedges (NASA GSFC)
Michelle Kunimoto (University of British Columbia)
Christopher Lam (Caltech/IPAC-NExScl)

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Stanimir Metchev (Western University)
Brandon Radzom (Penn State)
Jason Rowe (Bishop's University)
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NITE Science Motivation

- M dwarfs constitute ~70% of nearby stars.
- M dwarfs were not the focus of Kepler, and K2/TESS aren't very sensitive HZ Earths.
- There hasn't been a dedicated near-infrared transiting exoplanet survey from space.
- NITE can address several Astro2020 and ExEP Gap List questions/discovery areas, including:
 - How common are HZ Earths (eta-Earth)?
 - What are the occurrence rates of Mars to Jupiter-sized planets for all M dwarfs?
 - Do rocky planets orbiting M dwarfs have atmospheres?
- NITE can identify new HZ Earths for follow-up with upcoming facilities.

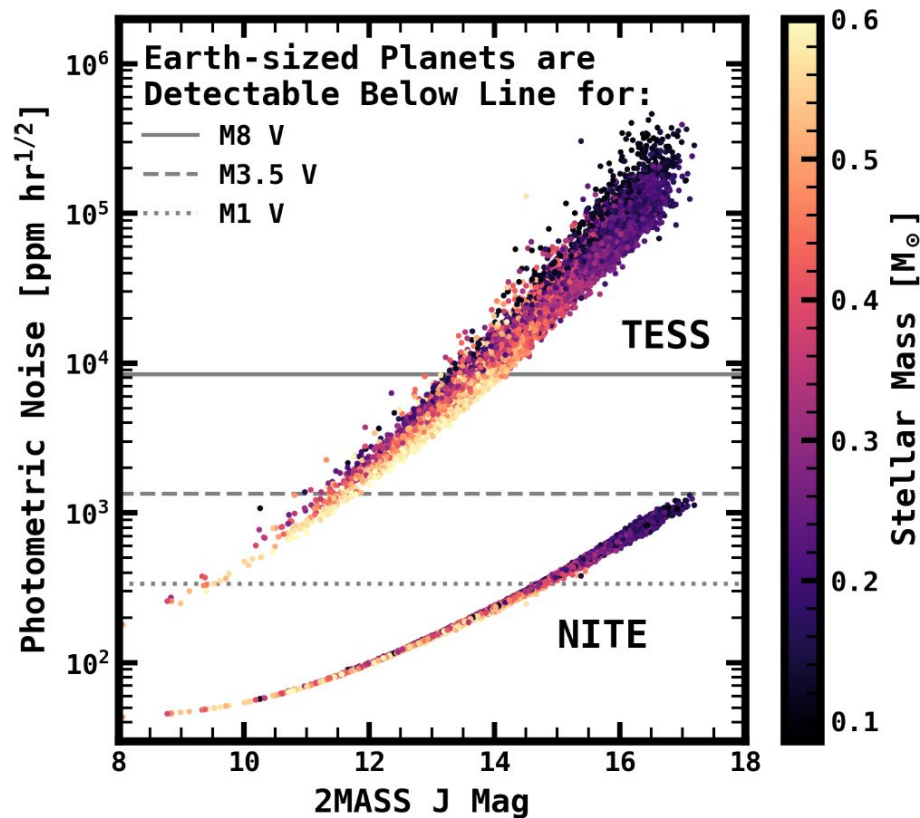
Capability needed - large field-of-view: 500 square degrees to optimize HZ Earth yield



Challenges:

- Telescope: ~0.5m f/1.0

Capability needed - large field-of-view: 500 square degrees to optimize HZ Earth yield

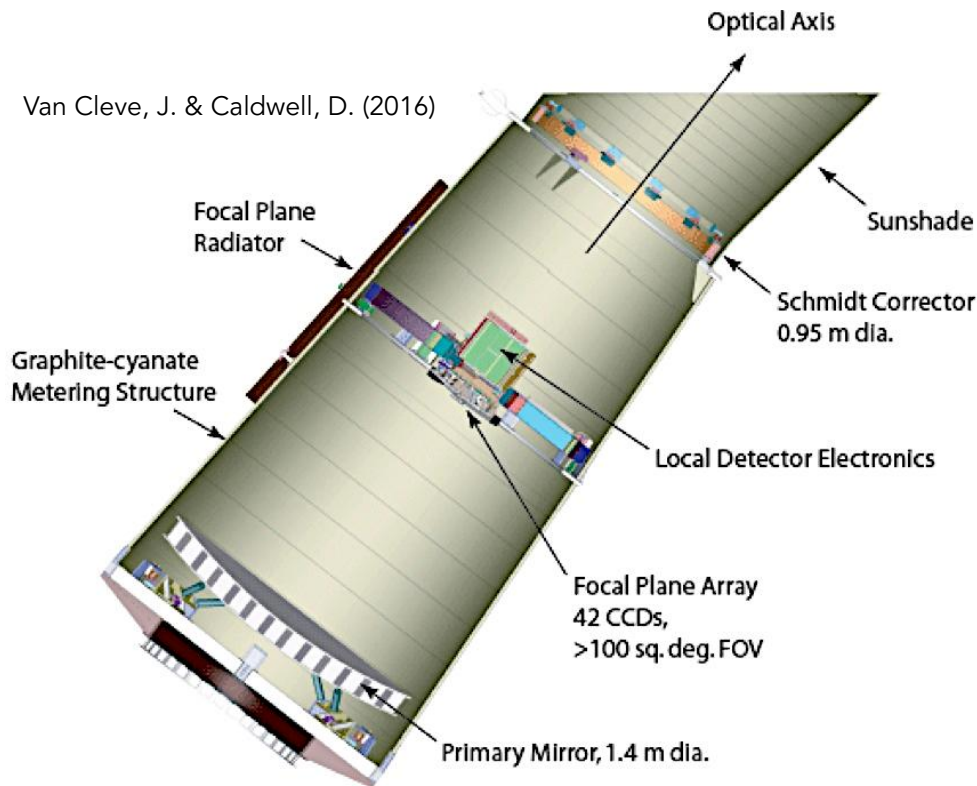


Challenges:

- Telescope: $\sim 0.5\text{m f}/1.0$
 - Saturation & diminished dynamic range for $>0.5\text{m}$

Capability needed - large field-of-view: 500 square degrees to optimize HZ Earth yield

Van Cleve, J. & Caldwell, D. (2016)



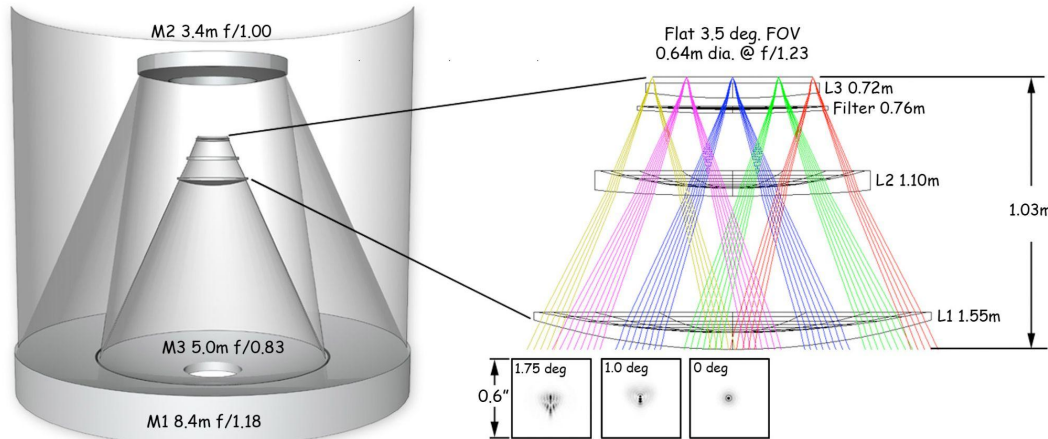
Challenges:

- Telescope: $\sim 0.5\text{m f}/1.0$
 - Saturation & diminished dynamic range for $>0.5\text{m}$
 - Kepler design: $1.4\text{m f}/1.4$, with 0.95 m corrector plate

Capability needed - large field-of-view: 500 square degrees to optimize HZ Earth yield

Challenges:

- Telescope: $\sim 0.5\text{m}$ f/1.0
 - Saturation & diminished dynamic range for $>0.5\text{m}$
 - Kepler design: 1.4m f/1.4, with 0.95 m corrector plate
 - Rubin design: 8.4m f/1.2



LSST Consortium

Capability needed - large field-of-view: 500 square degrees to optimize HZ Earth yield

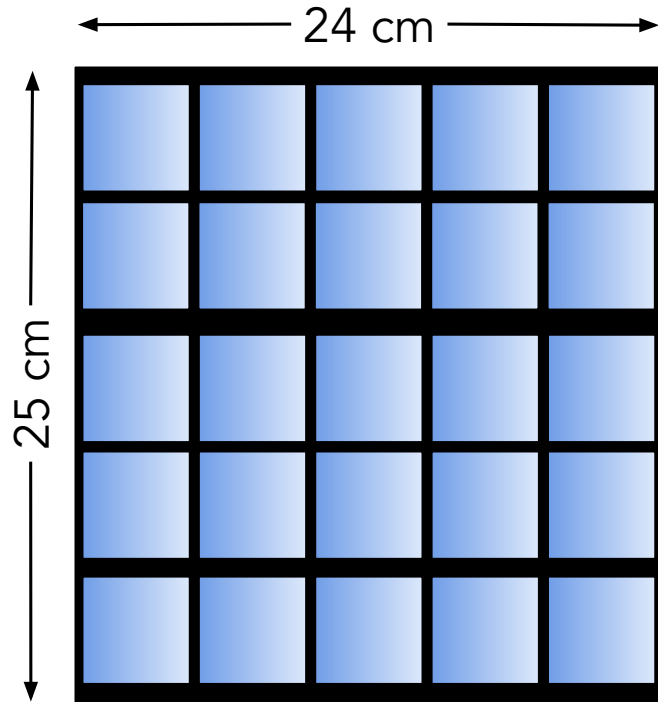


NASA

Challenges:

- Telescope: $\sim 0.5\text{m f}/1.0$
 - Saturation & diminished dynamic range for $>0.5\text{m}$
 - Kepler design: $1.4\text{m f}/1.4$, with 0.95 m corrector plate
 - Rubin design: $8.4\text{m f}/1.2$
- Detectors: 25 H4RG-10 array - Same as Roman, $\sim 4''$ pixel scale

Capability needed - high data downlink volume: Full-Frame Images and ~100,000 10x10 Cutouts

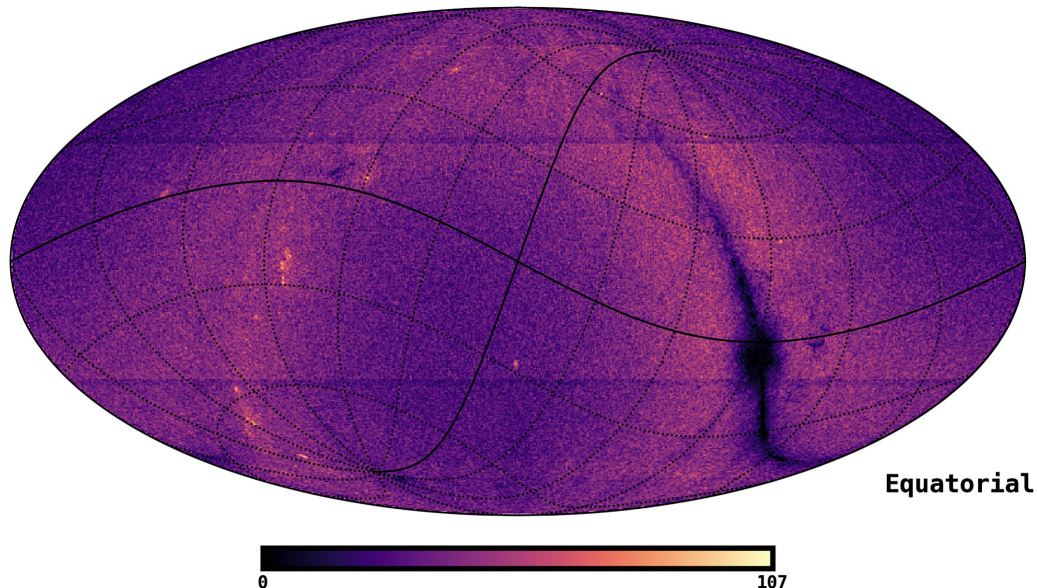


Challenges:

- High raw data volume
 - Full-Frame Images ~14TB/day
 - Cutouts ~4TB/day
 - Compression and onboard processing ~1.5TB/day
- Data transfer:
 - Deep Space Network
 - Optical lasers
 - ***Lunar Exploration Ground Sites - Artemis Infrastructure***
 - Data relay satellites
 - Data center in space

Capability needed - large field-of-regard: 5 one-year pointings

Number of Nearby (<400 pc) M Dwarfs per deg²



Challenges:

- Orbit: L2 or Earth-trailing to enable broad pointing near ecliptic poles
- Solar panels & shielding geometry: careful design to enable multiple pointings and passive cooling to provide thermal stability
- Pointing stability: ~few milliarcseconds

Multi-Bandpass or Multi-Telescope

Challenges:

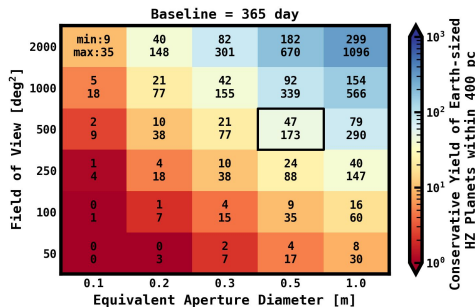
NITE	FOV (deg ²)	Bandpass(es) (μ m)	Observing Seasons (days)
Lite	500	0.9–1.8	365x5
Vision	500	0.7–0.9 0.9–1.8	365x5
Owl	500 2000	0.9–1.8	365x5 90x21

- Multi-Bandpass
 - Dichroic and second optical CCD array
 - Larger data volume
- Multi-Telescope
 - ~ 0.5 m f/0.5, $\sim 8''$ pixels

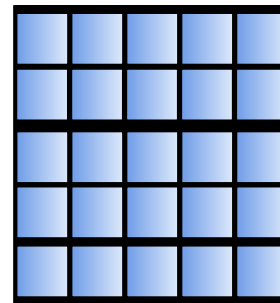
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Capabilities Needed Summary

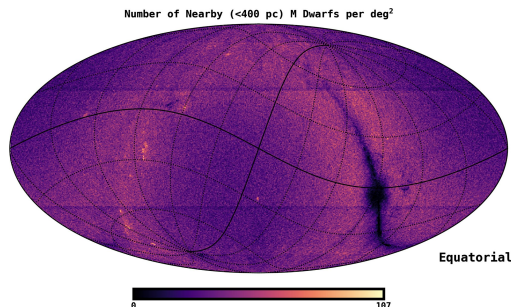
0.5m f/1.0 telescope



High data downlink volume



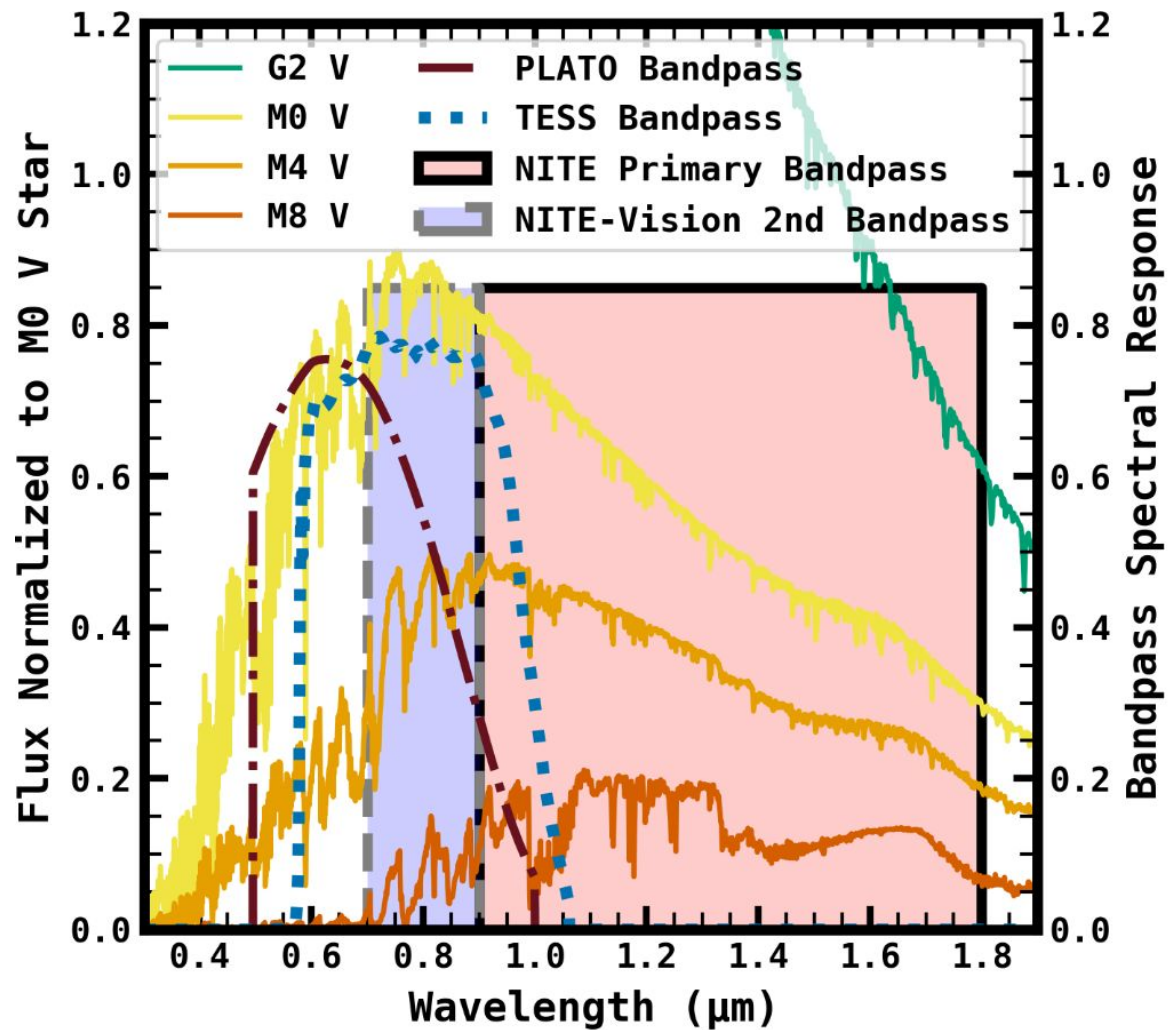
Careful design to enable large field-of-regard

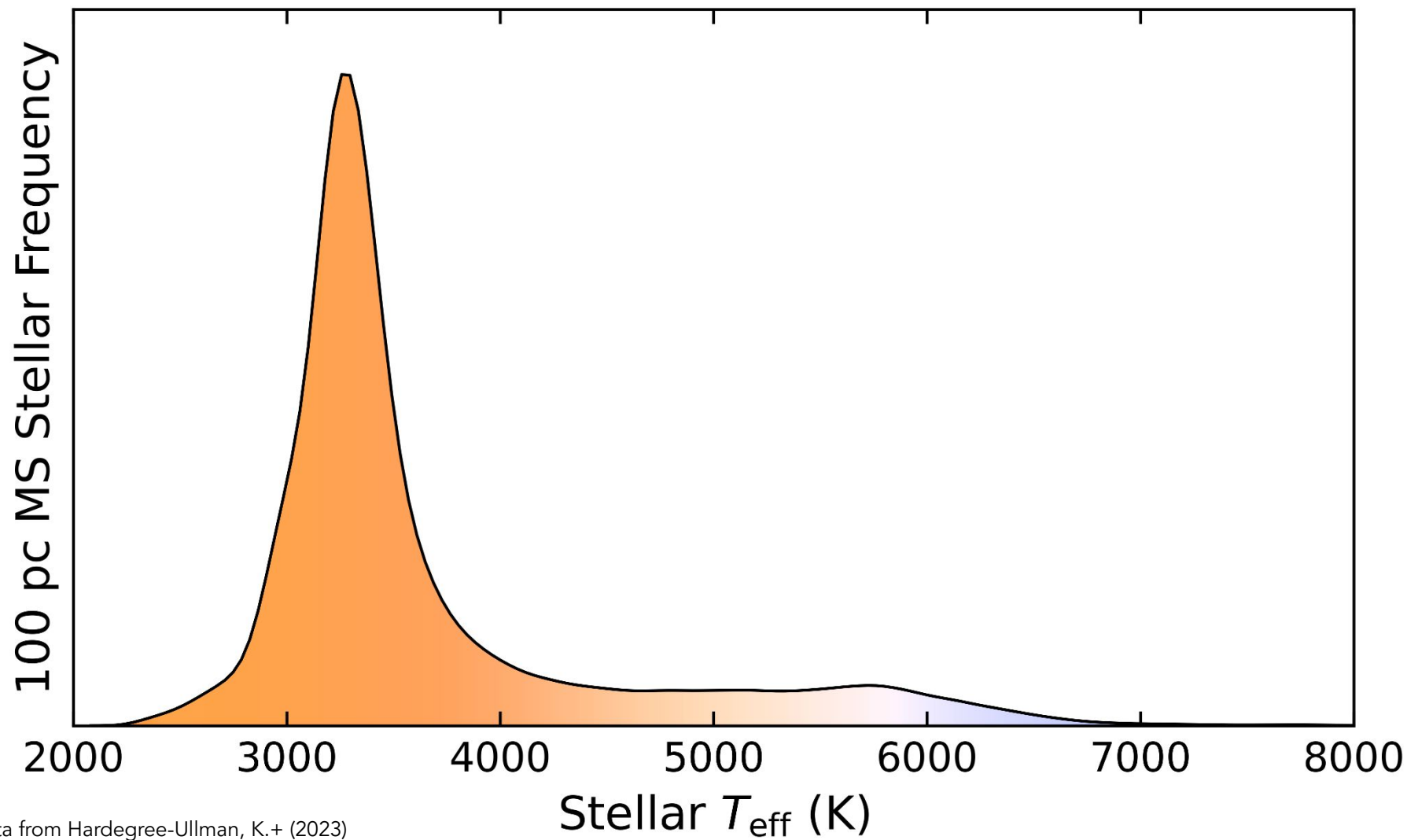


Additional optics for broader scientific impact

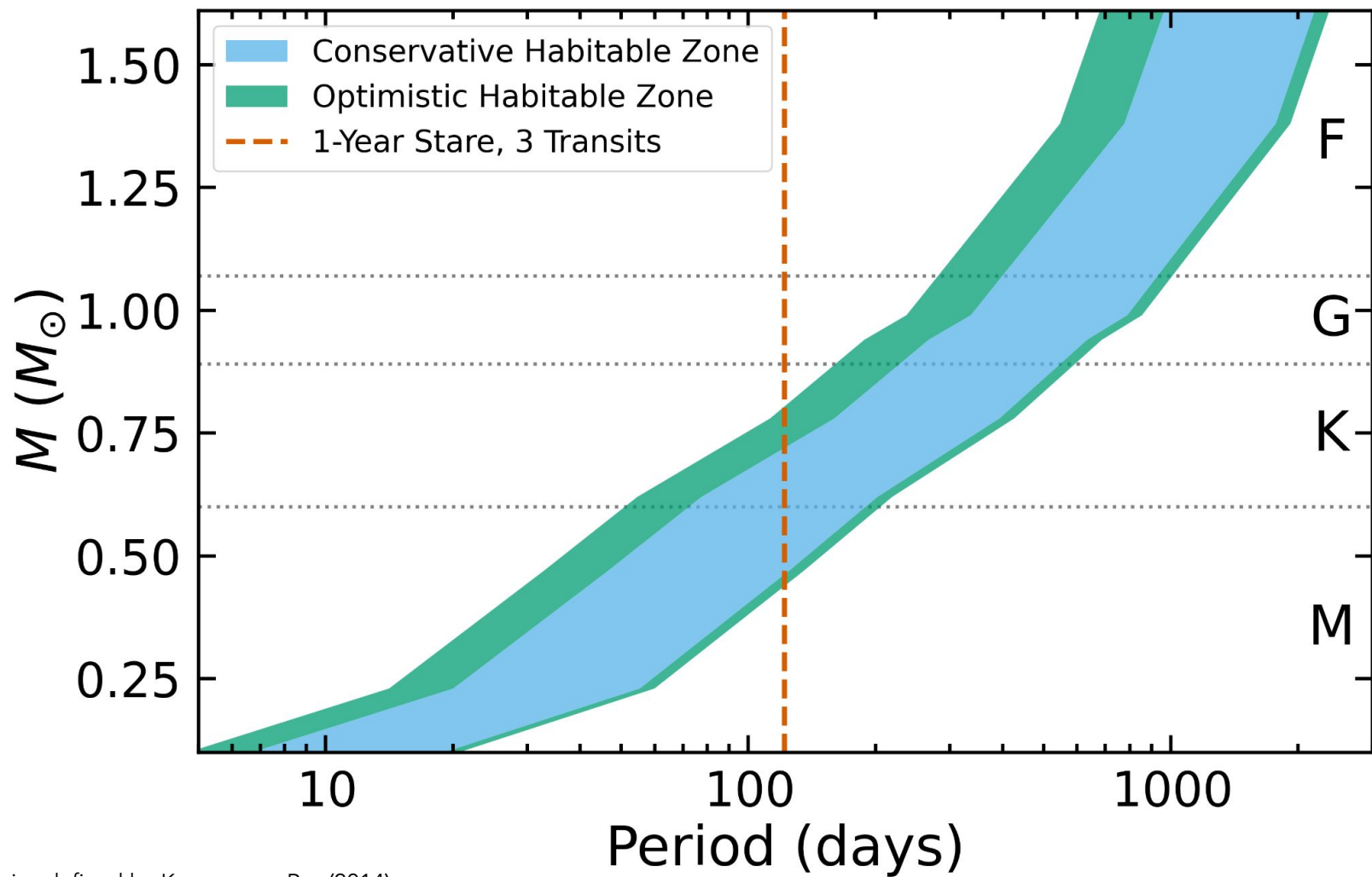
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Extra Slides

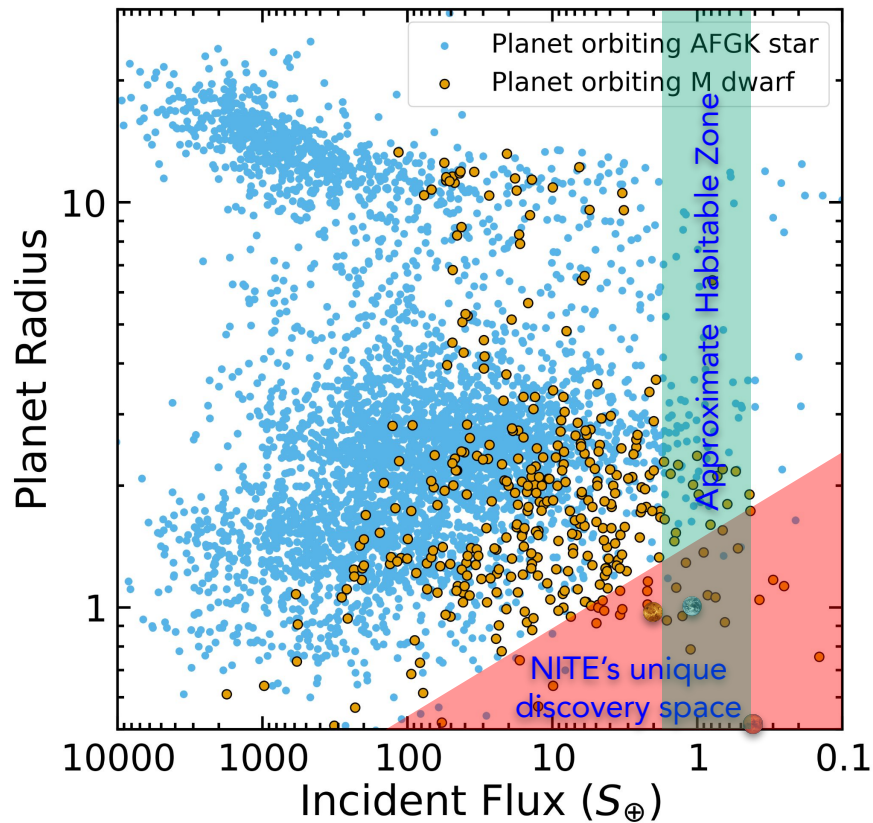
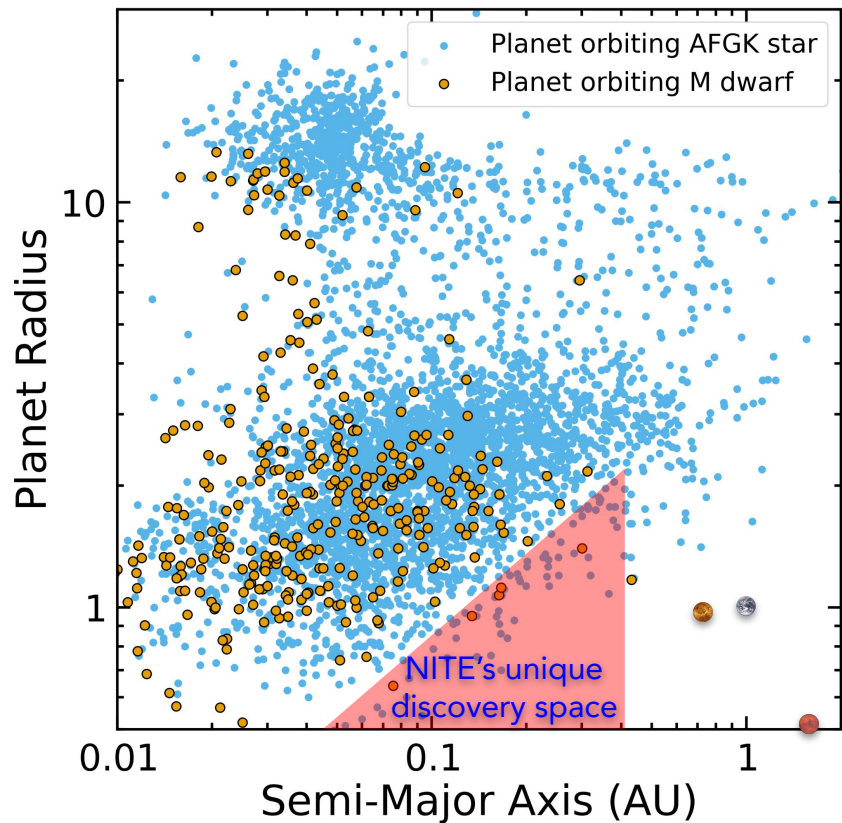




Data from Hardegree-Ullman, K.+ (2023)



NITE will fill in a critical gap in discovery space



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