Galactic Exoplanet Census wi the Roman Space Telescope

On the shoulders of giants

27 March 2026

Turin

Scott Gaudi

The Ohio State University

Roman Galactic Exoplanet Survey Project Infrastructure Team (RGES PIT)

Transits in the Roman Exoplanet Survey (TRExS) Team

HWO Community Science & Instrument Team (CSIT)

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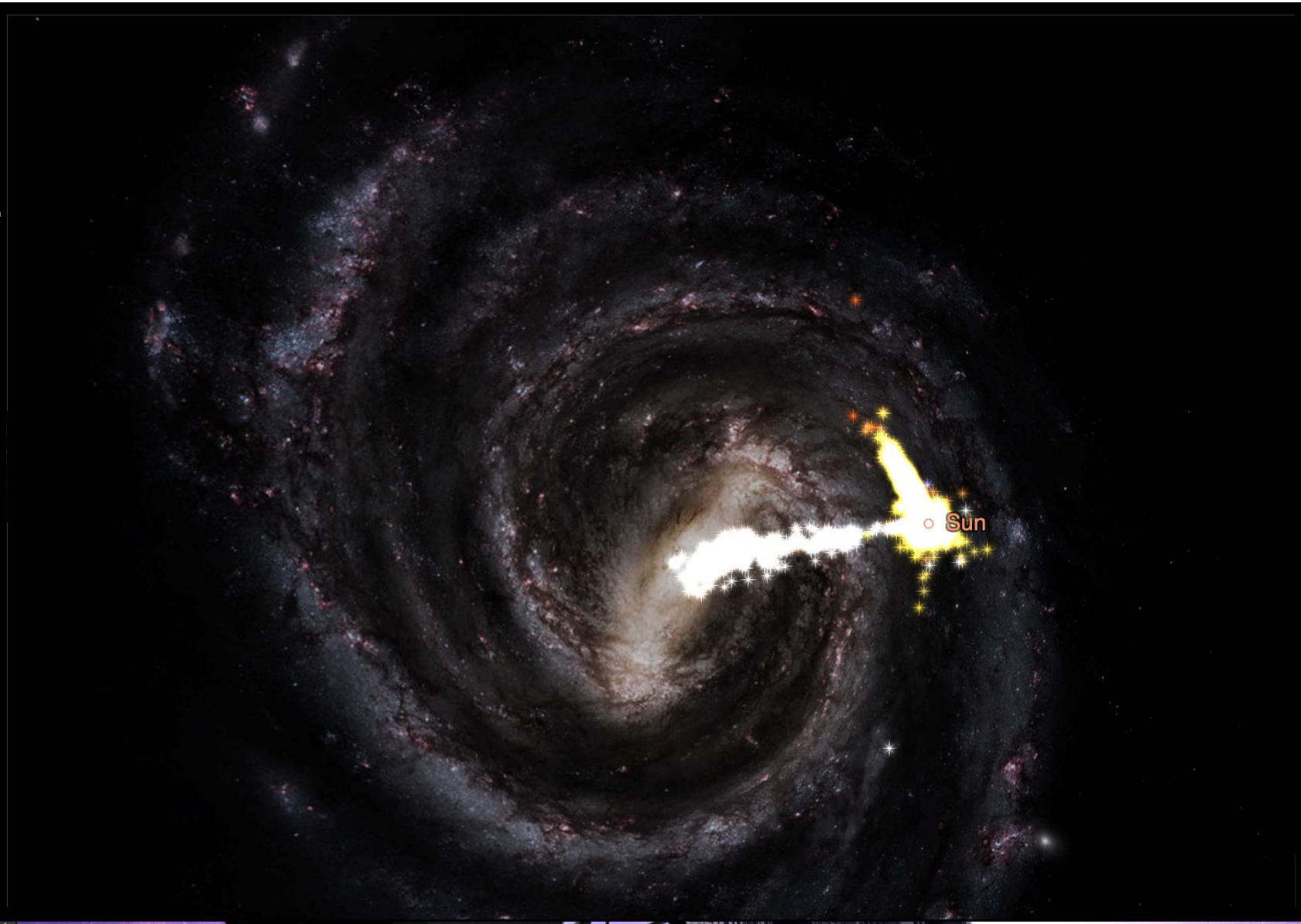

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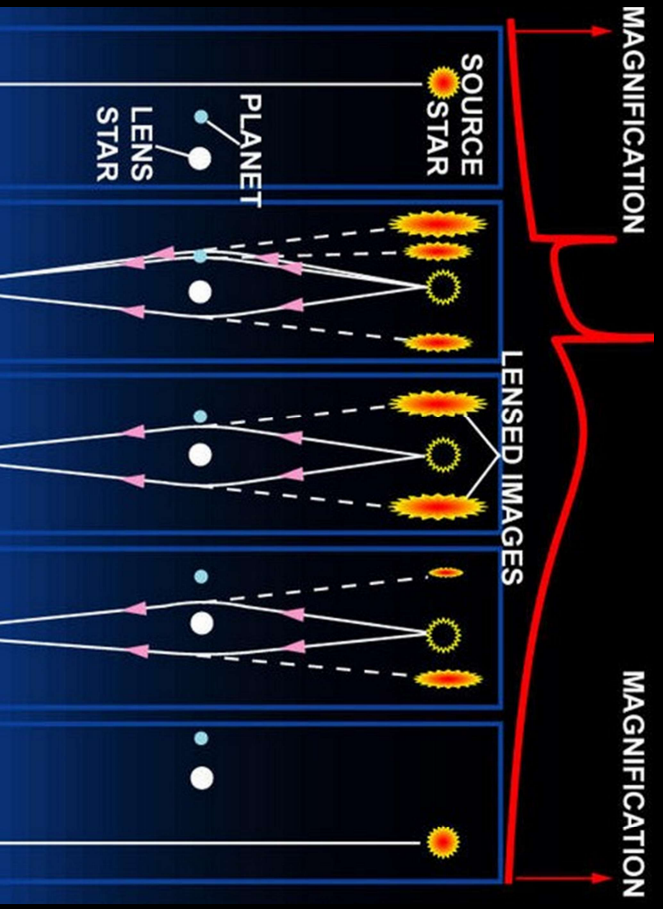
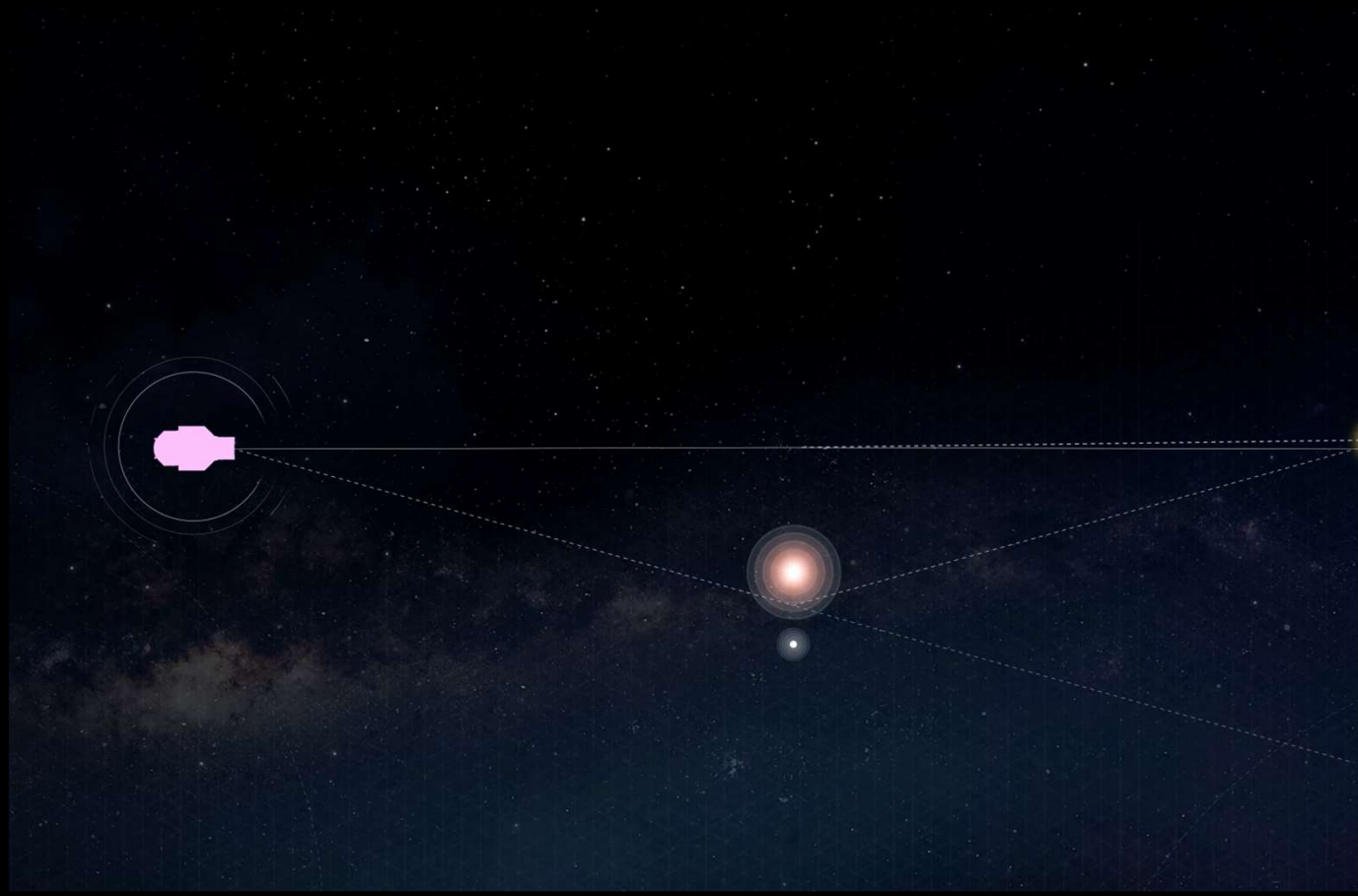
ROMAN GALACTIC
EXOPLANET
SURVEY
Project Infrastructure Team

Detecting Planets with Microlensing





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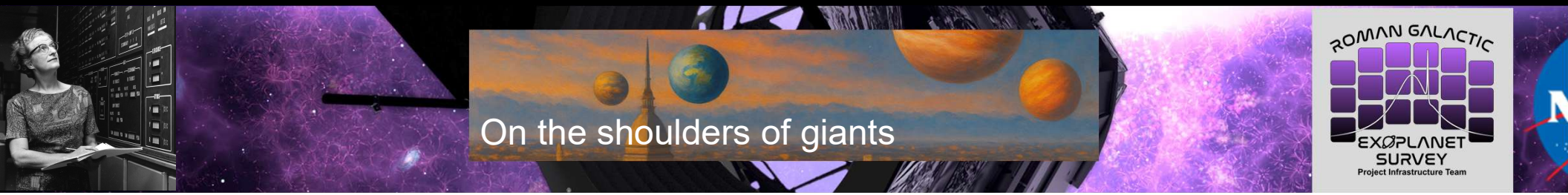
Microlensing is sensitive to:

nets beyond the snow line.
ost sensitive at ~few × a_{snow}
y low-mass planets
10% Mars.
g-period planets
cluding ice giant analogs
e range of host masses
ot just low-mass stars!
own dwarfs, FGKM MS Stars, WD, NS, BH
pical mass ~0.5 M_{Sun}
e-floating planets
>M_{Mars}

- Giant moons
  - Earth moon analogs
- Multi-planet systems
- Analogs of our solar system
- Wide circumbinary planets
- Outer habitable zone planets
- Planets throughout the Galaxy
  - 1-10 kpc
  - Thin disk, thick disk, bulge populati
  - Planet frequency vs [alpha/Fe]



ncy Grace Roman

ed as NASA's first Chief of
nomy throughout the 1960s
970s

n to many as the "Mother of
le" for her foundational role in
ing the Hubble Space
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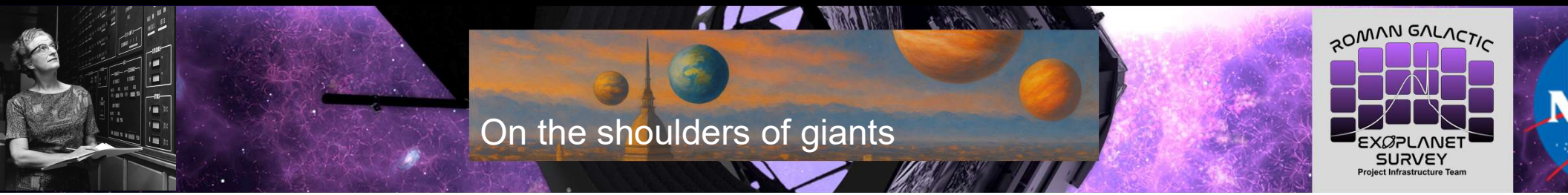
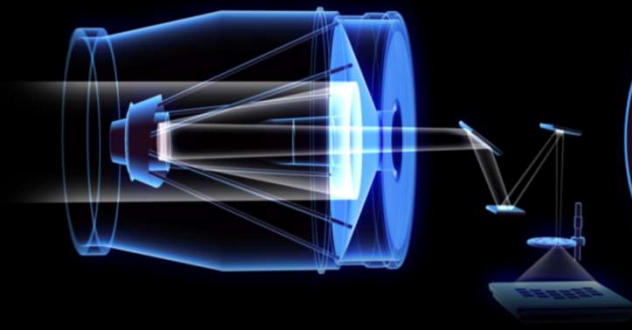


mmary of Roman Space Telescope Properties

rties	Roman
rture	2.28m
	0.281 deg^2
gths	~0.5-2 μm (WFI)
@1μm	0.10”
ze	0.11”
	Late 2026/Early 2027
	5 + 5 years
	L2

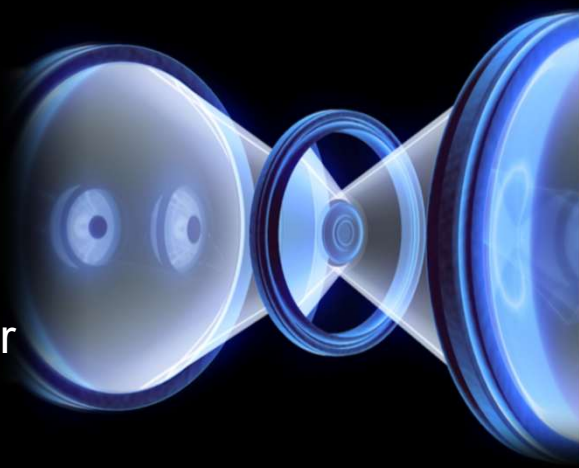
Wide-Field Instrument (WFI)

- ~0.5–2.0 micron bandpass
- 0.281 sq. deg. FoV (~100x HST ACS FoV)
- 18 H4RG detectors (288 Mpixels)
- 7 filter imaging, grism and prism spectroscopy



Coronagraph Instrument (CGI)

- Visible (545-865nm) high-contrast imager
- Polarimeter and spectrograph
- 3 types of coronagraph masks



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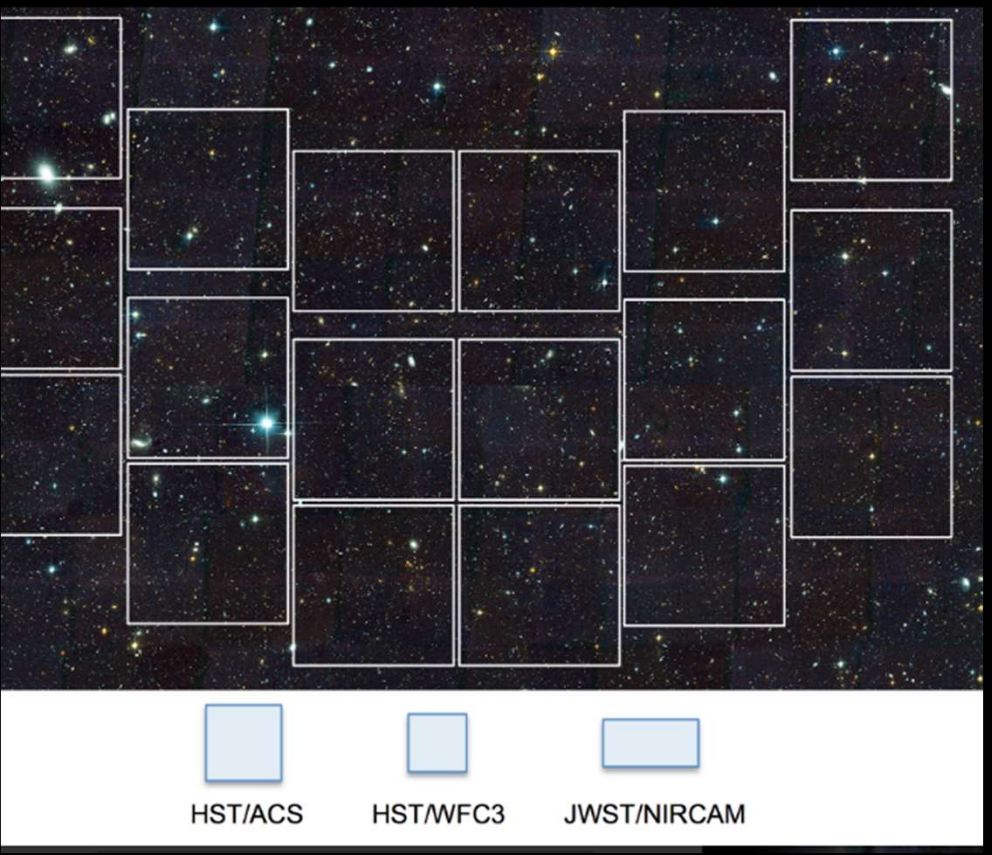
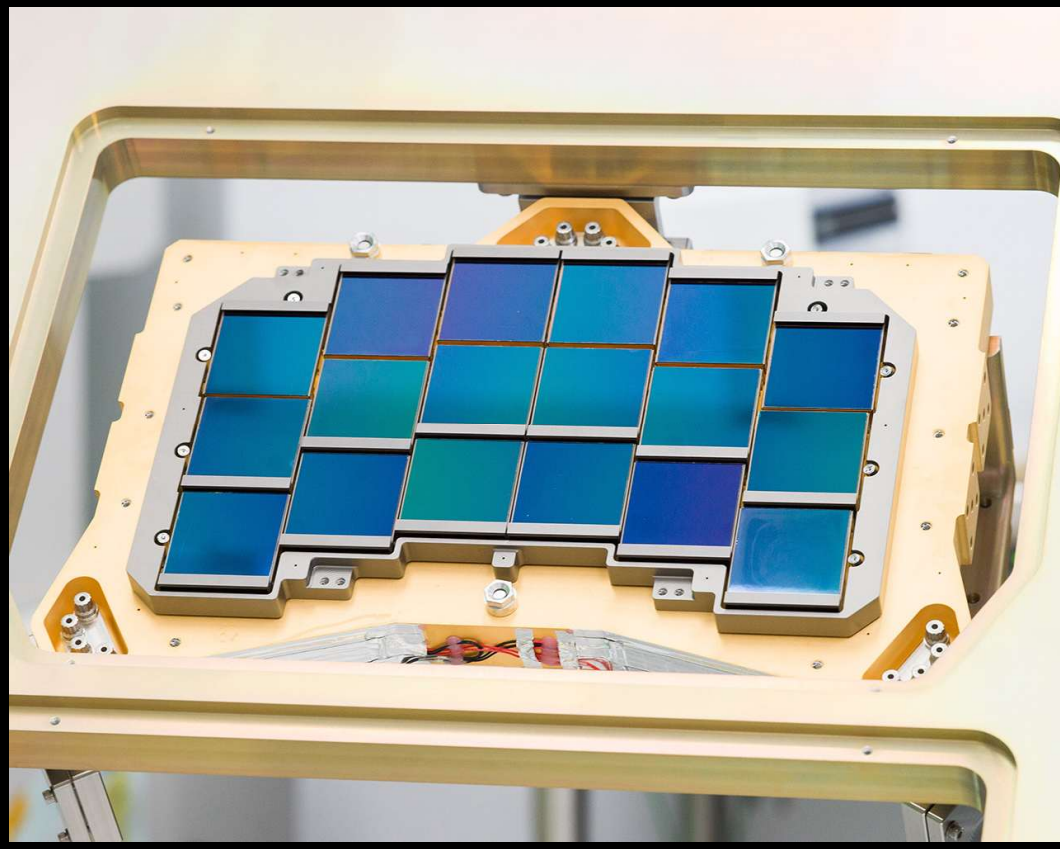
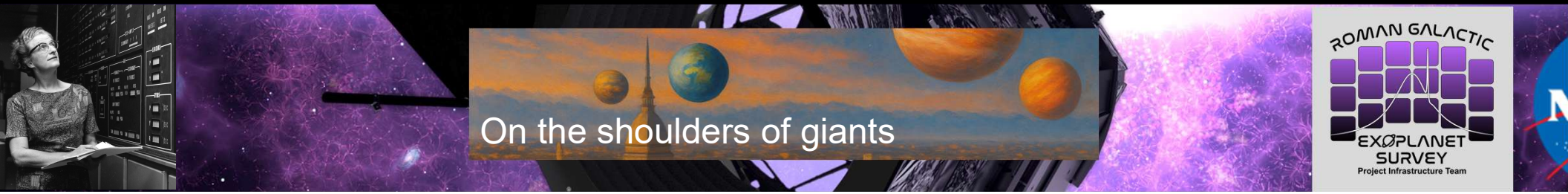
100 times the field-of-view of Hubble/JWS

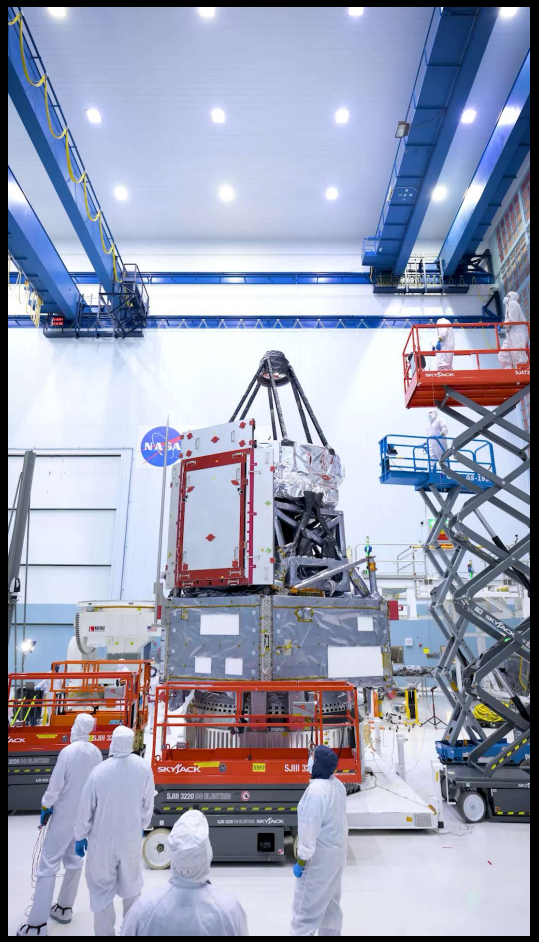




000 times the sky-mapping speed of Hub



man is complete!



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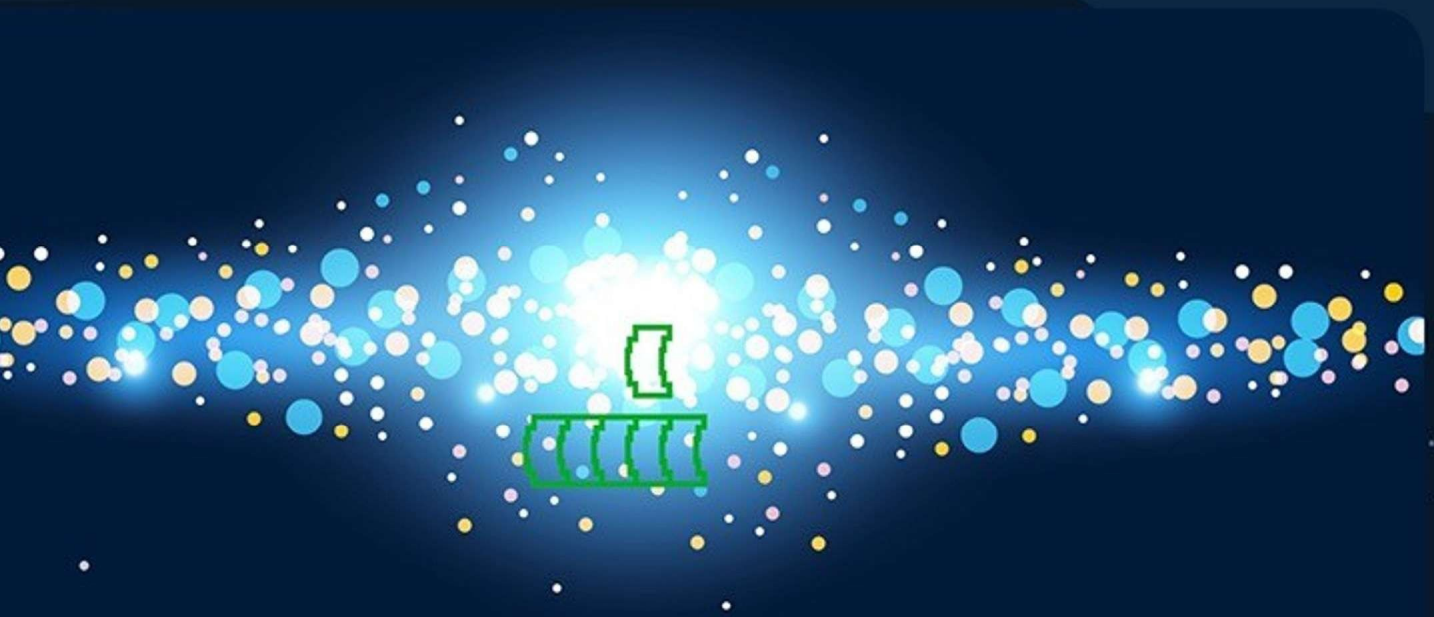
Current launch date:
no earlier than
September 7, 2026

First bulge observations
February 12, 2027

GALACTIC BULGE
TIME-DOMAIN SURVEY



The area of

8.5

full moons

Exoplanets

Transients

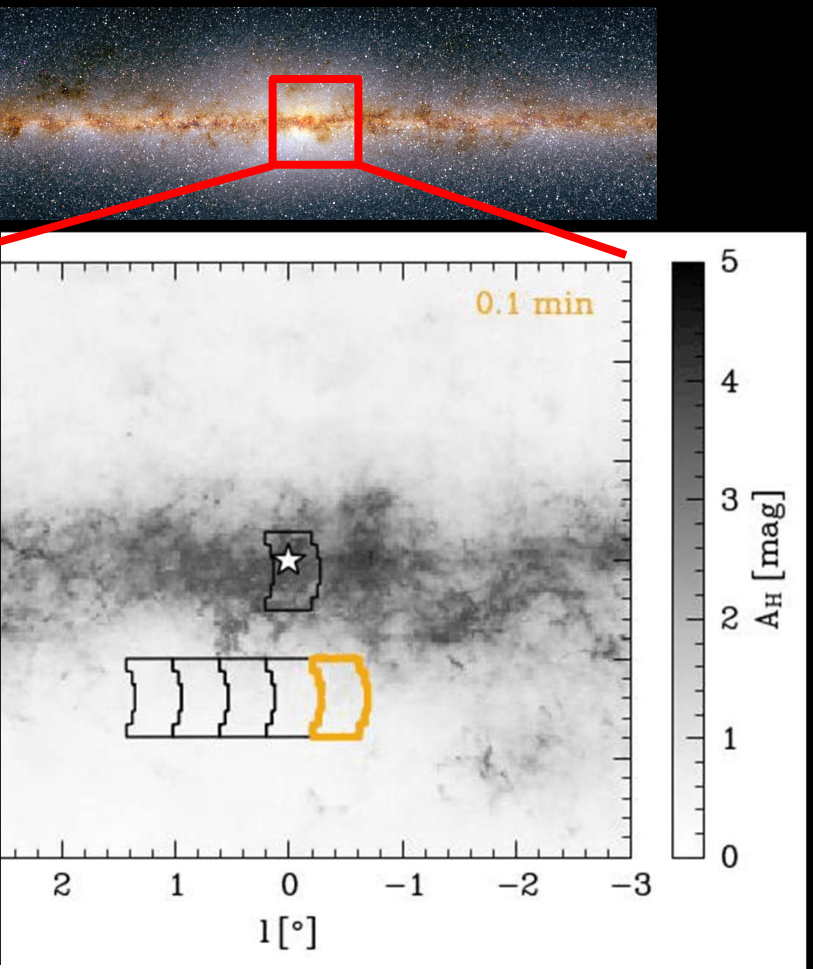
Black Holes

438 days, primarily in six sets of 72 days e

Full survey area imaged every 12 minutes

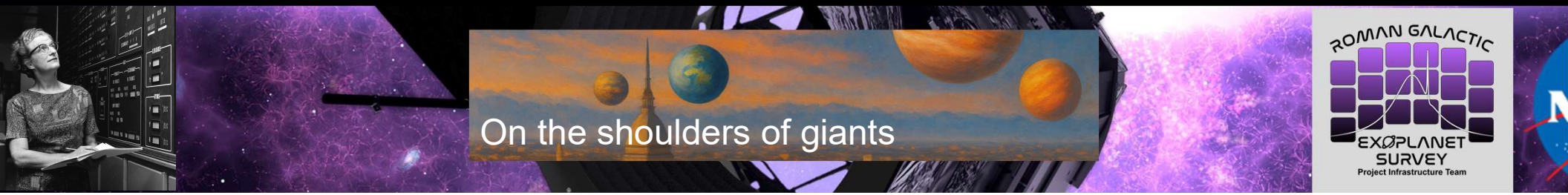
1.7 square degrees

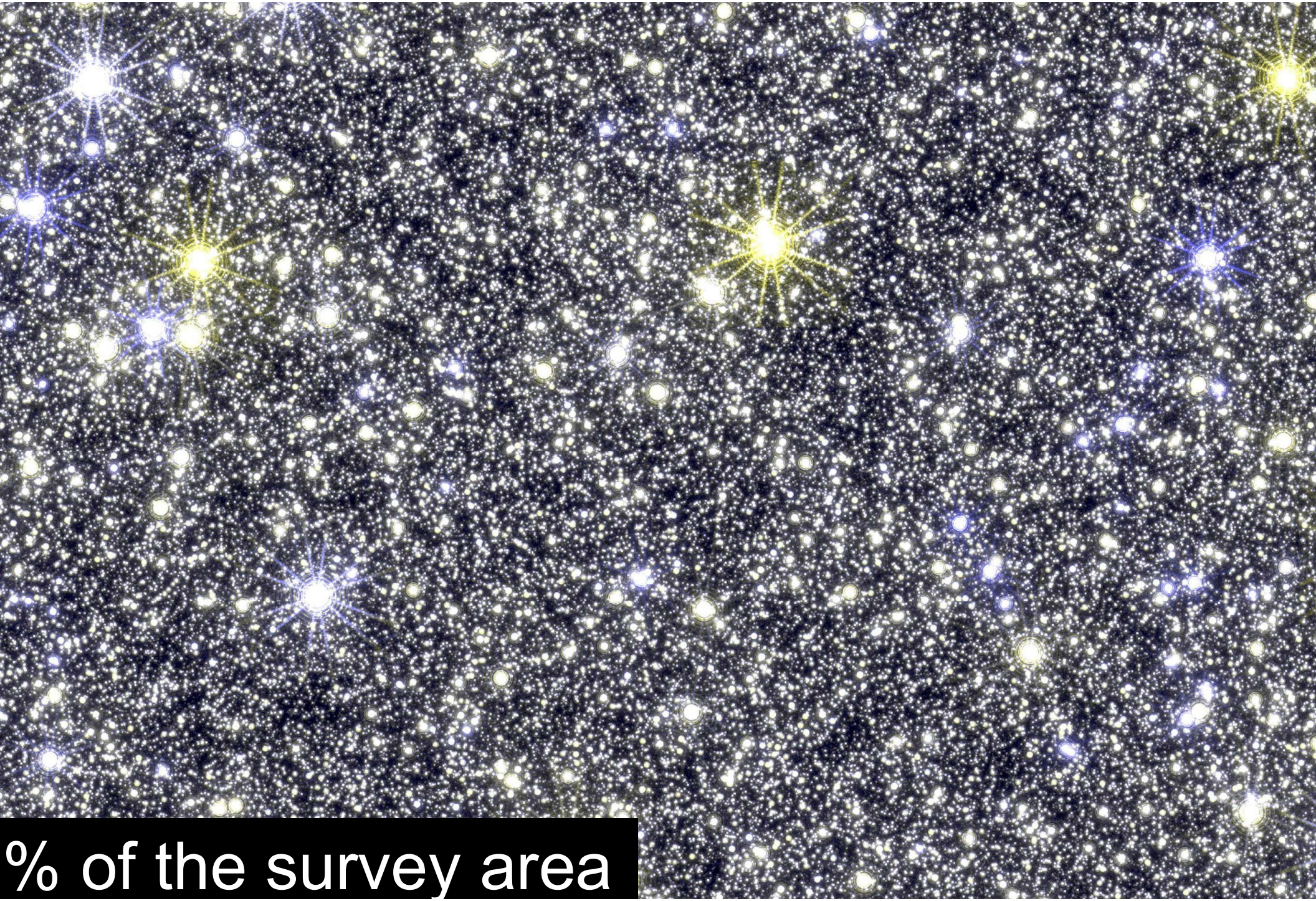
neters for the Roman Galactic Bulge Time Domain Survey (RGB



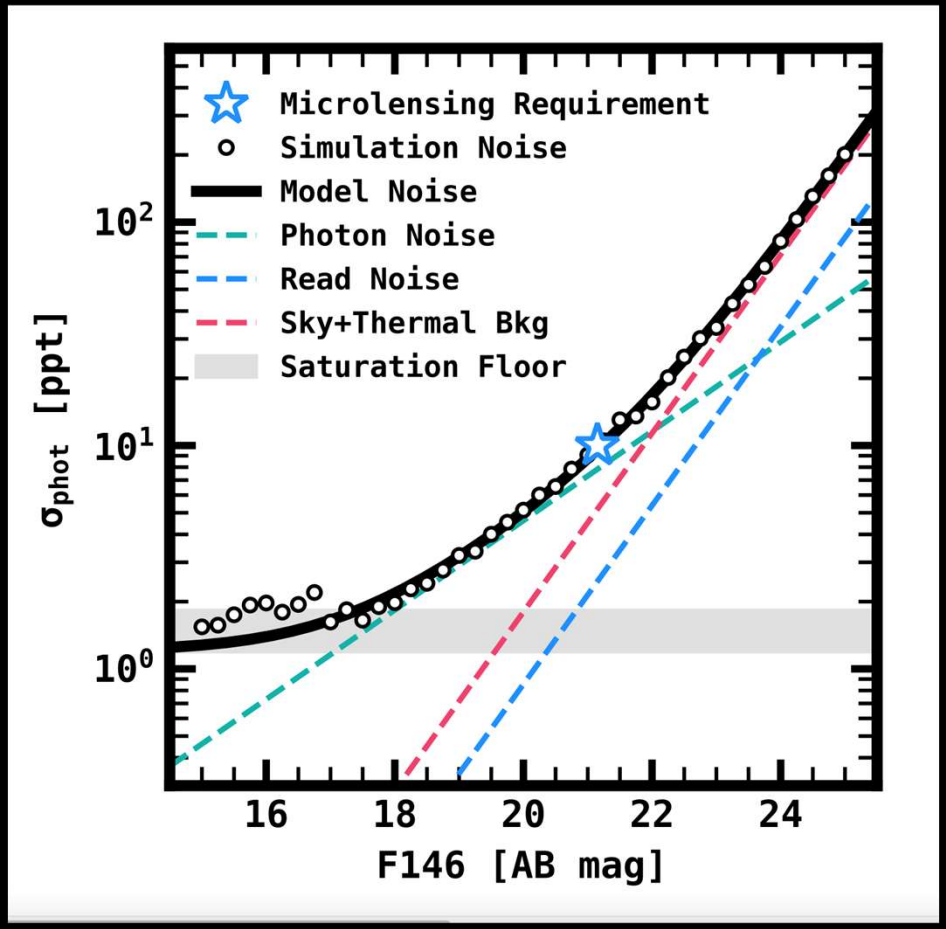
Credit: R. Wilson (GSFC)

- 5 fields for a total of ~1.5 deg^2 + GC
- 6 x 72-day high-cadence seasons (9 efficiency), ~67s exposures
  - ~12-minute cadence in W146 (0 μm) filter,
  - ~3-hour cadence in alternating Z087/K213 filters
- 4 x 72 low-cadence seasons, ~67s e
  - ~3-day cadence in W146+K213
- ~50,340 exposures in W146.
- ~438 total days over 5-year mission




% of the survey area

Statistical Power of the RGBTDS

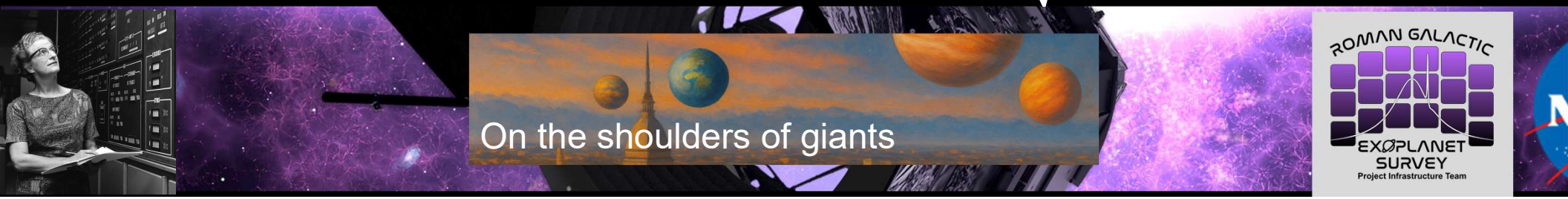


For a W146~21 star:

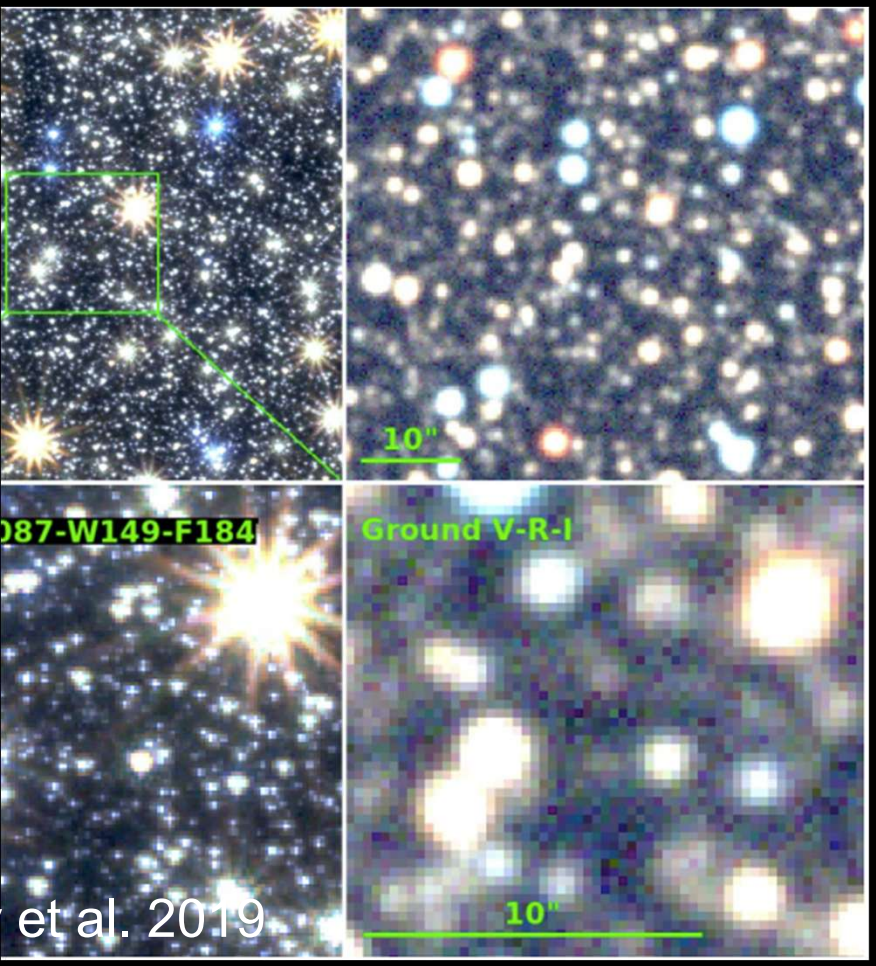
- Photometric precision of σ~0.01 mag per exposure
- Astrometric precision of ~ mas per exposure
- Total of ~10^9 photons over the survey.

Saturation @ W146 ~15.

Root N: $\sqrt[2]{50{,}000}$ ~ 220.



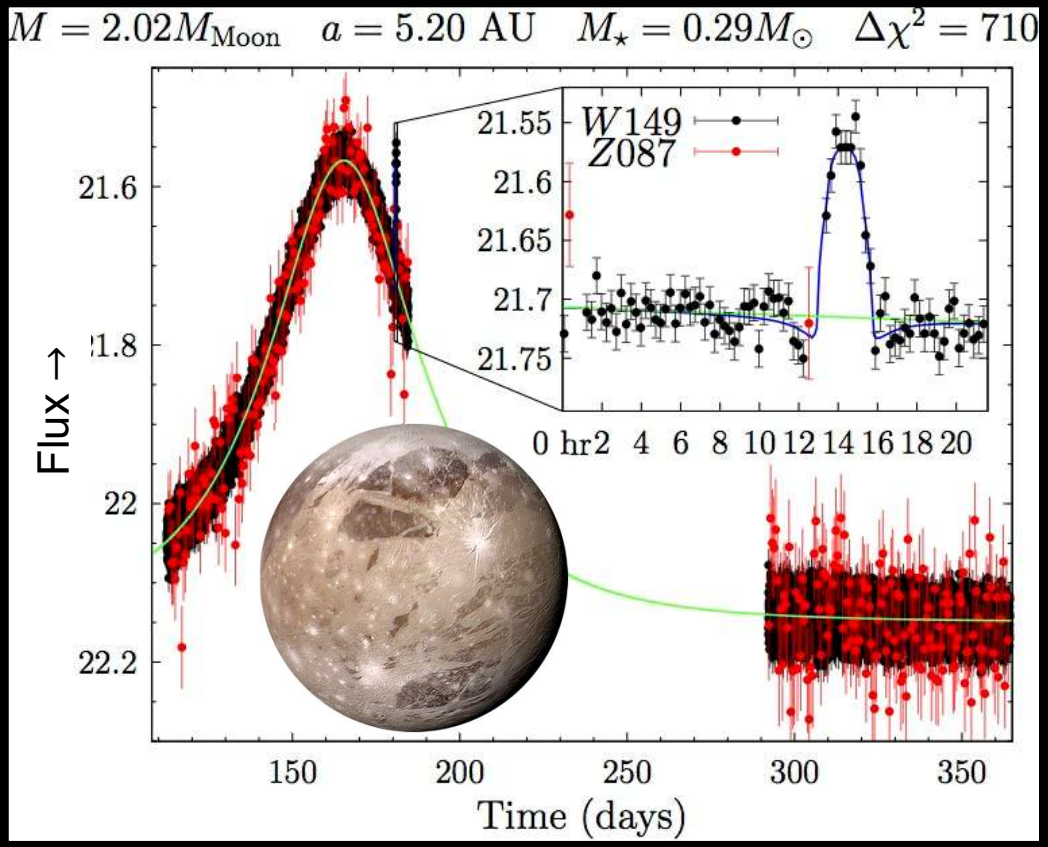
Number of Sources and Microlensing Events



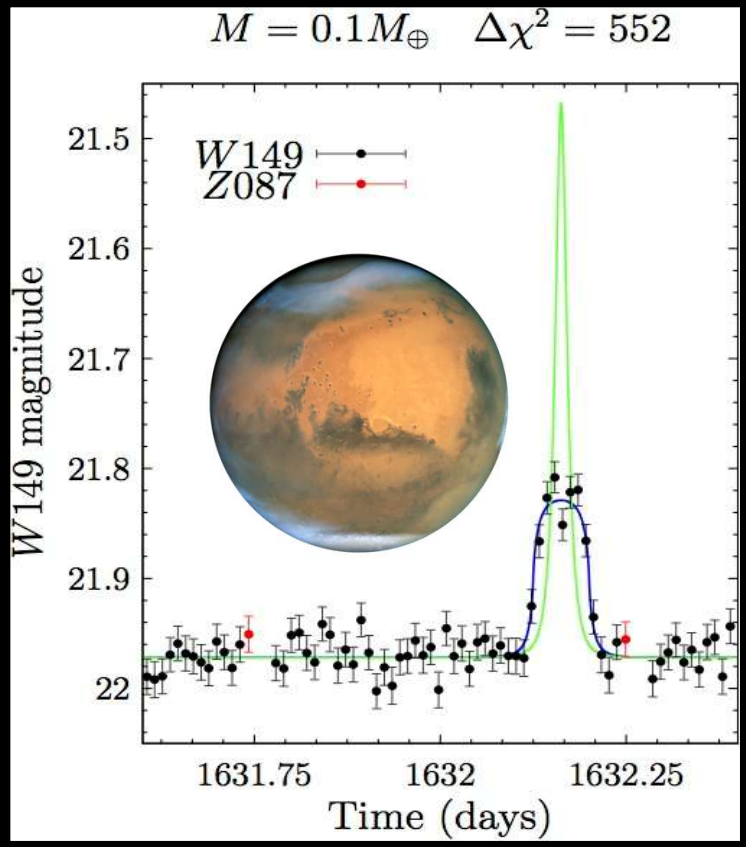
et al. 2019

Stars ($W149 < 15$)	$\sim 0.3 \times$
Stars ($W149 < 17$)	$\sim 1.4 \times$
Stars ($W149 < 19$)	$\sim 5.8 \times$
Stars ($W149 < 21$)	$\sim 38 \times$
Stars ($W149 < 23$)	$\sim 110 \times$
Stars ($W149 < 25$)	$\sim 240 \times$
Microlensing events $\lvert u_0 \rvert < 1$	$\sim 27,00$
Microlensing events $\lvert u_0 \rvert < 3$	$\sim 54,00$

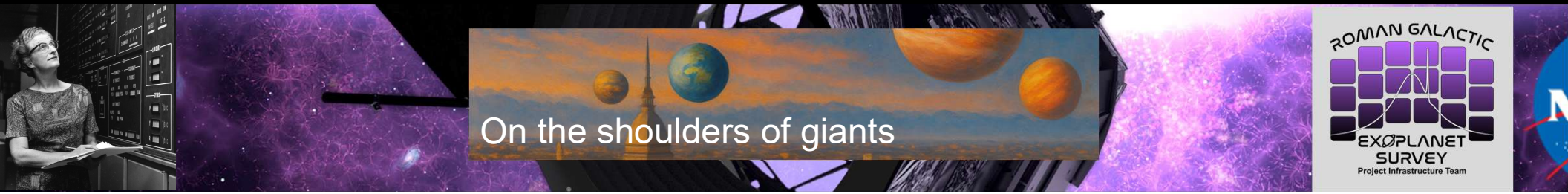
Simulated Microlensing Planet Detections



2 × Mass of the Moon @ 5.2 AU
(~27 sigma)



Free floating Mars
(~23 sigma)



Yields for Notional Survey Design

$M_\oplus$	0.1 -0.3	1	10	100	1000	3000-10000	Total
r of ons	20	181	545	412	224	91	1474

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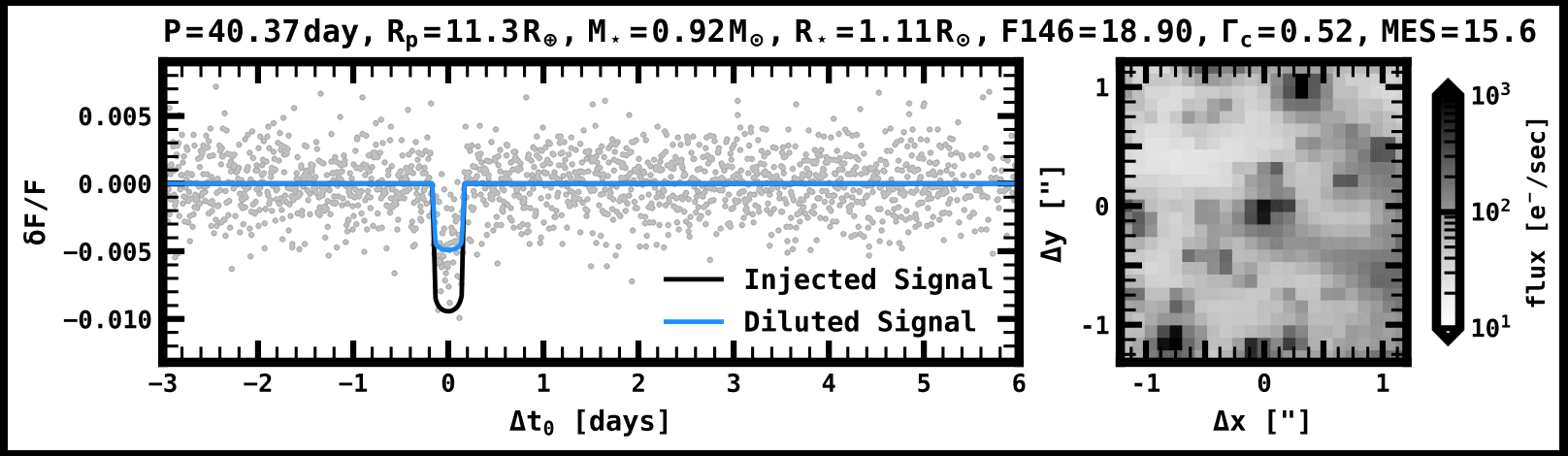
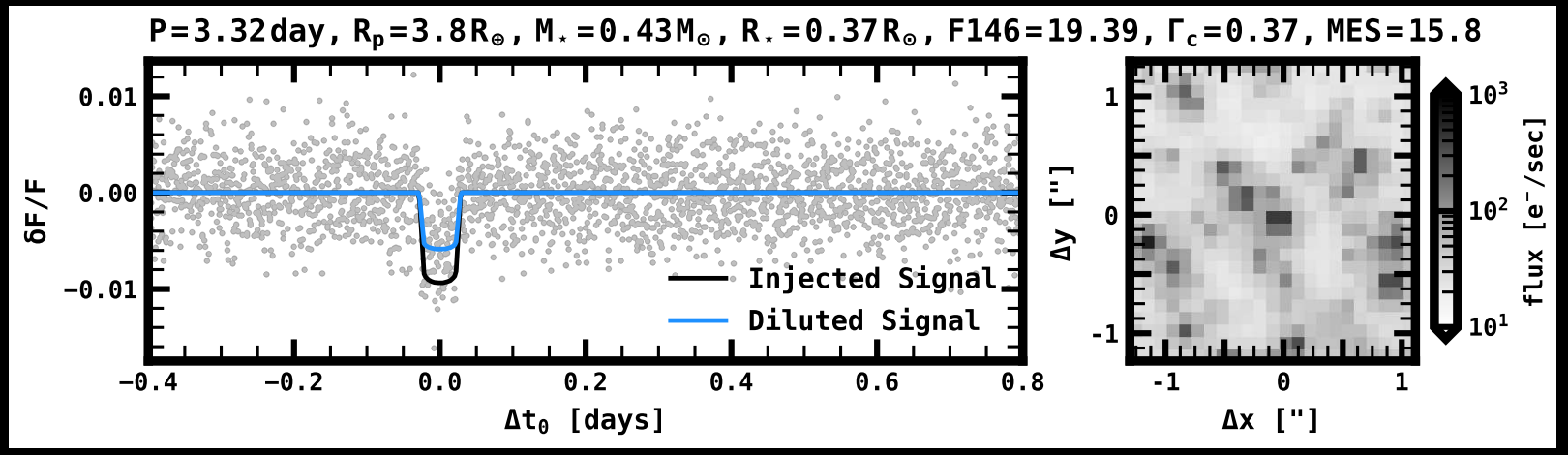
Warning! Don't believe these numbers

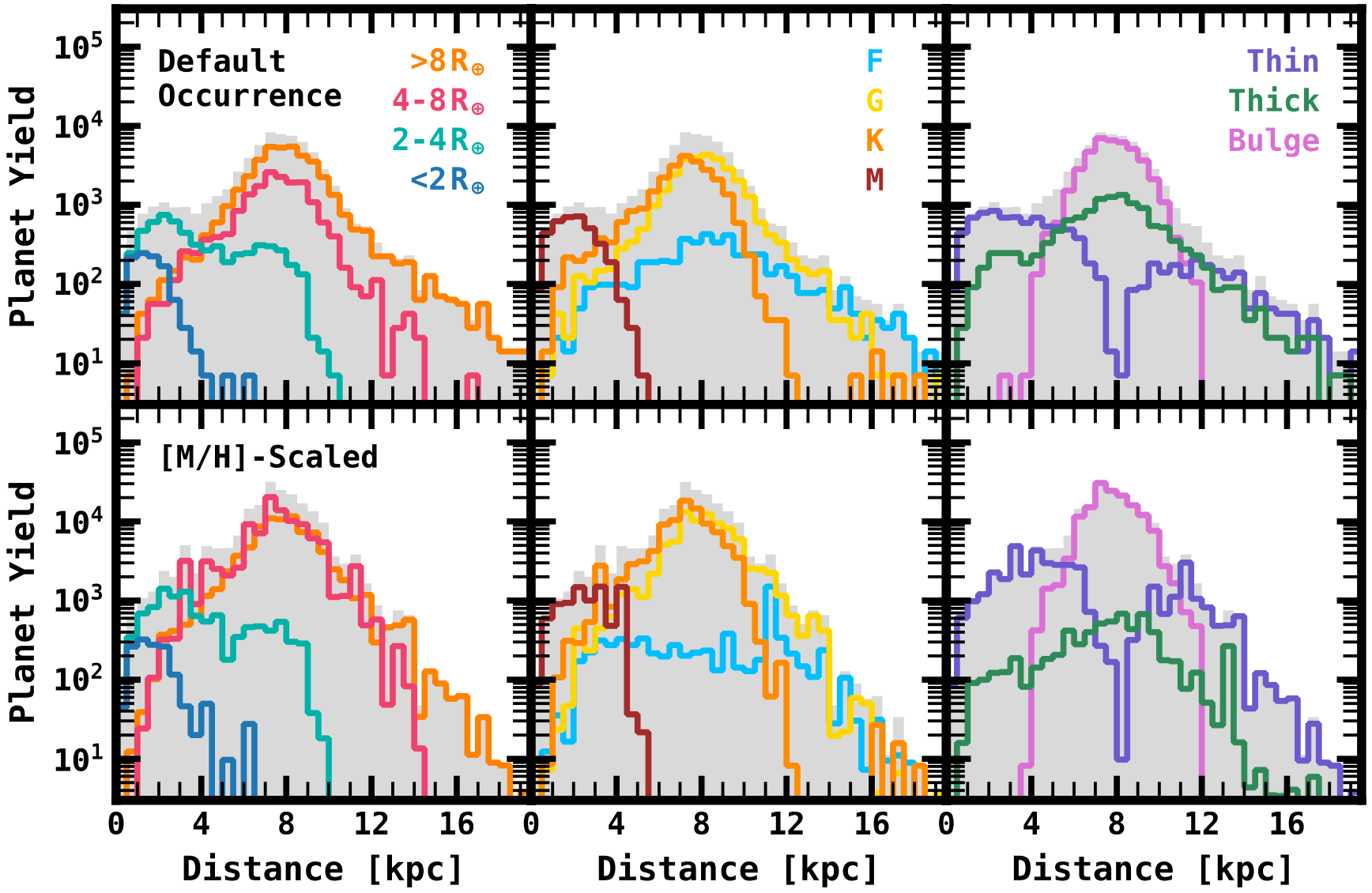
Simulated Transit Planet Detections





Wilson et al. 2023

Estimated Exoplanet Yield



Wilson et al. 2023

100,000 Planets

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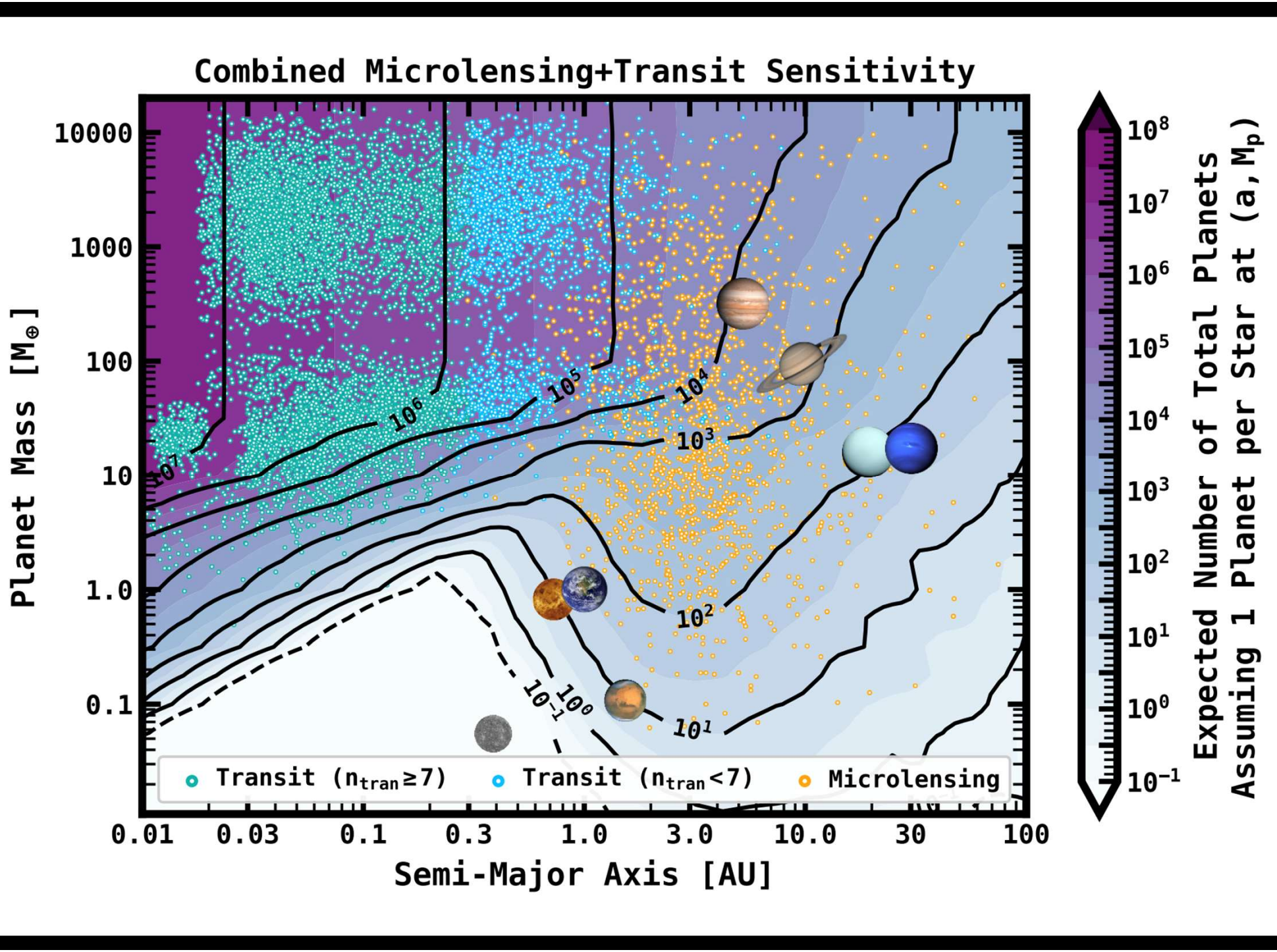
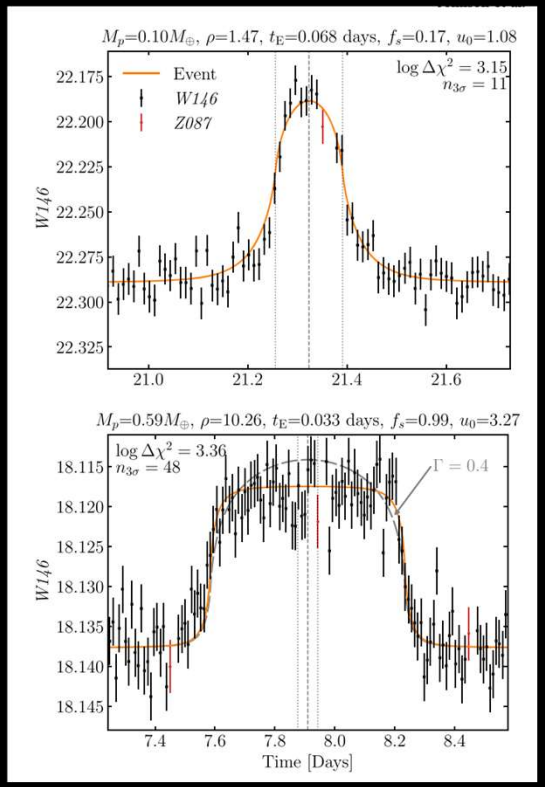

Combined Microlensing+Transit Sensitivity
Planet Mass [M⊕]
10000
1000
100
10
1.0
0.1
0.01
0.03
0.1
0.3
1.0
3.0
10.0
30
100
Semi-Major Axis [AU]
10^7
10^6
10^5
10^4
10^3
10^2
10^1
10^0
10^-1
Transit (n_tran≥7)
Transit (n_tran<7)
Microlensing
Expected Number of Total Planets
Assuming 1 Planet per Star at (a, M_p)
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10^1
10^0
10^-1

FFPs with Roman: Yields



Mass	Mass Function			
($M_\oplus$)	One-Per-Star	Log-Uniform	N/star/dex	N_{det}
0.01	1.22	0.349	1335	466
0.1	17.9	5.13	146	751
1	88.3	25.2	16	404
10	349	83.0	1.8	146
100	1250	298	0.2	57
1000	4100	976	0.02	21
10000	13300	3170	0.002	7
Total	3750	897		1852

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Johnson et al. 2020

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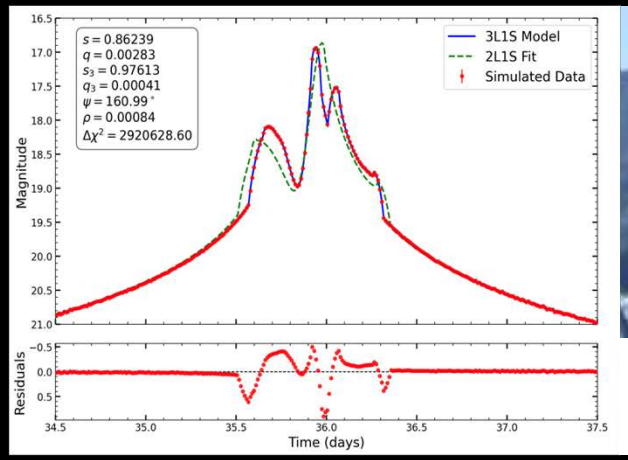
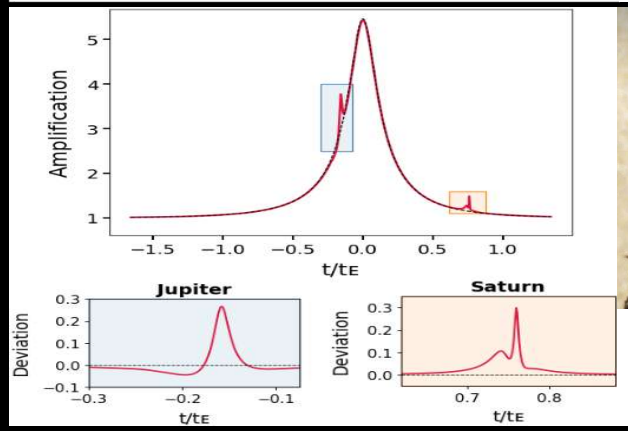
Roman's Sensitivity to Mutliplanet Systems

- Roman has sensitivity to multiplanet systems
- This includes some sensitivity to systems with outer giant planets and inner super-Earth planets.
- Detecting more than 2 planets is unlikely, but possible.
- Constraints on the orbital parameters of the planets are weak.



Vi
Sagg



Sincl
Jon

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What do we measure?

For nearly all planetary systems– mass ratio q and instantaneous projected separation in units of the Einstein ring radius s

For ~40% of systems, we can

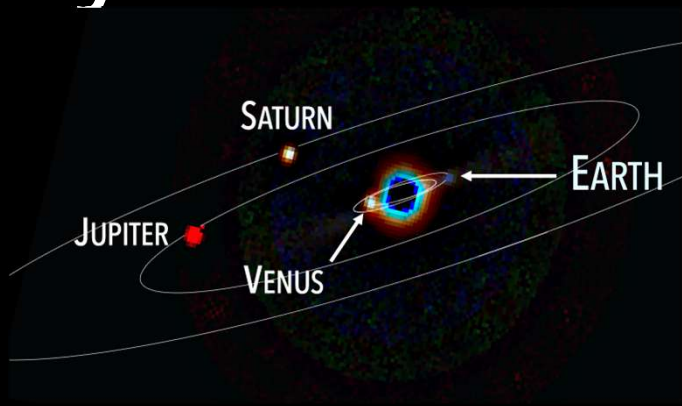
- Infer host star mass, planet mass, and distance to the system to 20%.
- Infer the semimajor axis to a factor of 2.

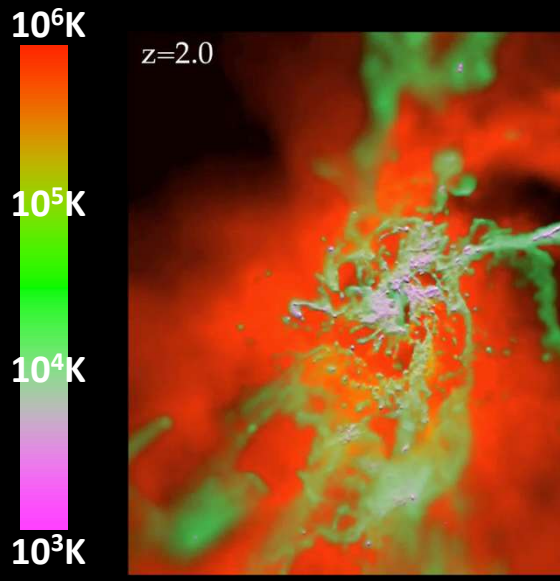
For a small subset of events, we can measure orbital motion and obtain a better measurement of a and crude constraints on the other orbital elements (i, e, ω)

For the brighter host stars, we can use JWST to infer the log g, [Fe/H], and likely [α/Fe] of the lens

abitable Worlds Observatory

- SA's next flagship mission concept commended by Astro2020 Decadal rvey
- st telescope designed to search for ns of life on planets outside our solar stem
- rge-aperture UV / Optical / NIR servatory performing transformative trophysics





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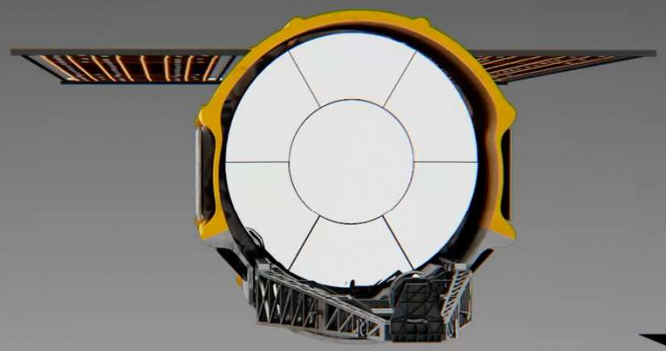
Exploring the technical trade space

Exploration of EACs 1 – 3 nearly complete. Work started on EACs 4 & 5

EAC3

8-m diameter on-axis



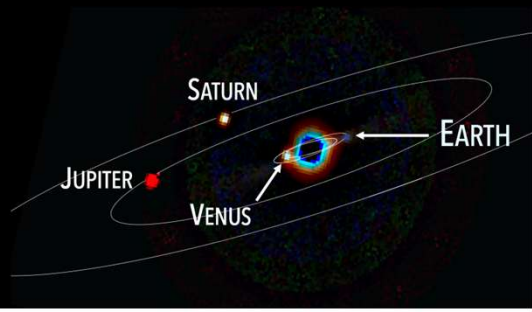
EAC2

6-m diameter off-axis

EAC1

6-m inner diameter / 7.2-
outer diameter off-axis

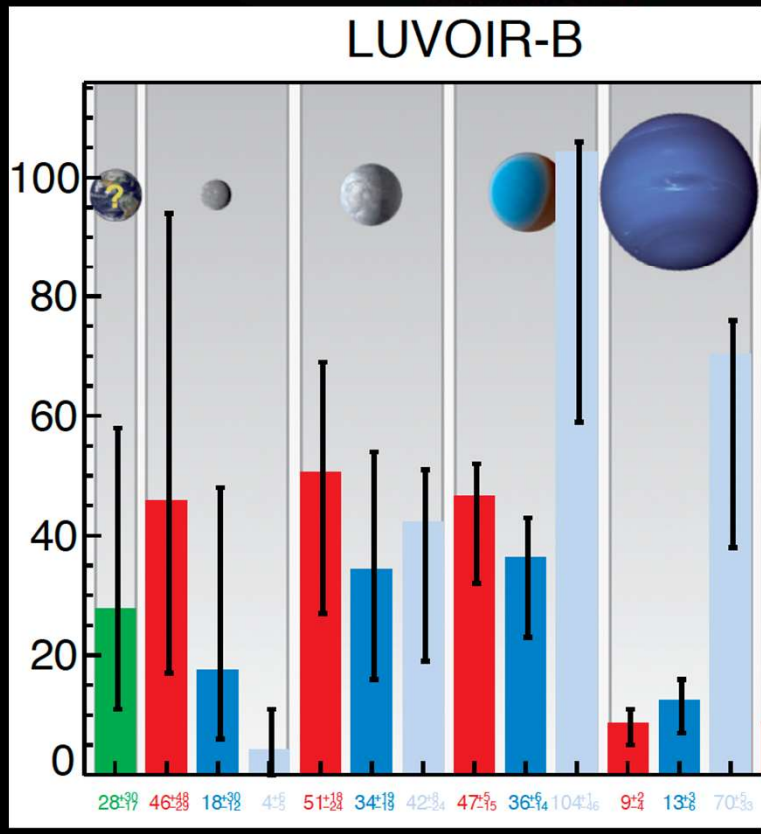
ection and Characterization of netary Systems with HWO



VO can directly image and take ectra of nearly complete planetary stems

- Inner terrestrial planets
- Outer giant planets (out to 8-15 au)

n, in principle, search for a correlation tween liquid water on potentially bitable planets and the presence of nt planets.



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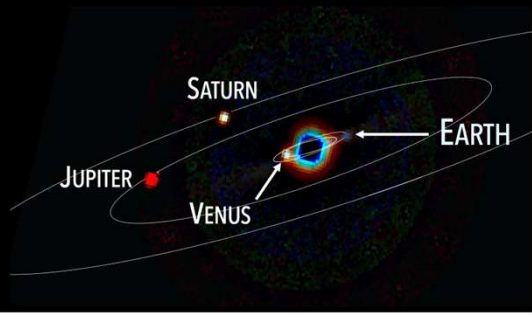
ection and Characterization of netary Systems with HWO



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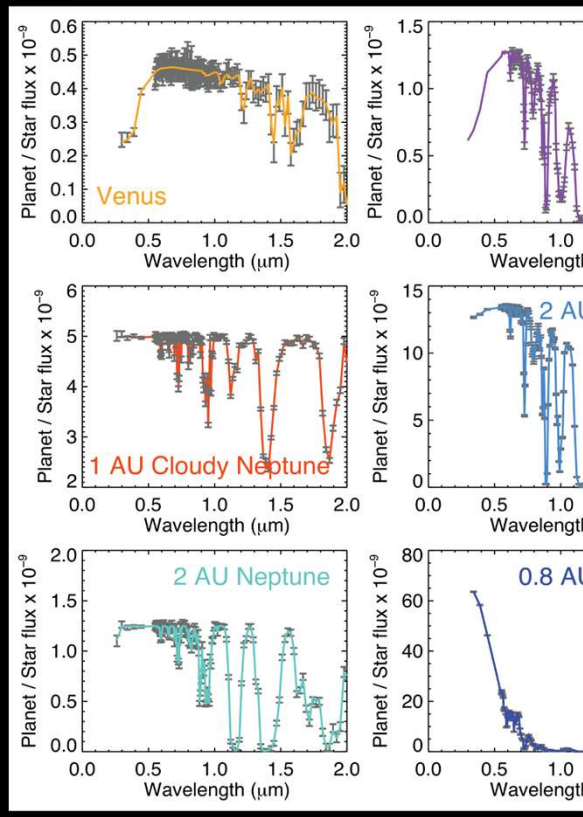


Roman Galactic Exoplanet Survey Project Infrastructure Team (RGES PIT)

al: Ensure the success of the RGES, RGBTDS and man!

rently ~50 active members

rteen working groups

lic website: https://rges-pit.org/

ExS and RGES PIT Meeting, Columbus, Ohio, October 13-17, 2025

man Microlensing Data
allenge 2026 (RMDC26)

Alison Crisp

Jon Hulberg

+many others

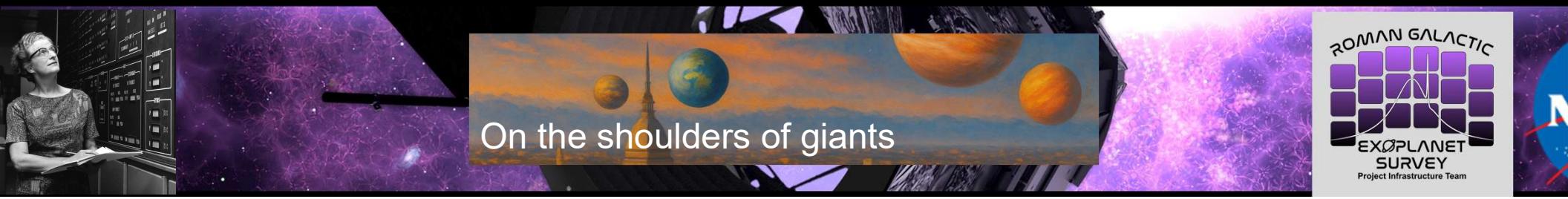
DC26 is a community challenge to model simulated an microlensing data

is to broaden participation, standardize best practices, spur innovation in microlensing modeling and tooling.

is intended to be a semi-realistic representation of the olensing data volume and type expected from the Roman ctic Bulge Time Domain Survey.

ial launch will very soon!

s://rges-pit.org/data-challenge/



This is an exciting time!

Roman will launch in just over 6 months and the first bulge data will arrive in less than a year.

All data will be non-proprietary and publicly available as soon as possible after the observations.

High-level data products will be available

There is a lot of science to be done with the Roman data, as well as with synergistic observations with other observatories

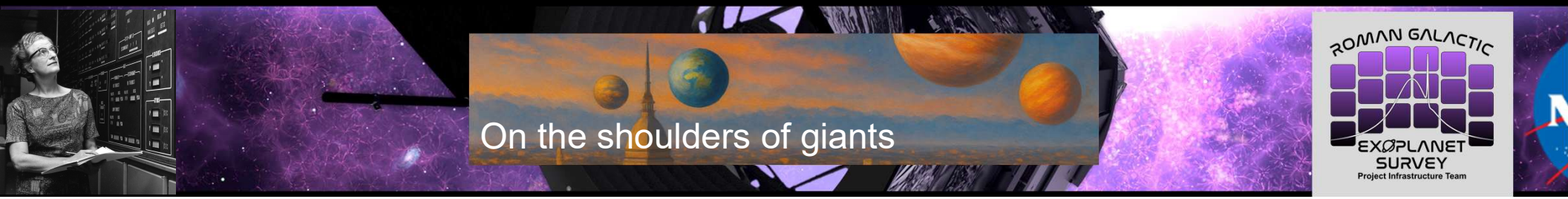
Summary

Roman will provide a nearly complete galactic census of planets

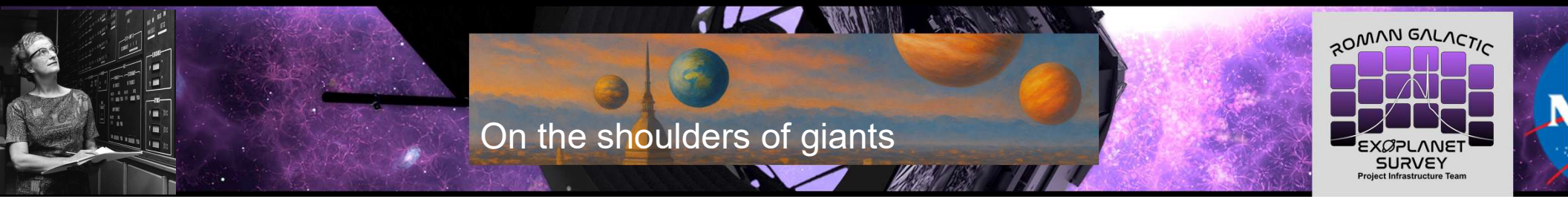
Roman will not only probe planets beyond the snow line, but als have some sensitivity to inner planets down to ~Earth mass

Multiplanet system detections will allow one to probe the connection between inner/outer regions of planetary systems

HWO will allow for the detection and characterization of planetary out to ~10-15 au.



Thank you!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