

RoSETZ

Roman Survey of the Earth Transit Zone

A SETI-optimized survey for habitable-zone exoplanets

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RoSETZ

Roman Survey of the Earth Transit Zone

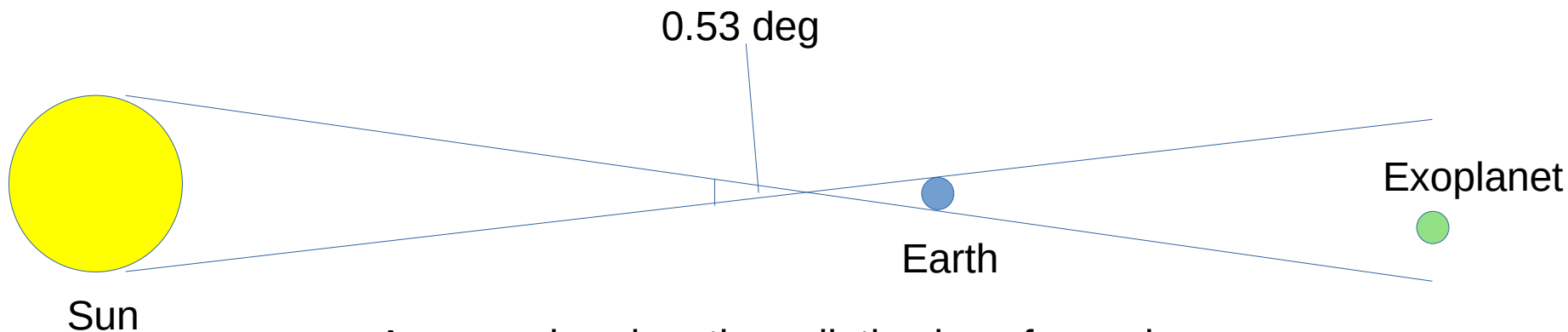
- First ever exoplanet survey optimized for future SETI follow-up. Breakthrough Listen willing to follow-up with Allen Telescope Array
- RoSETZ would significantly expand number of known HZ Earth-sized planets around most common Galactic stars – dominant contributor to eta-Earth.
- Provides systematics control for GBTDS microlensing and transit exoplanet surveys
- White paper: Kerins et al (2023, arXiv:2306.10202)



RoSETZ

Roman Survey of the Earth Transit Zone

- Targeting transiting habitable zone (HZ) planets located within the **Earth Transit Zone** (Heller & Pudritz 2016)



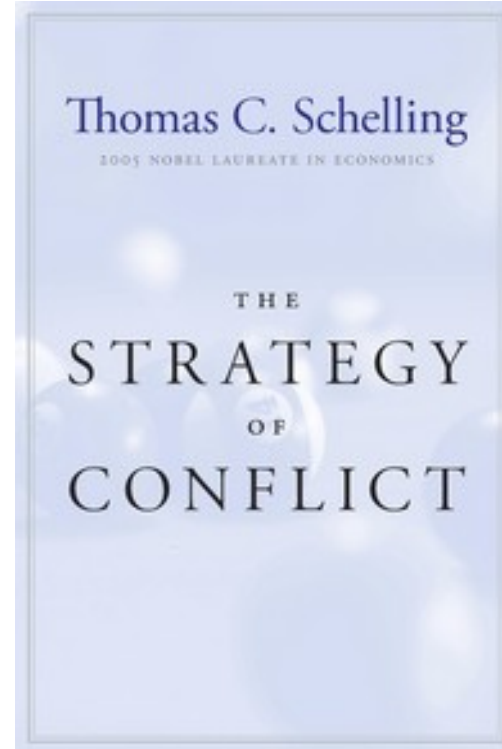
A narrow band on the ecliptic plane from where Earth can be seen transiting the Sun

The ETZ is a key target region for **SETI research**

SETI and game theory



Thomas Schelling:
pioneer of game theory

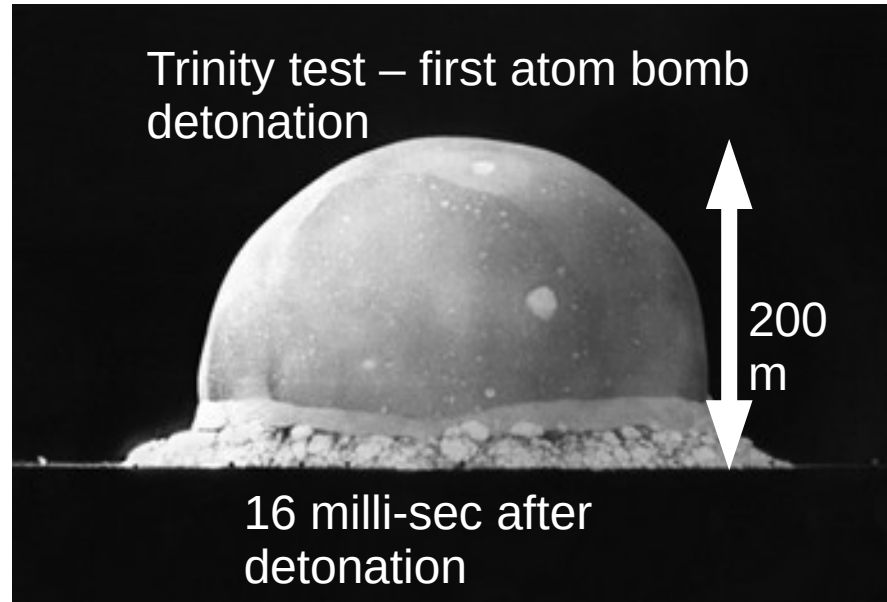


SETI: great example
of a 2-player non-
communicating
cooperative game

SETI and game theory



Thomas Schelling:
pioneer of game theory



Credited with devising doctrine of
Mutually Assured Destruction!

2-player uncooperative game

Game of chicken



Schelling's solution in action

Objective is to remove “win” choice from opponent
(and hope they act rationally!)



2-player cooperative game

Strangers in New York

<https://www.youtube.com/watch?v=uESGjRQNEYk>

Objective is for incentivised participants to decide on a mutual strategy that has best chance of success

Chance of success can become much higher than random



ABC News: Mission Impossible: Lost in NYC



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Mutual detectability

(Kerins, 2021, AJ, 161, 39)

- Idea of Mutual Detectability provides a natural focal point for SETI
- Communication incentivized by information both know the other knows
- With transiting ETZ planets:
 - **Both parties reside on HZ transiting planets**
 - **The intrinsic transit signal strength of both planets is known to both**
 - **Each side knows that the more the other side looks at them the more they'll see evidence of their existence (biomarkers, technosignatures, ...)**
 - **Both know who observes the strongest signal (most incentivized to transmit?)**



Mutual detectability

(Kerins, 2021, AJ, 161, 39)

Intrinsic signal strength: $\frac{S}{S_{\oplus}} = \frac{L_*}{L_{\odot}} \left(\frac{R_*}{R_{\odot}}\right)^{-2} \left(\frac{R_p}{R_{\oplus}}\right)^2 \left(\frac{P}{\text{yr}}\right)^{-1} \frac{t_{14}}{t_{\oplus}}$

They have a clearer view of us if $\frac{R_p}{R_{\oplus}} \lesssim \left(\frac{L_*}{L_{\odot}}\right)^{-1/7}$

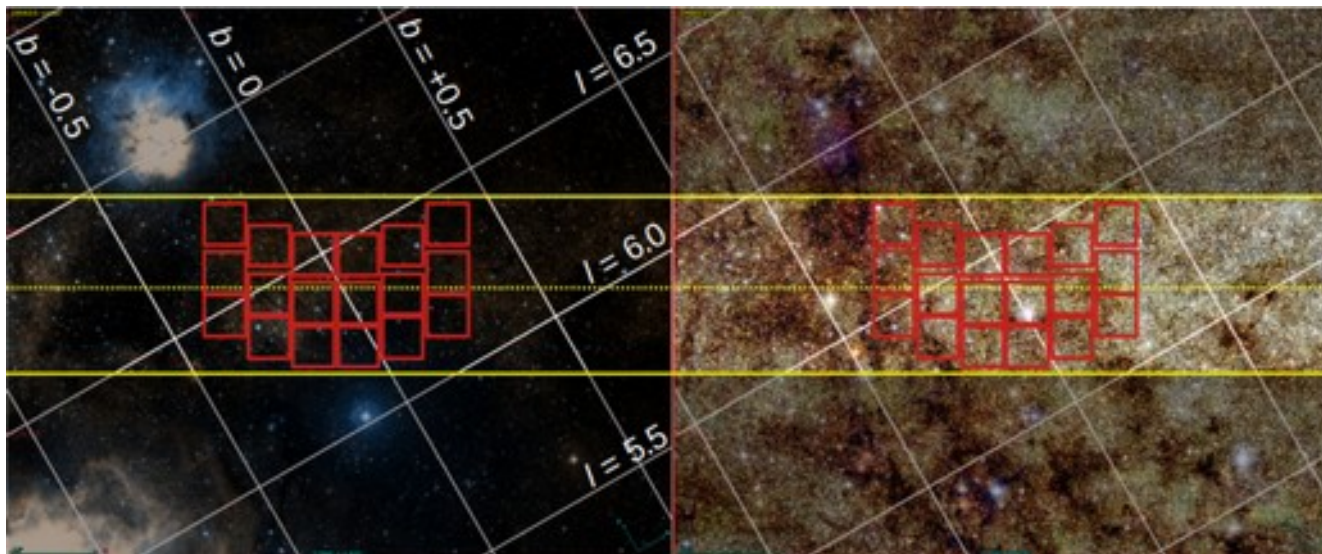
Target transiting HZ planets in the ETZ orbiting around sub-solar luminosity hosts

Population is largest contributor to η_{\oplus}



RoSETZ

Roman Survey of the ETZ



Kerins et al
(2023)

Target region: intersection of the Ecliptic and Galactic planes.
6.4 deg from the Galactic Centre – lots of stars to monitor!

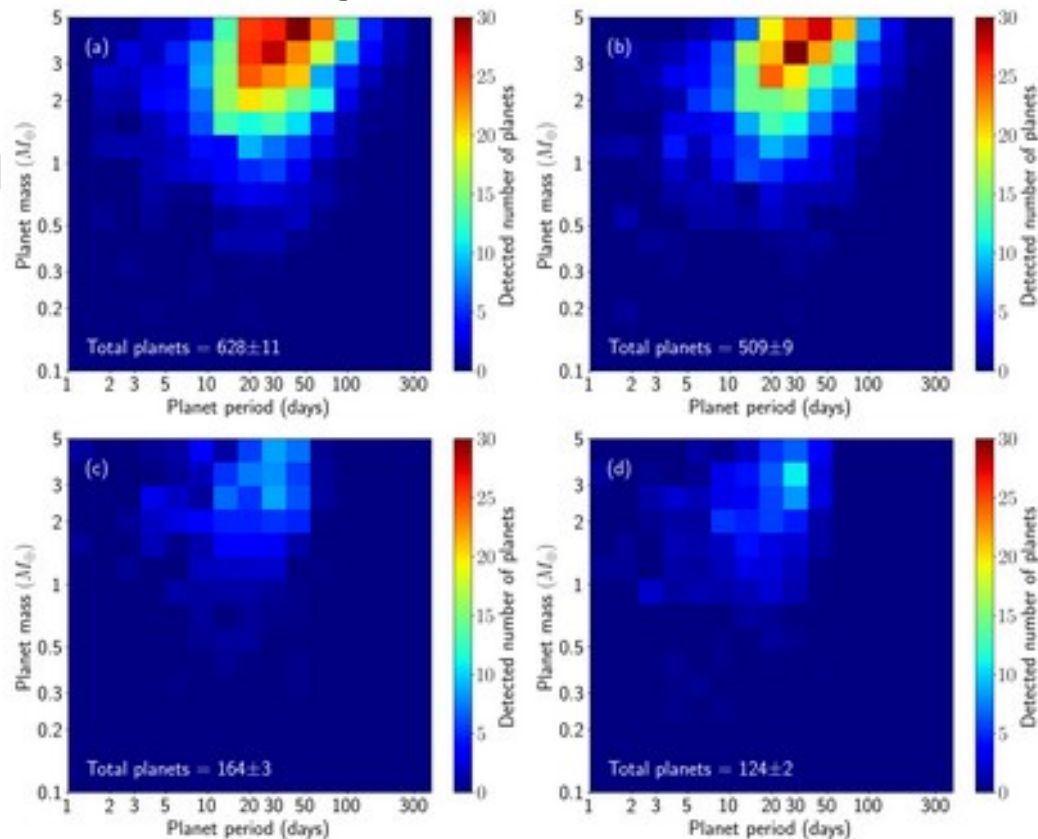


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Roman Survey of the ETZ

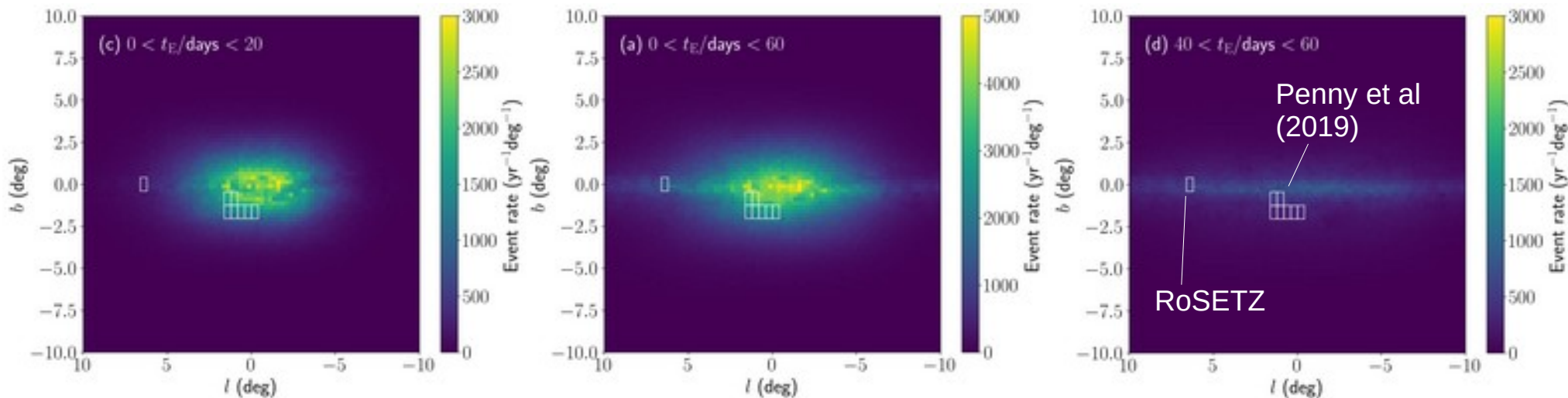
Kerins et al
(2023)

Predicted yield: 5-20x
currently known HZ
planets around K,M type
hosts, depending on
time allocation (2
seasons or 6 seasons).





Microlensing systematics control



Short duration events,
mostly from bulge

Total rate

Long duration events,
mostly from disk

RoSETZ microlensing will be almost entirely from the disk. Provides important cross-check on Galactic models used for exoplanet analyses

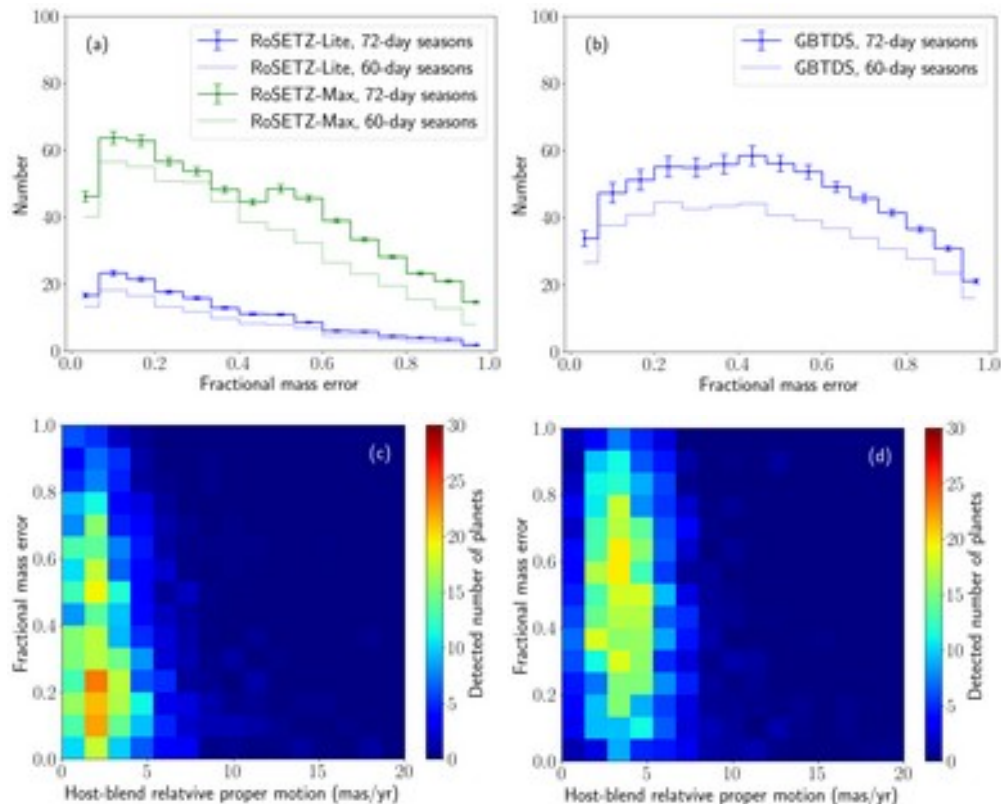


Transit systematics control

GBTDS fields better for proper motion separation but ETZ field better for more reliable transit depth

K,M-type hosts are within 4 kpc and lines of sight are very similar.

**Differences are due only to variation of blending:
Two locations provide better control**





Summary

- Roman is ideal for finding large numbers of rocky HZ planets within the ETZ
- Such a list provides the opportunity for targeted-SETI follow-up that is motivated by “mutual detectability” game-theory approach
- RoSETZ would provide systematics control for both GBTDs microlensing and transit samples
- Targetting and greatly enlarging catalogue of exoplanets that dominate eta-Earth
- Breakthrough Listen is willing to deploy Allen Telescope Array to conduct SETI follow-up of Roman ETZ HZ planet candidates
- Novel project promising high-impact science and high-impact public appeal