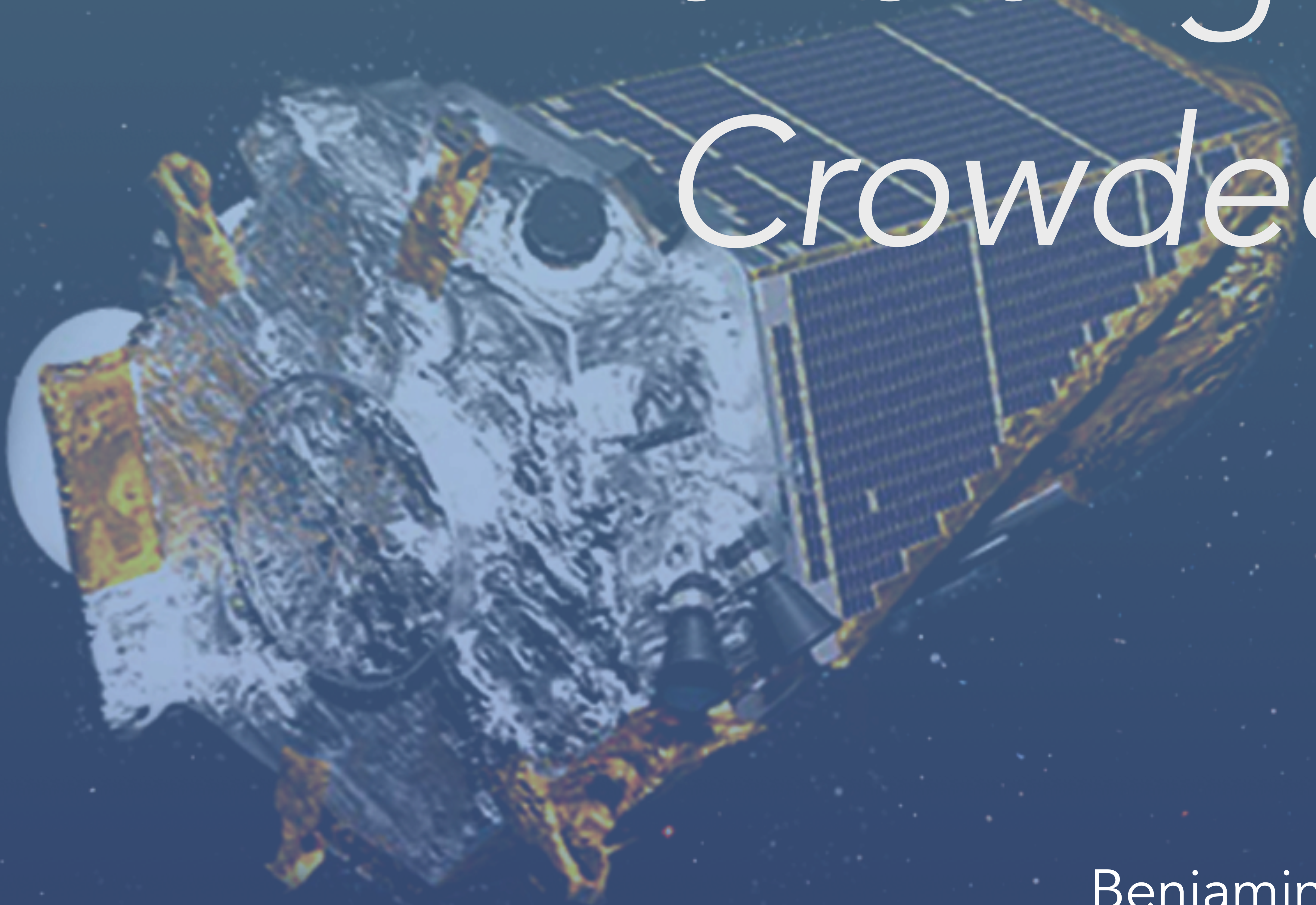
Transiting Planets in Crowded Places



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UNSW Physics + UNSW Data Science Hub

19 October 2021

@benmontet

UNSW SYDNEY

NEWTS
NEarby Worlds and Their Stars

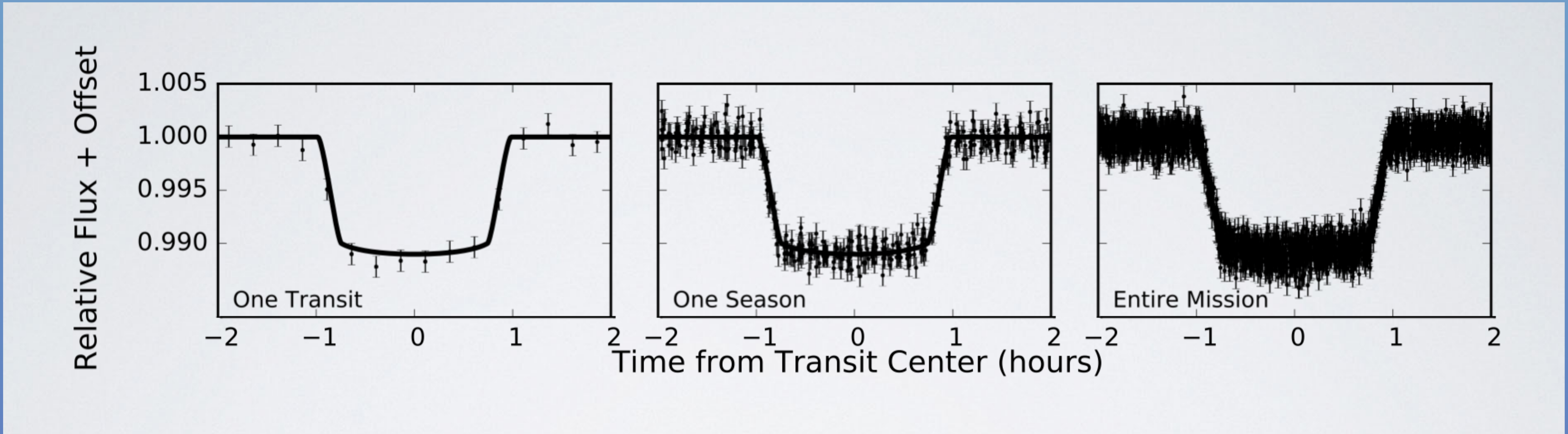

Kepler
TESS


Kepler Search Space
3,000 light years
Sagittarius Arm
Sun
Orion Spur
Perseus Arm
Jon Lomberg

Roman (~2028) requirements

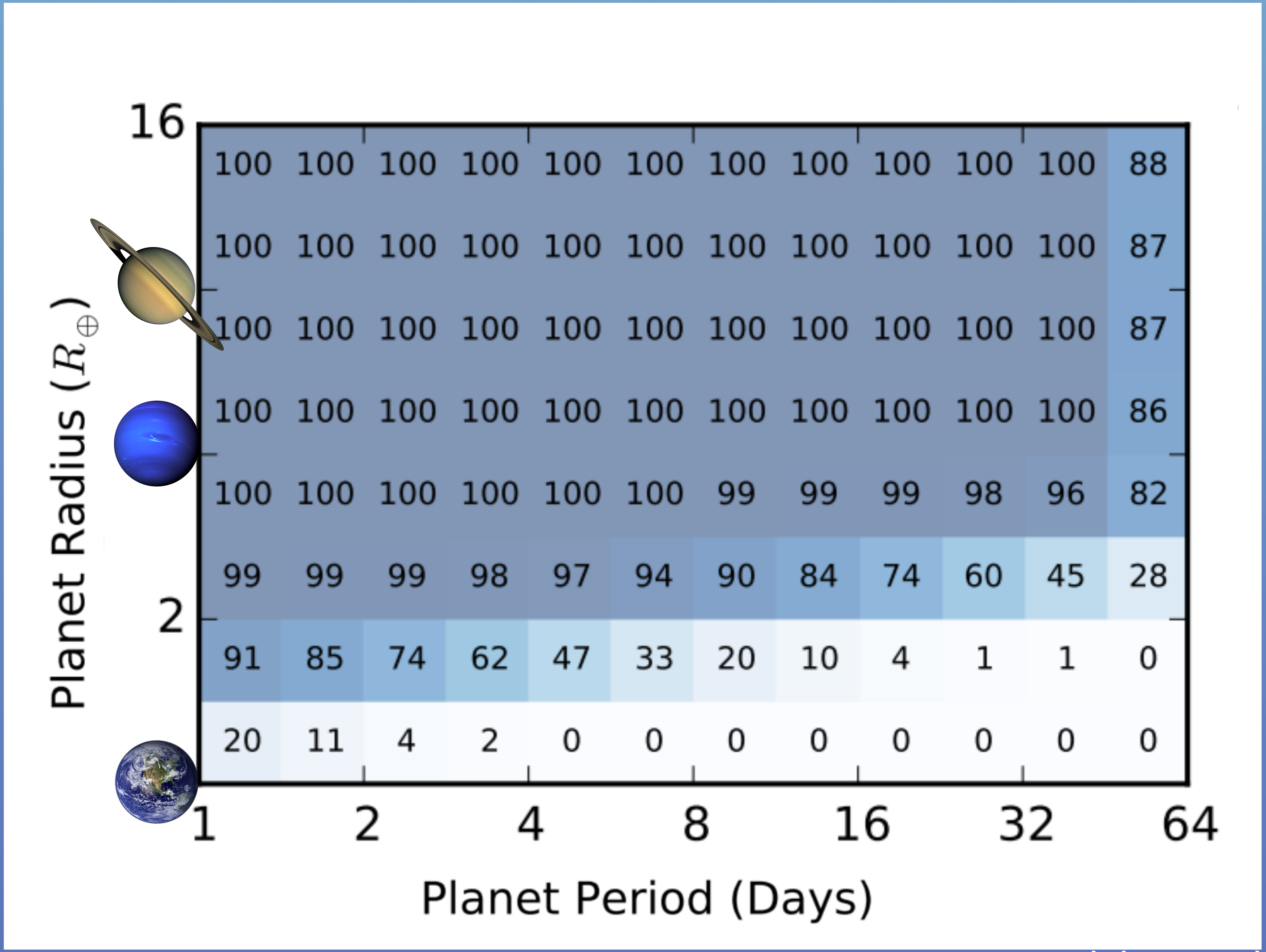
- Observations of 20 million stars in 2 square degrees
- High photometric precision (0.1% for bright stars)
- Repeat observations of fields (15 minute cadence)
- Very small pixels! Same stellar density in stars/pixel as *Kepler*

Simulated *Roman* data



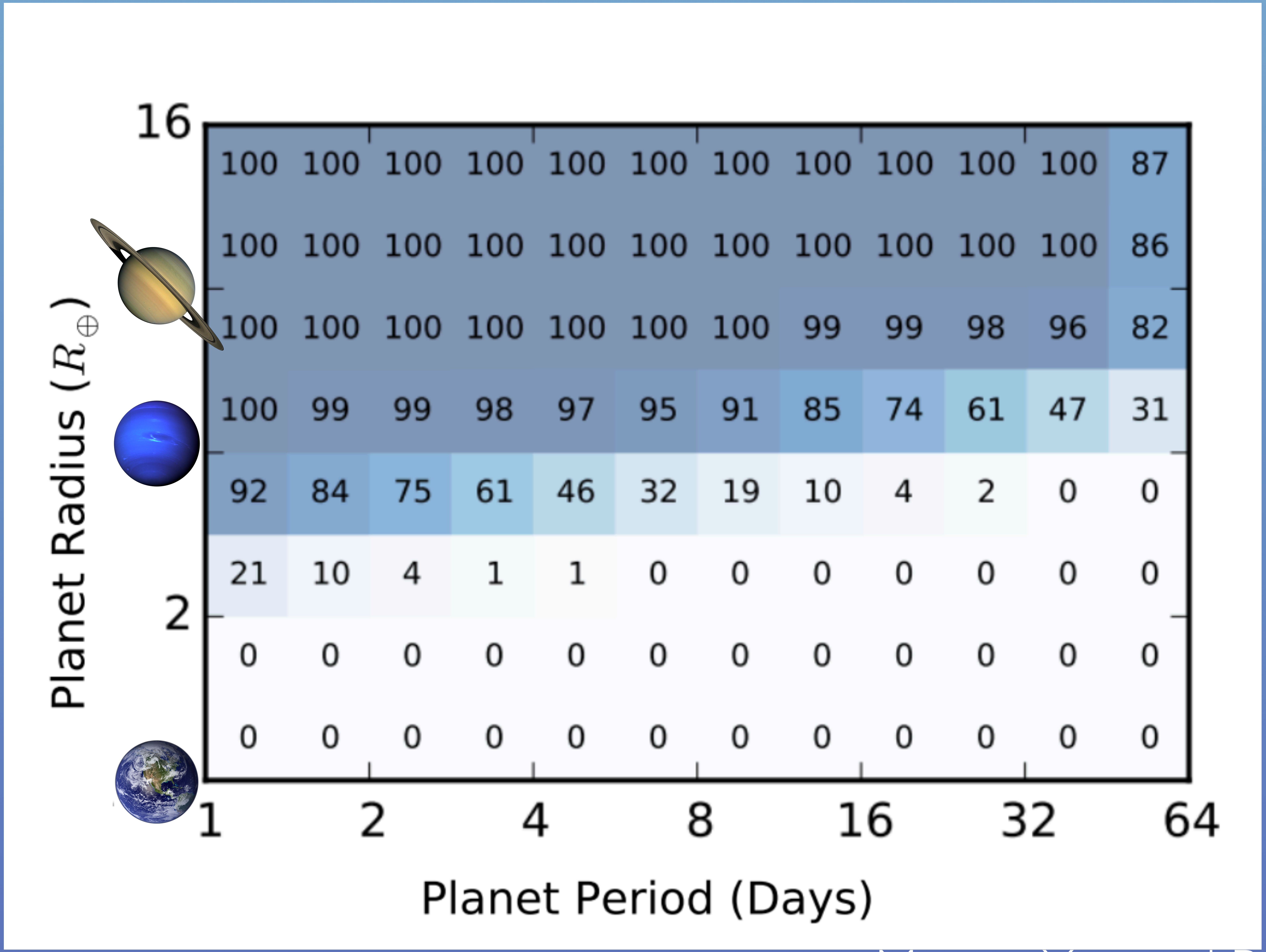
Montet, Yee, and Penny (2017)

Planet detectability around bright *Roman* stars



Montet, Yee, and Penny (2017)

Planet detectability around typical *Roman* stars



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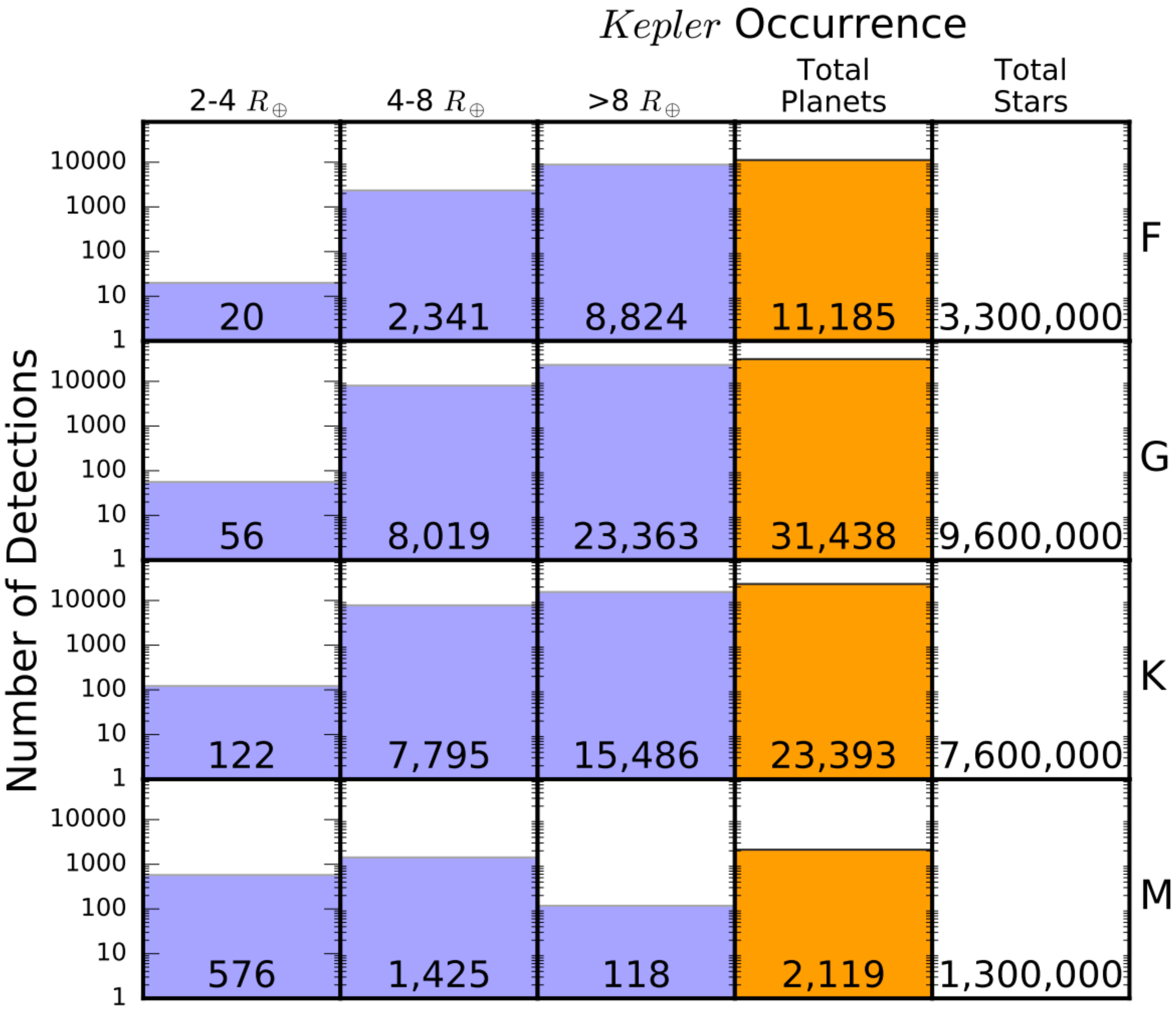

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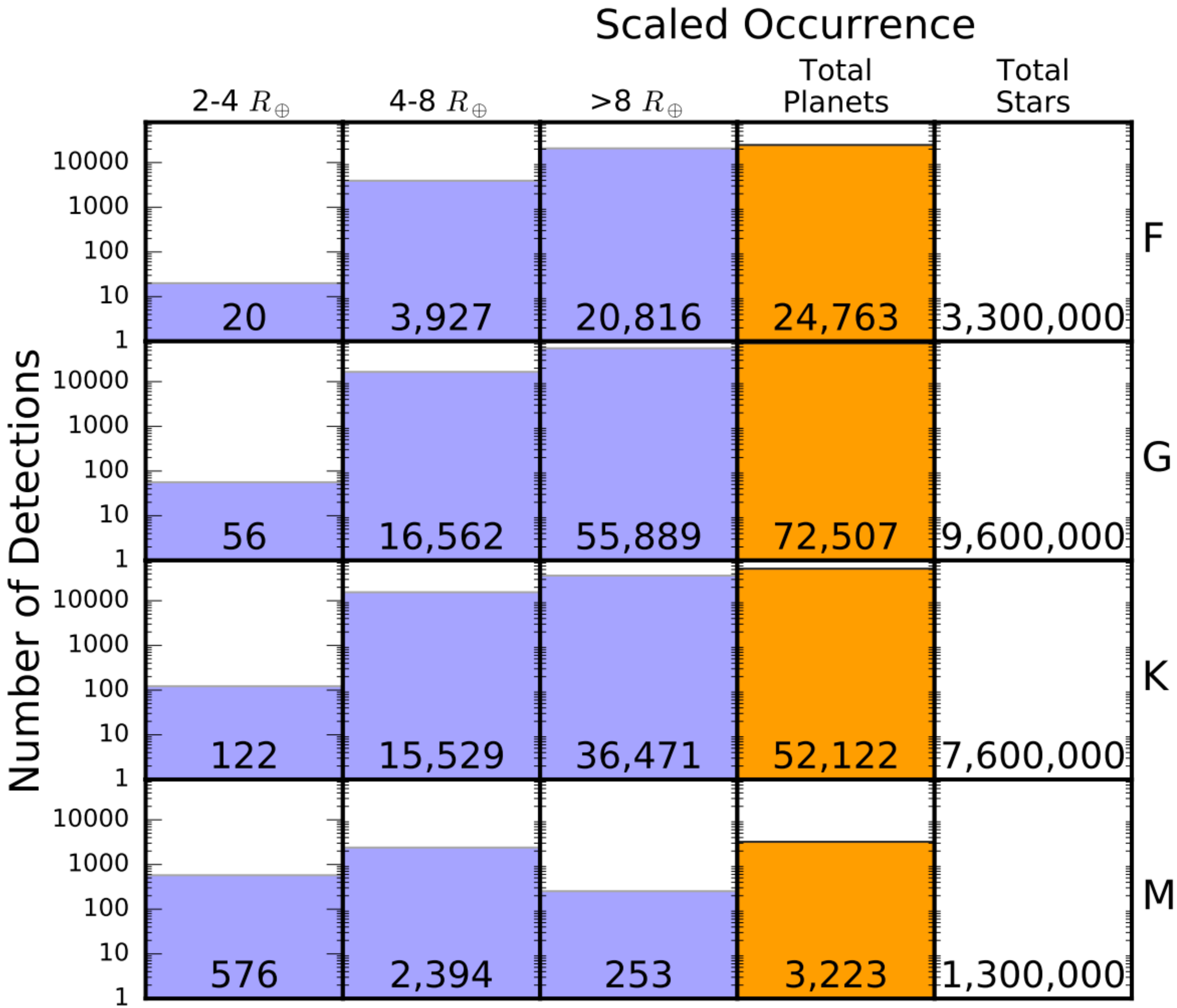
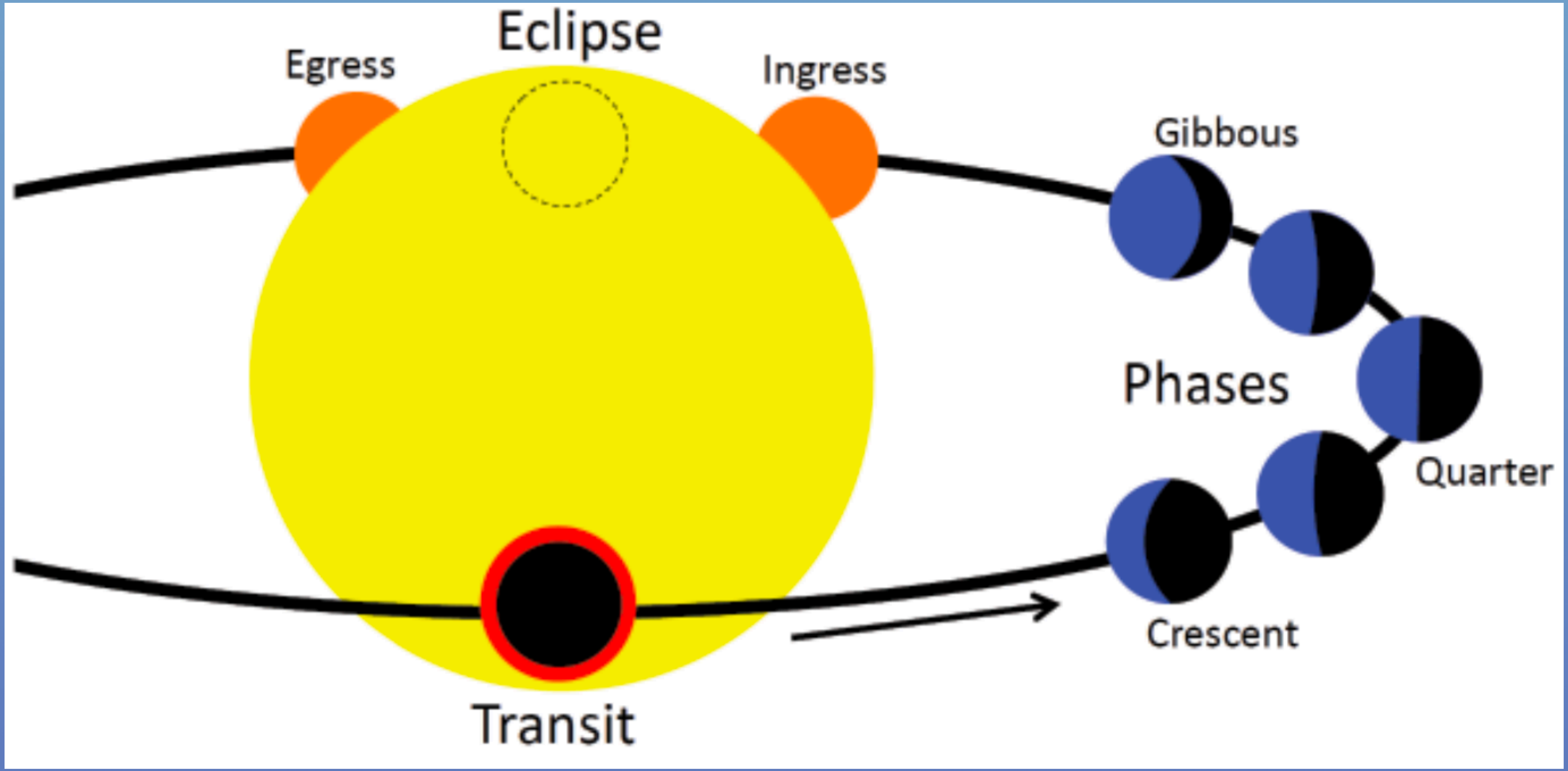


Montet, Yee, and Penny (2017)

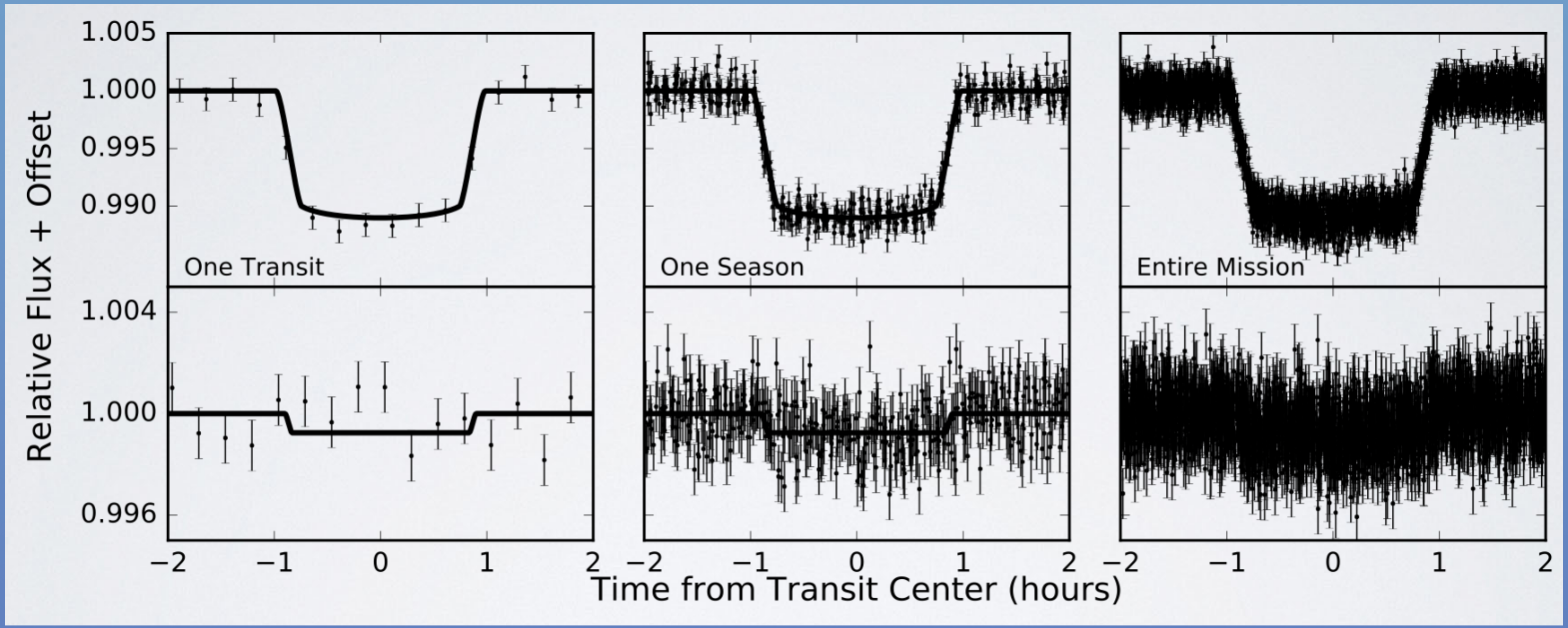
Confirming *Roman* planets



Cowan (2014)

Confirming *Roman* planets

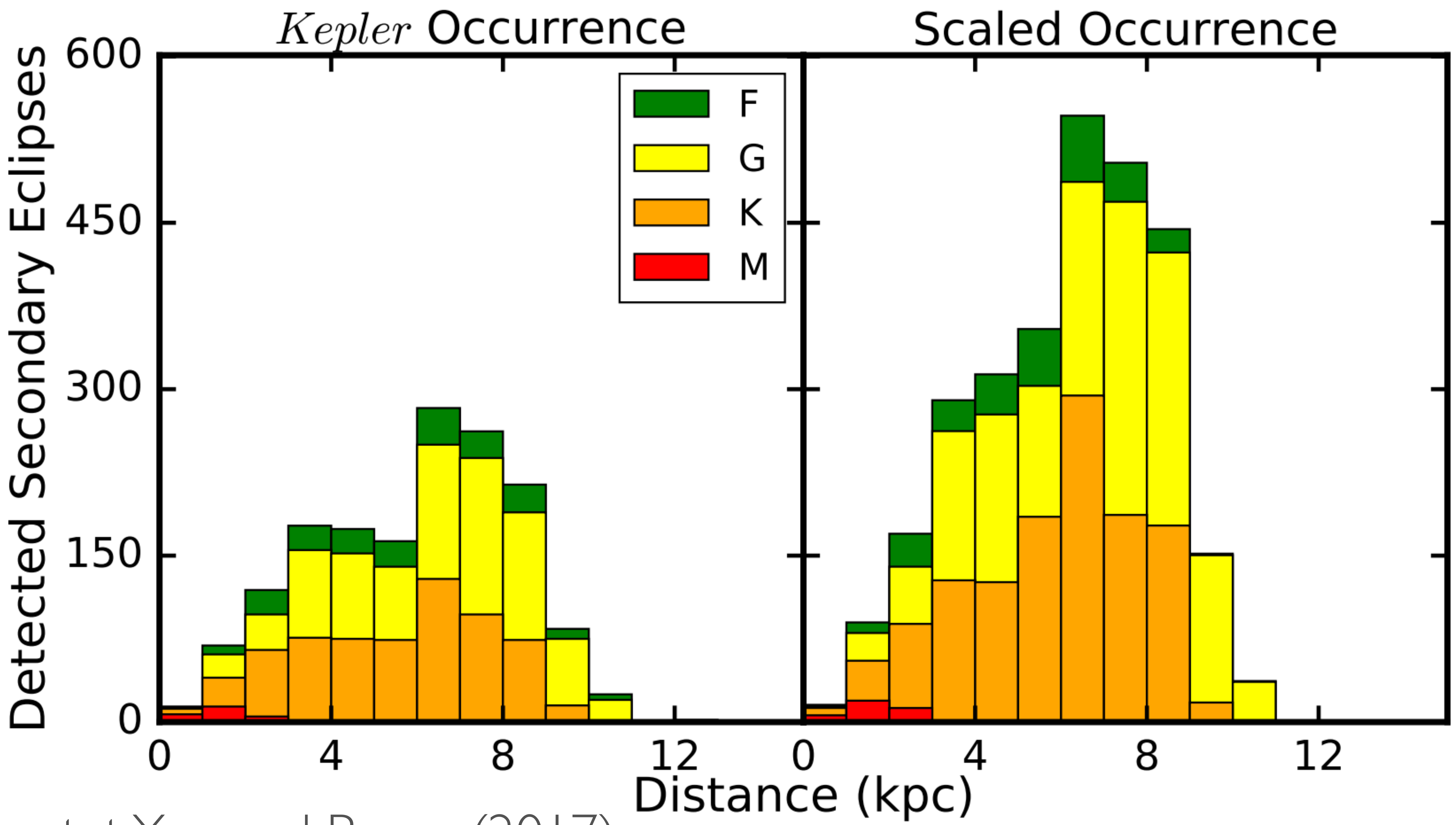
"Primary" Transits



"Secondary" Eclipses

Montet, Yee, and Penny (2017)

Secondary eclipses with *Roman*



Montet, Yee, and Penny (2017)

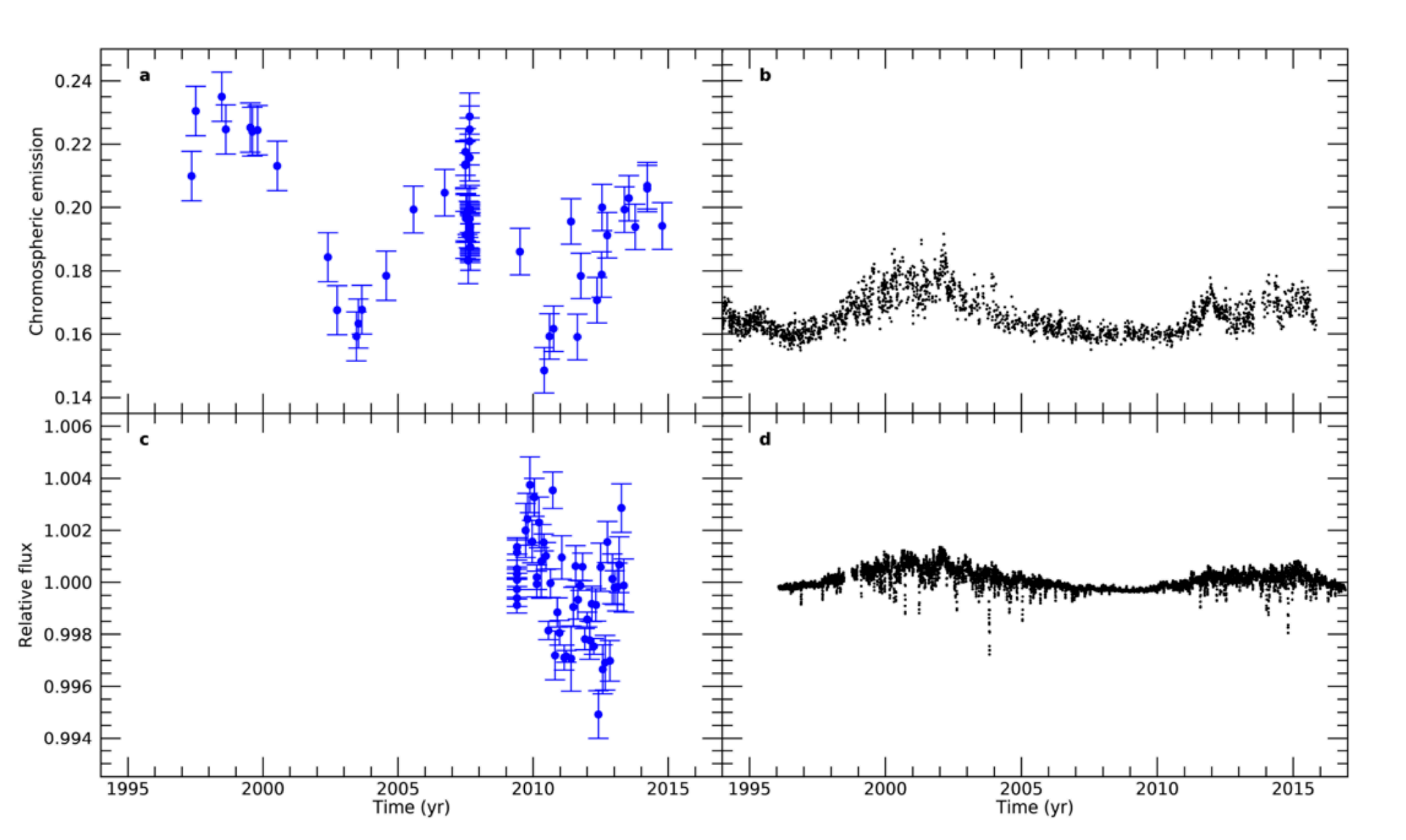
There will be on average, 11 transiting planets per every square arcminute in the *Roman* microlensing field

There will be ~100 unknown planets that do not transit to be discovered in each square arcsin!

Also much to learn about stellar activity from photometric monitoring and RV time series of these systems

Big question: Do we know these planets can survive such crowded environments?

Montet, Yee, and Penny (2017)



Karoff et al. 2018

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NGC 6791: an old, metal-rich cluster

Montet et al. in prep

Dark Horse Observatory

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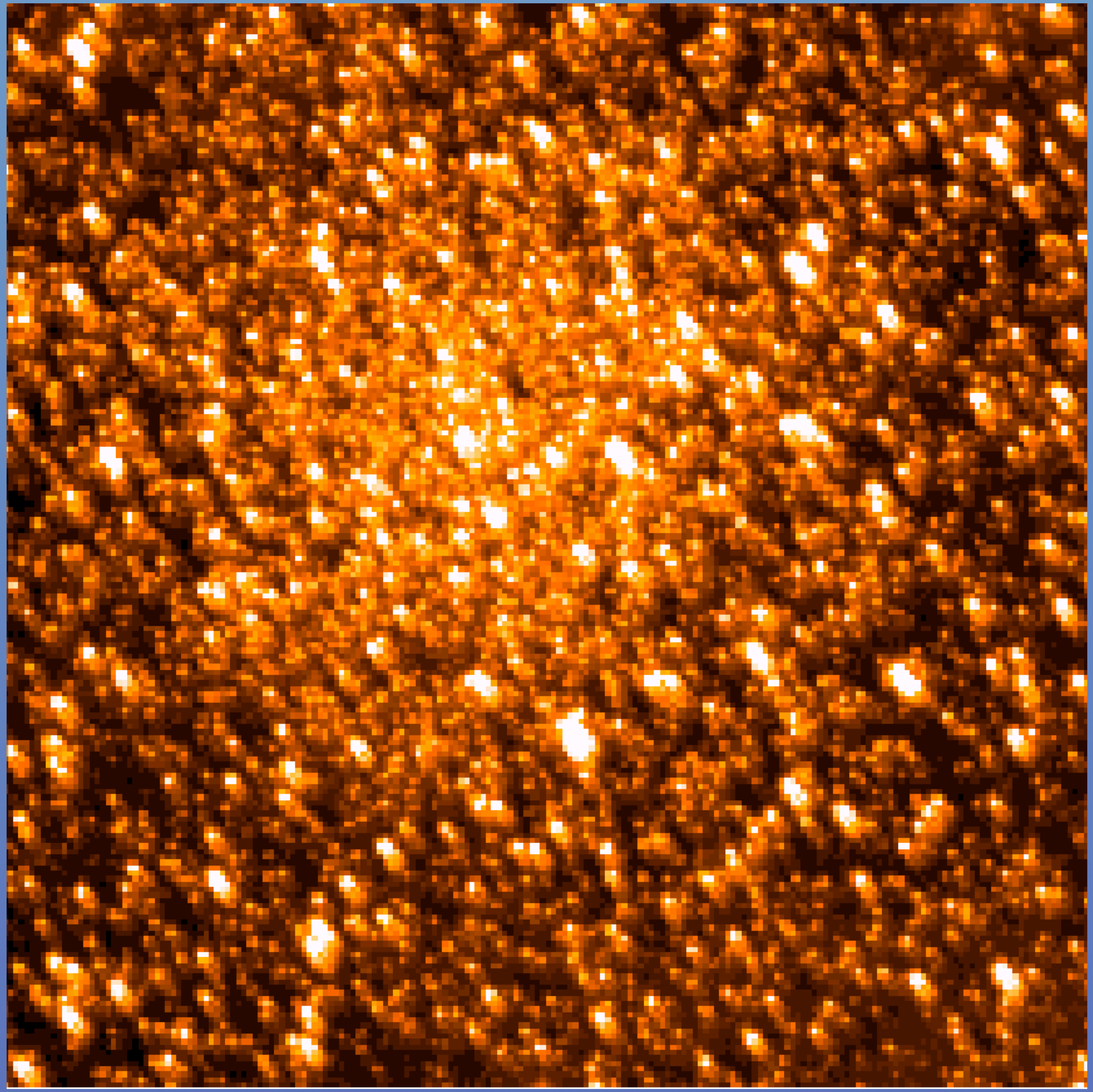

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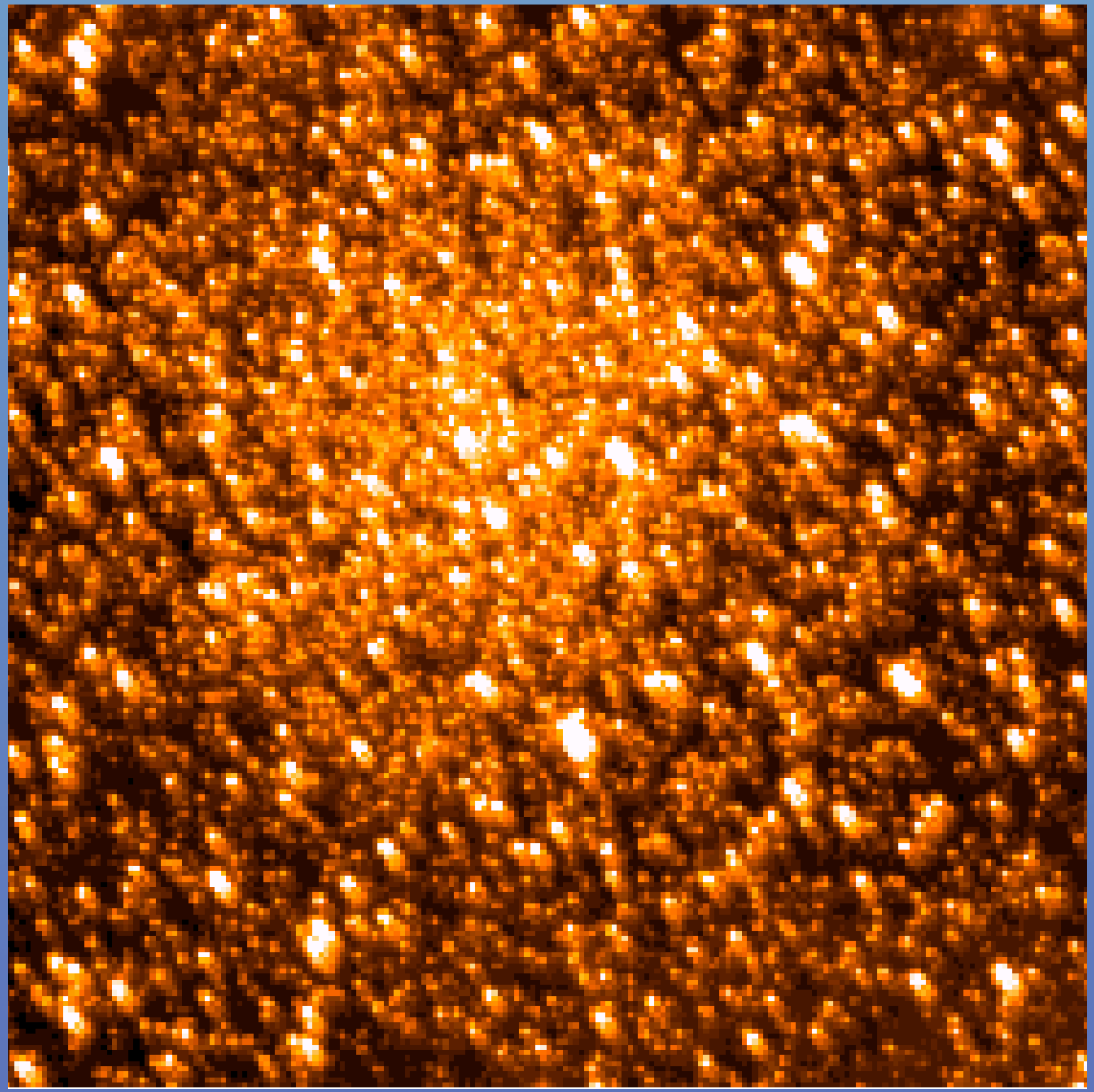
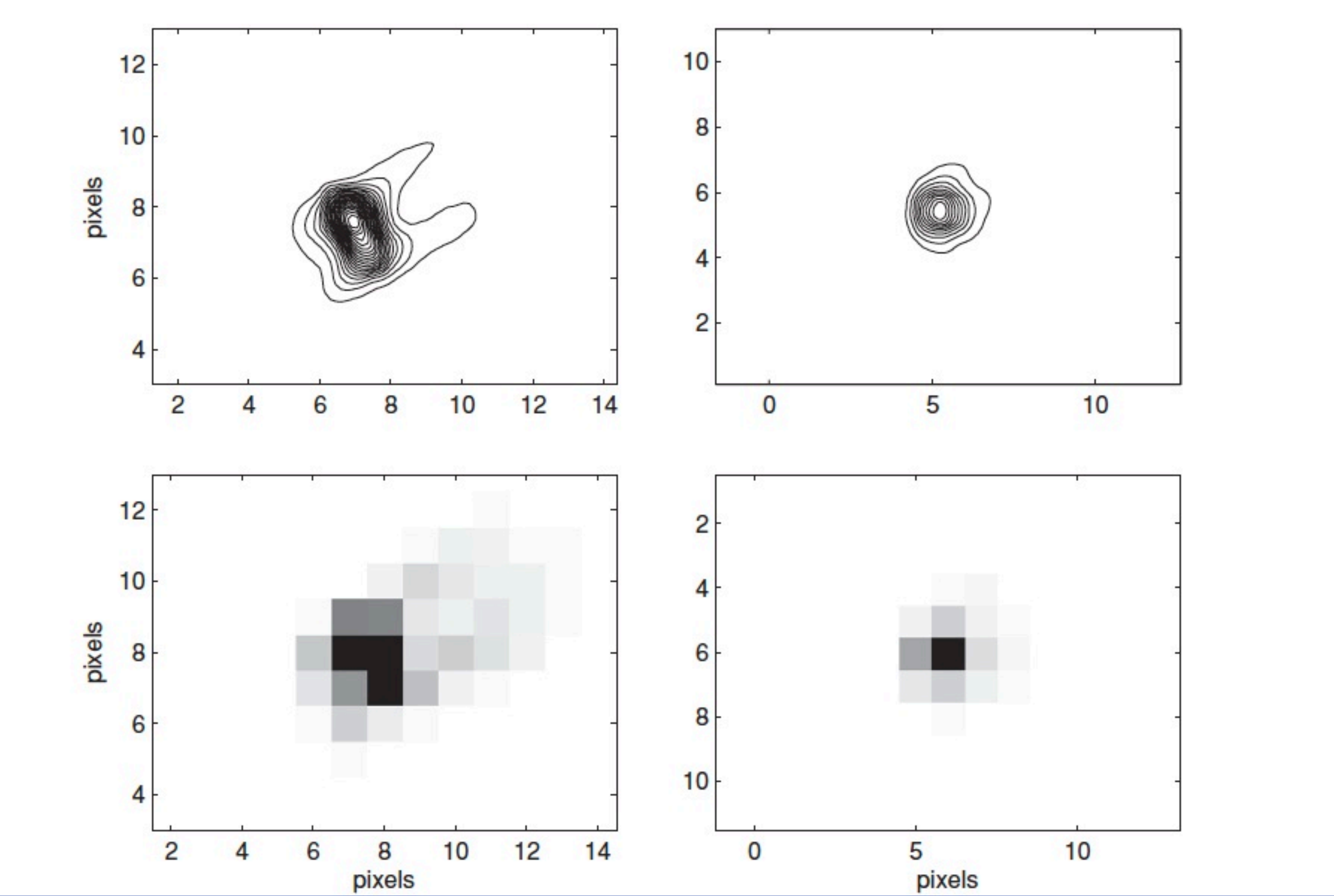


Montet et al. in prep

We can forward model the Kepler detector



TensorFlow

Bryson et al. 2010

Montet et al. in prep

NGC 6791 planet candidates… but no hot Jupiters

Montet et al. in prep

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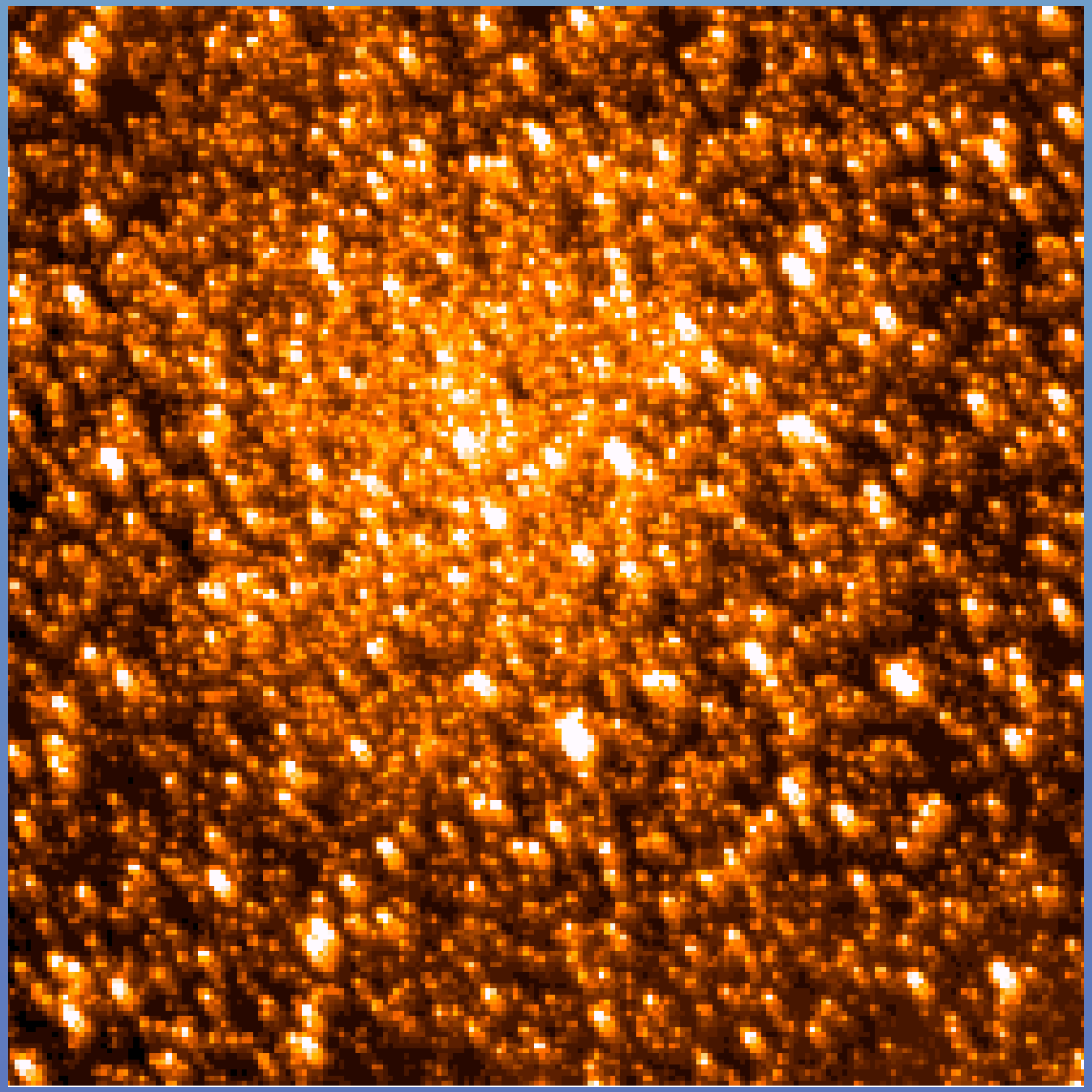
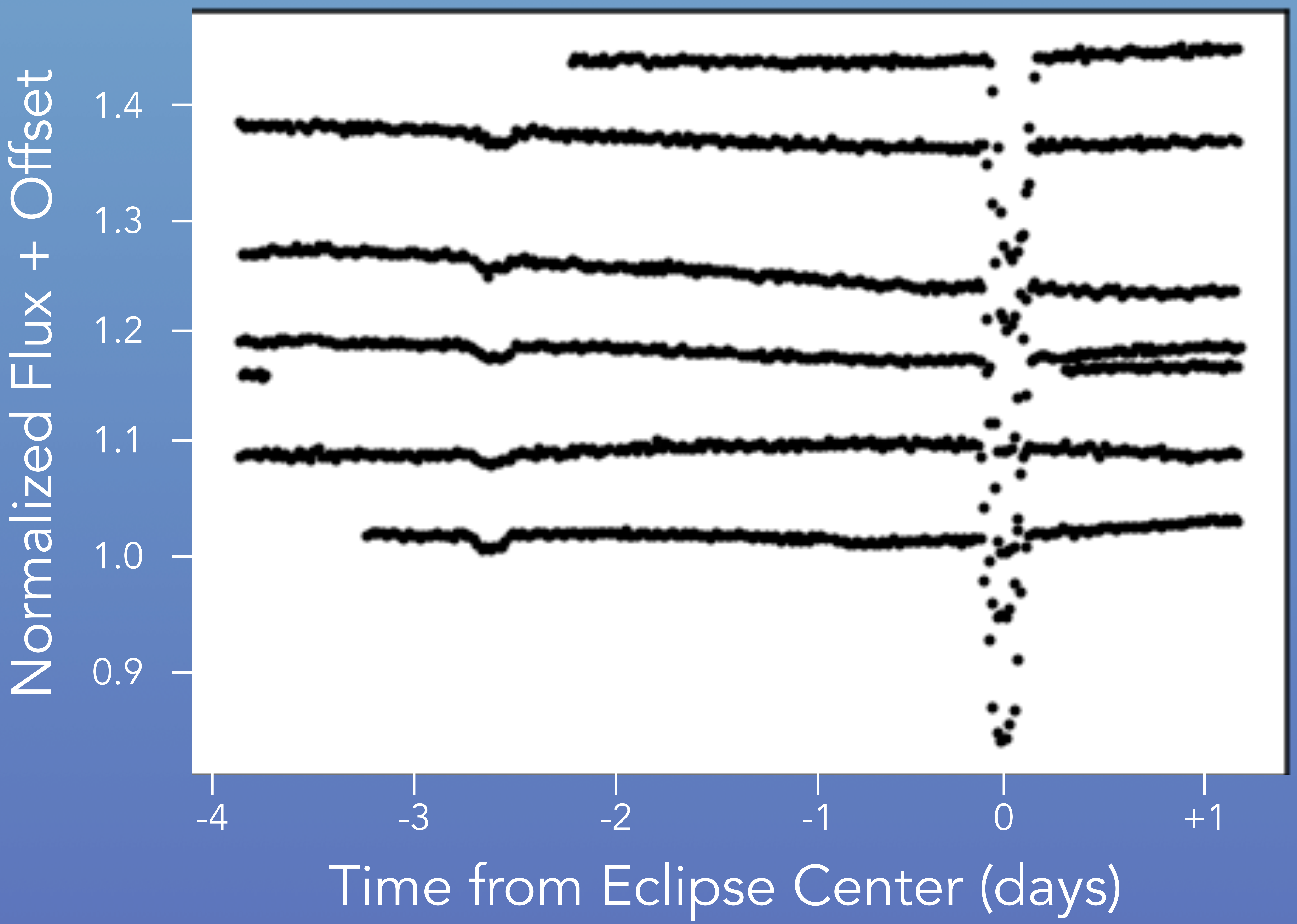
Extreme stellar systems: eclipsing binaries





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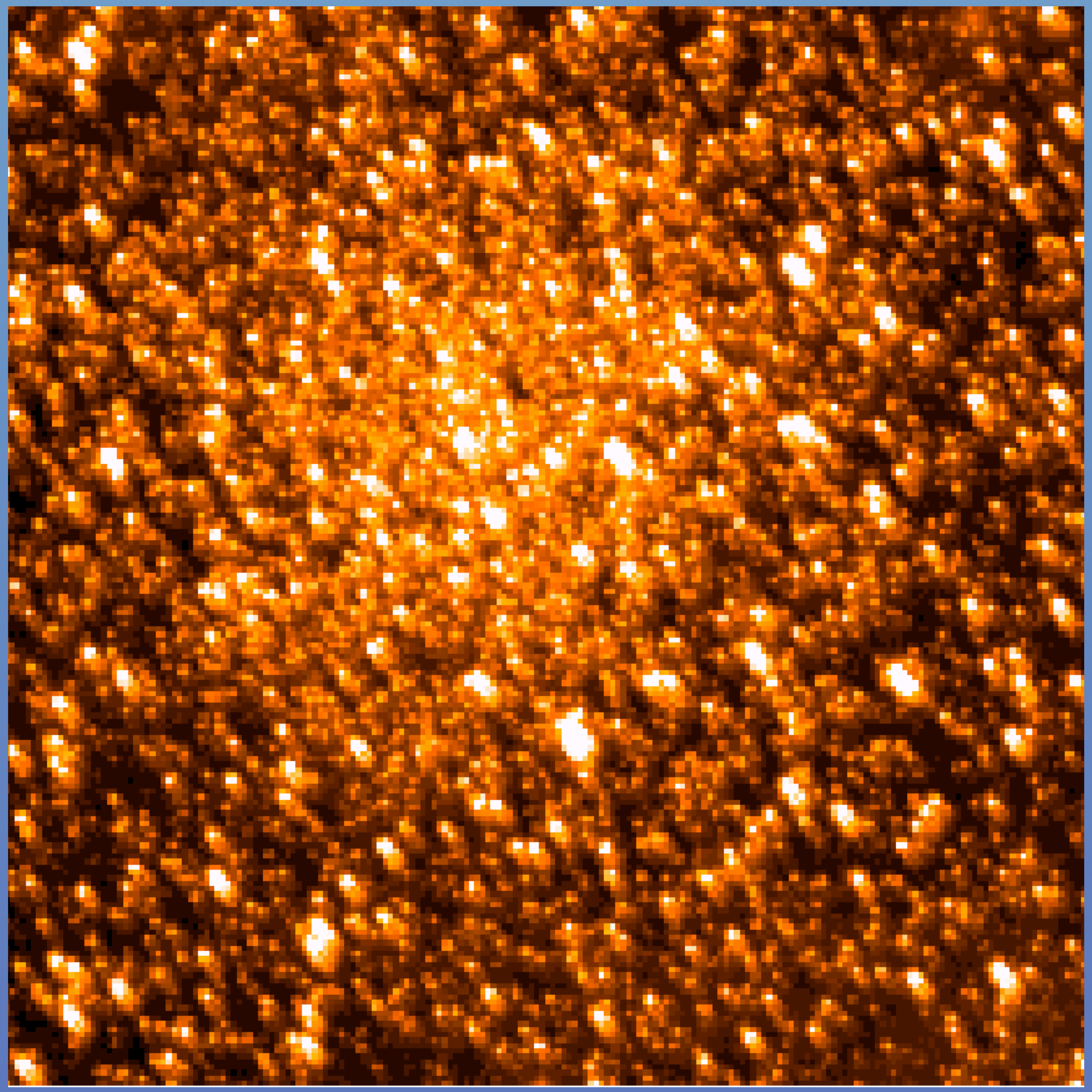
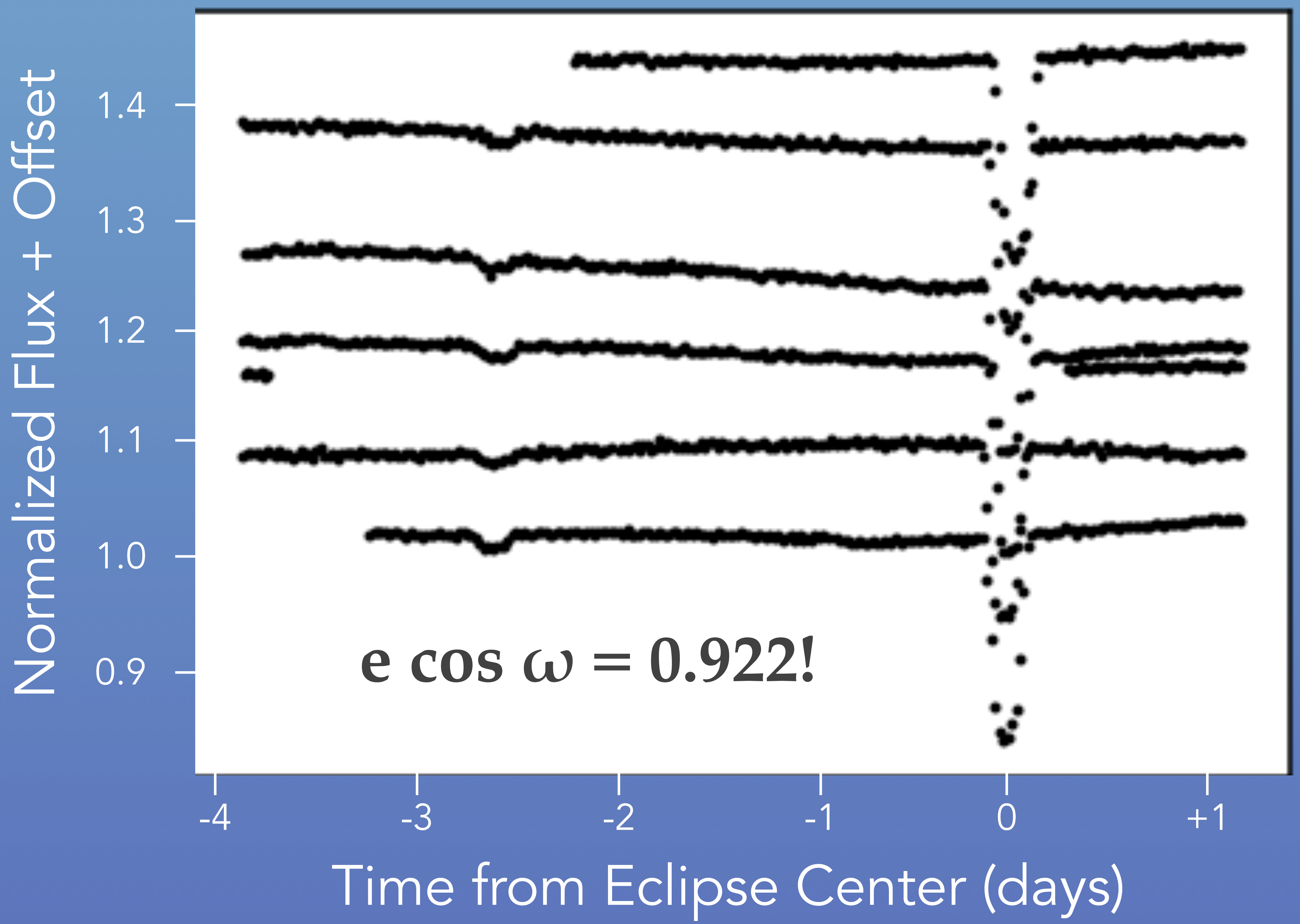
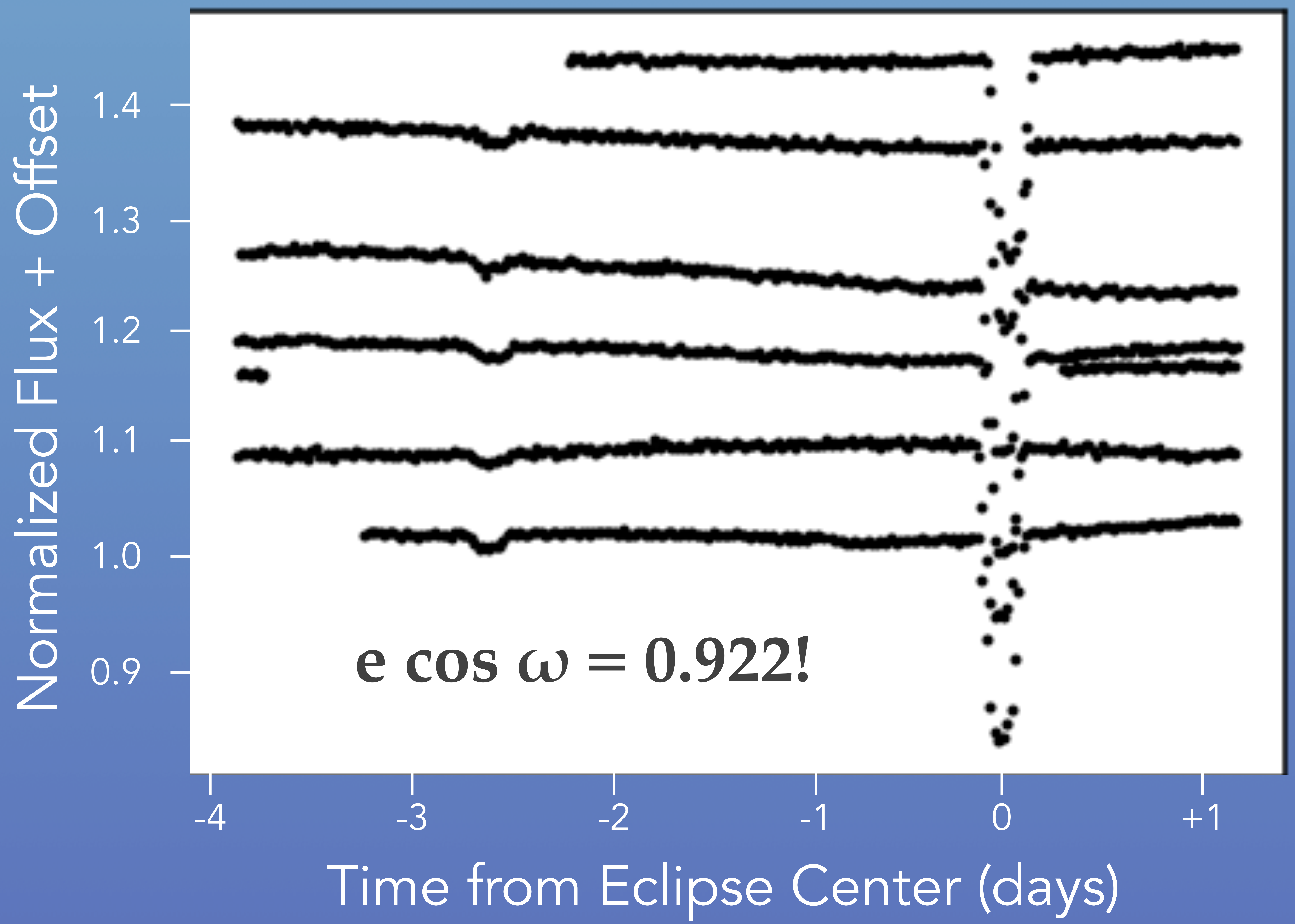




HRMOS can measure binary obliqities to understand the dynamics of orbits in these environments



Understanding how environment affects planet formation is one of the key open questions over the next decade of exoplanet science

TESS is exploring young moving groups

Direct imaging is exploring wider separation planets

Gaia will find all the old Jupiter analogs

HRMOS is one of our best opportunities for dense environments

Teaming up with *Roman* is even more powerful

Thank you!

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