# Transiting brown dwarfs from the TESS mission

Theron Carmichael
TESS Science Conference I

Image credit:
Mark Garlick

CENTER FOR ASTROPHYSICS
HARVARD & SMITHSONIAN

# Brown dwarfs and where to find them

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- 22 transiting brown dwarfs

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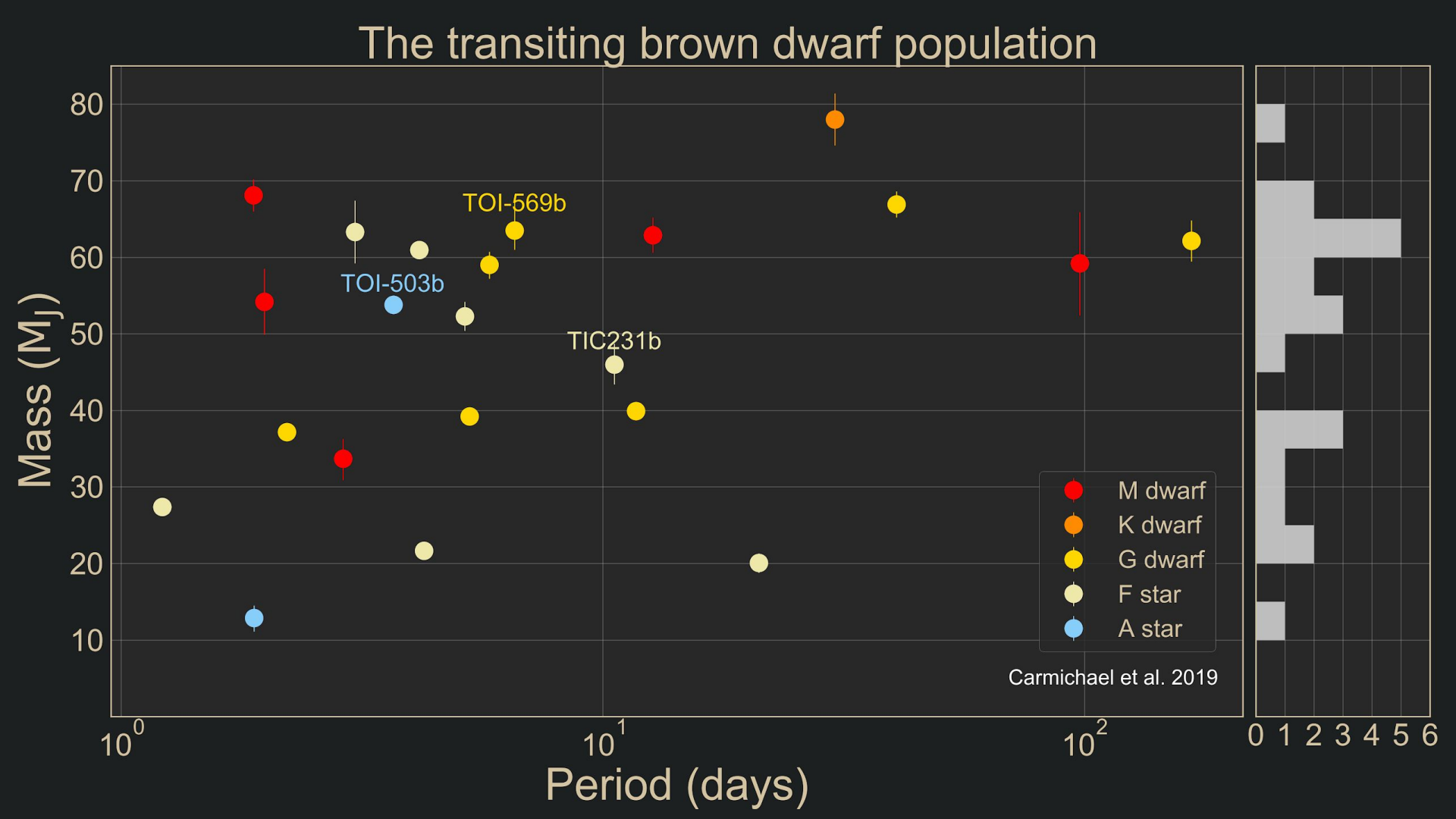
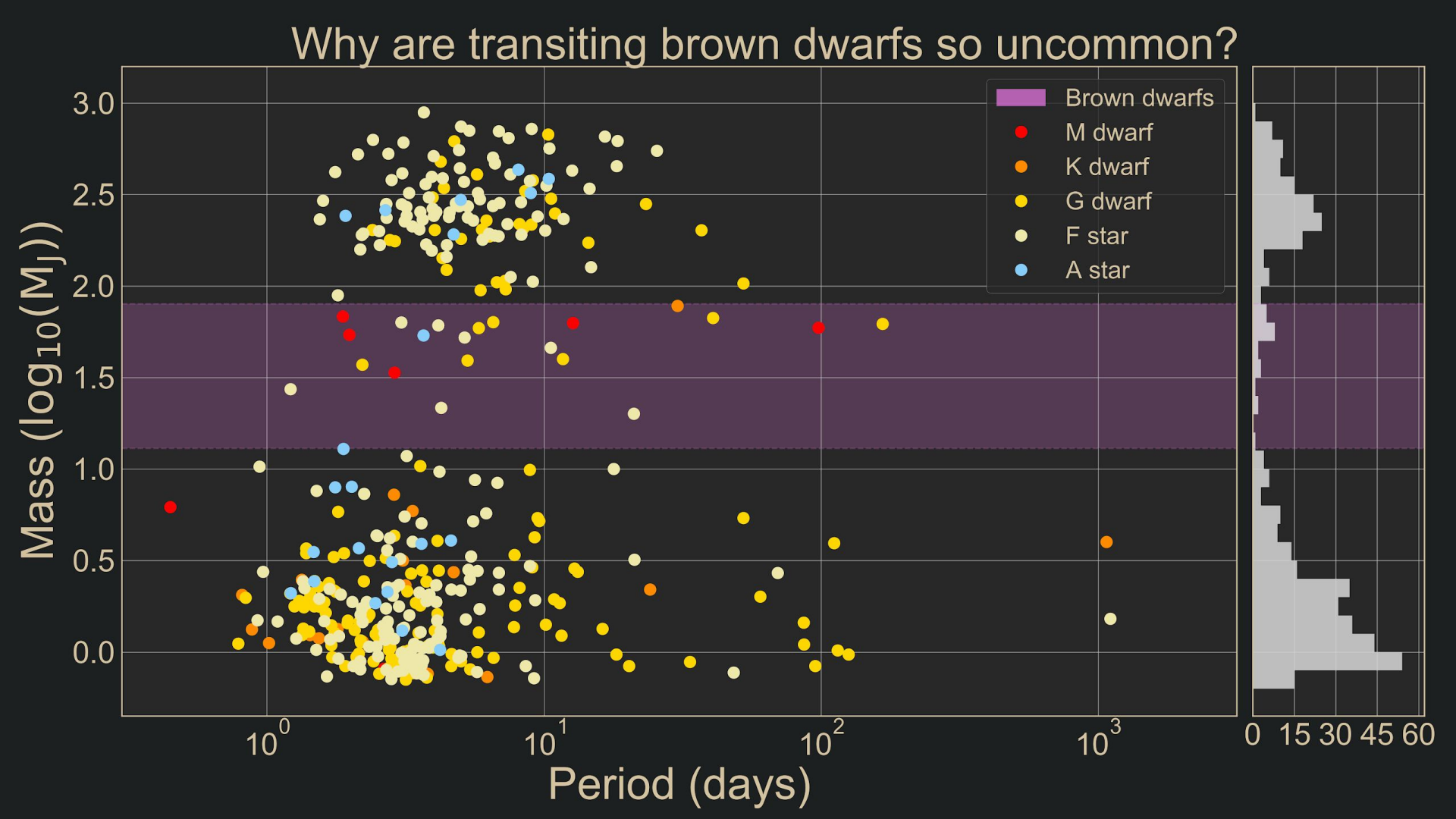
- Objects between 13 and 80Mj
- 22 transiting brown dwarfs
- One eclipsing brown dwarf binary


The transiting brown dwarf population
Mass ($M_J$)
Period (days)
TOI-569b
TOI-503b
TIC231b
M dwarf
K dwarf
G dwarf
F star
A star
Carmichael et al. 2019


Why are transiting brown dwarfs so uncommon?
Brown dwarfs
M dwarf
K dwarf
G dwarf
F star
A star
Mass ($\log_{10}(M_J)$)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
$10^0$
$10^1$
$10^2$
$10^3$
Period (days)
0
15
30
45
60

# The big questions

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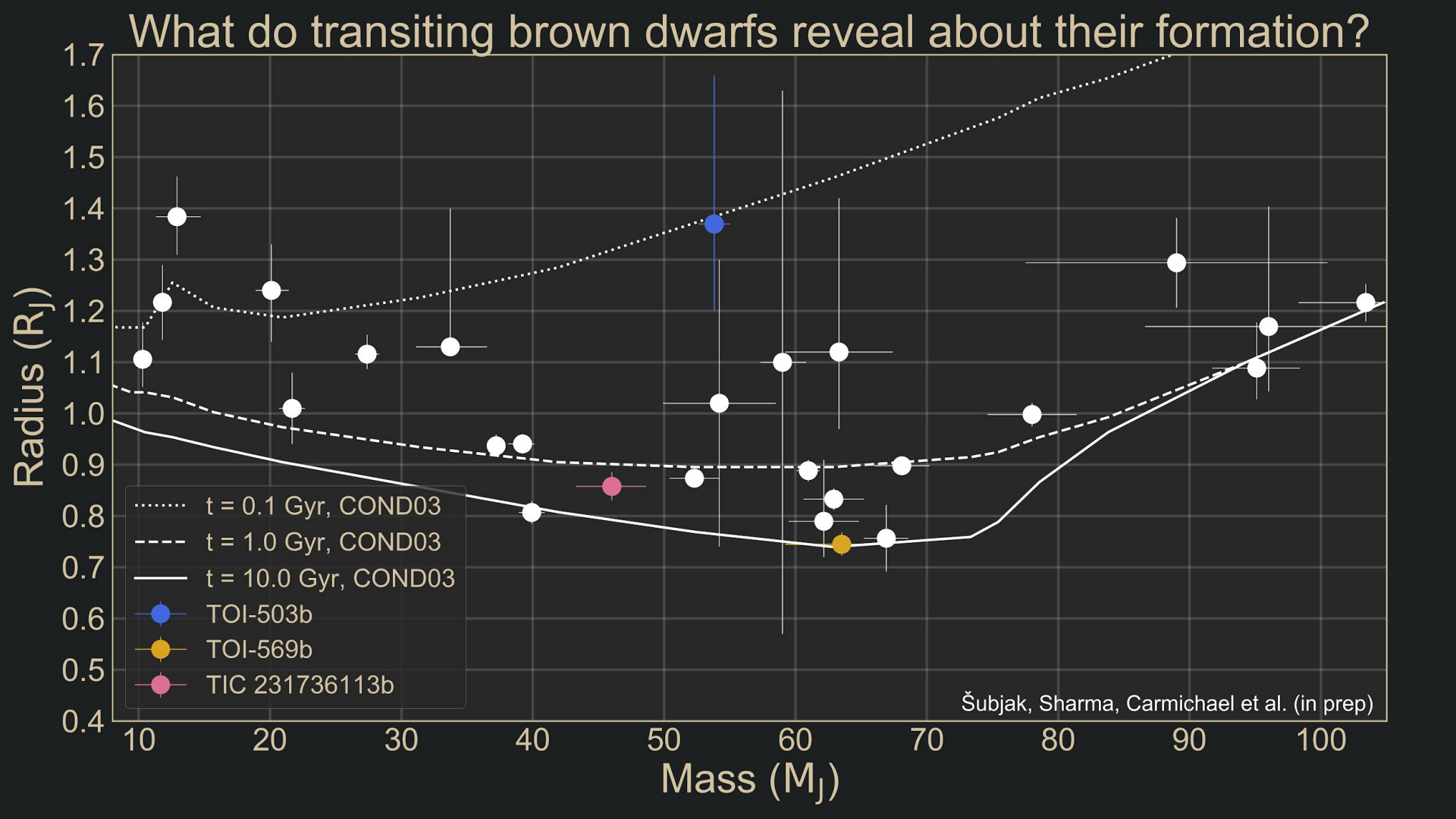
- How to brown dwarfs form?
  - Like stars?
  - Like planets?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Radius ($R_J$)
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1.7
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0.6
0.5
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10
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t = 0.1 Gyr, COND03
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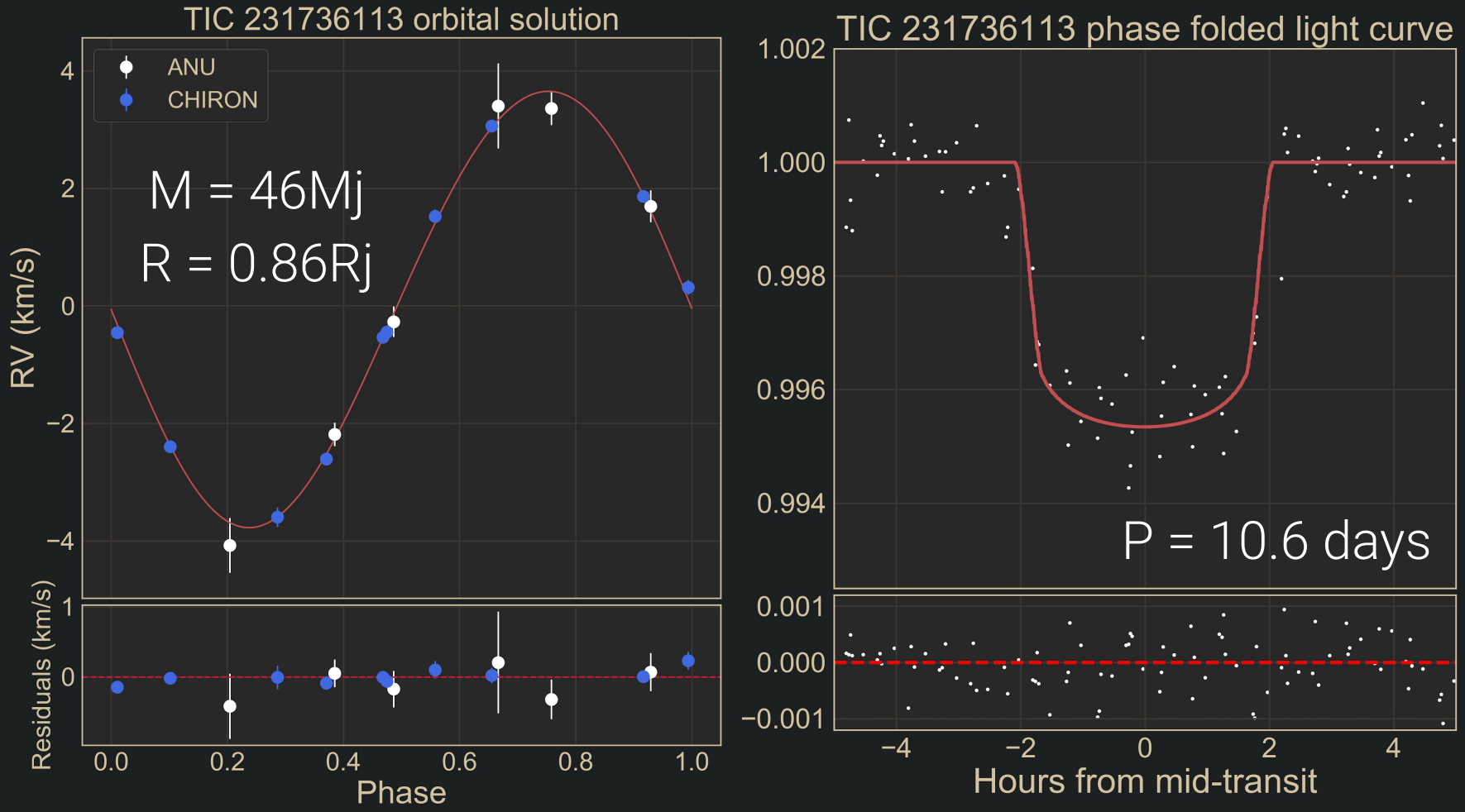
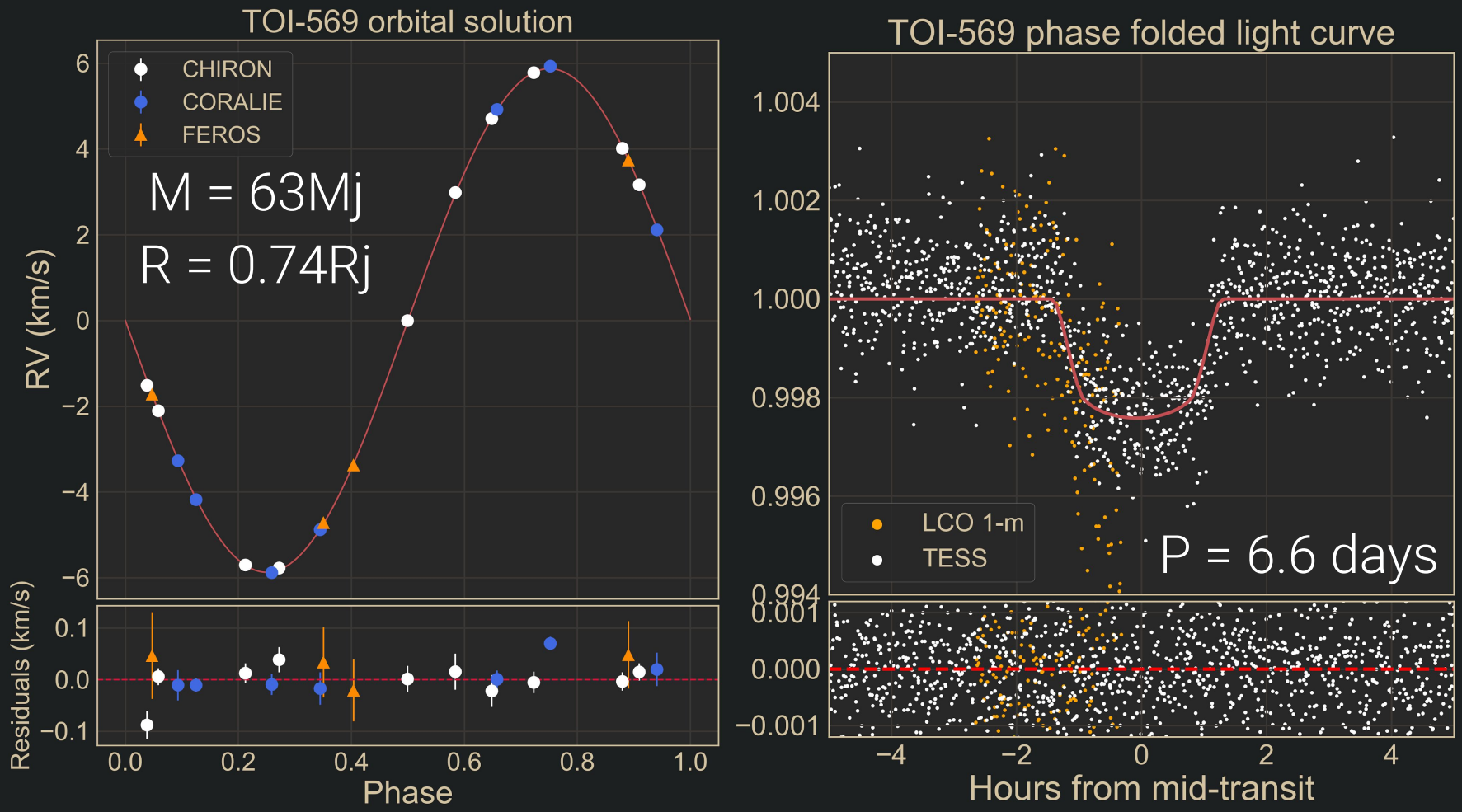
TOI-503b
TOI-569b
TIC 231736113b
Šubjak, Sharma, Carmichael et al. (in prep)




Carmichael & TFOP team et al. in prep

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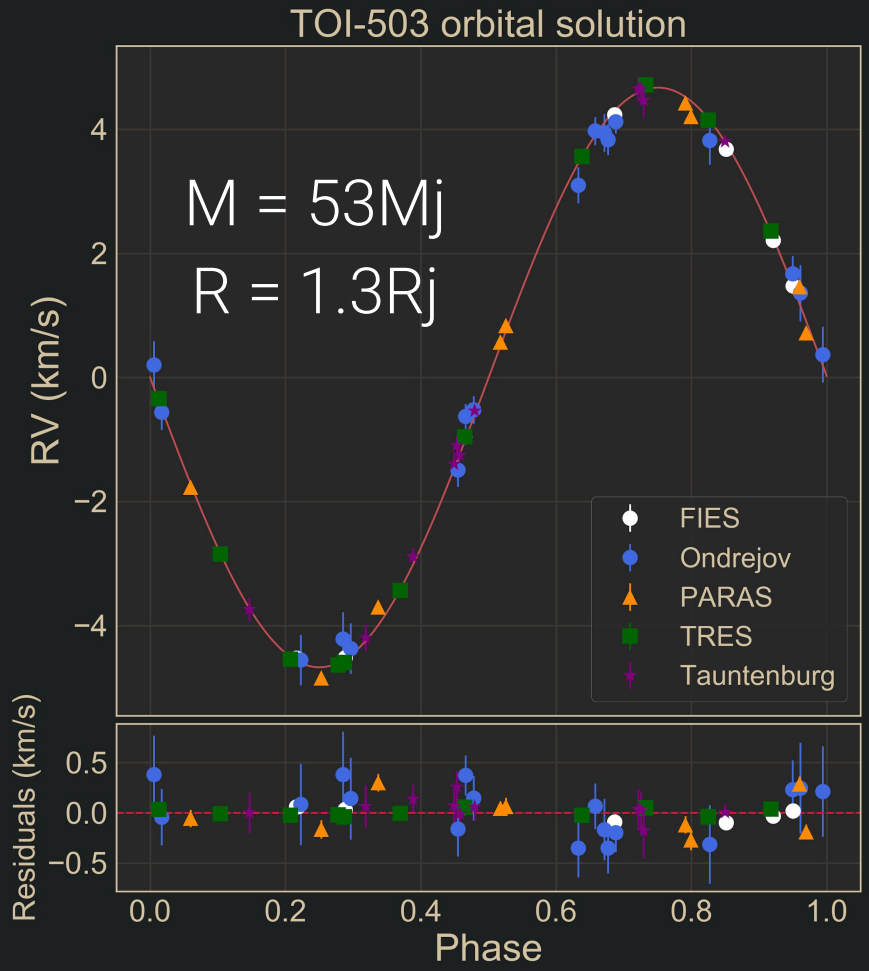


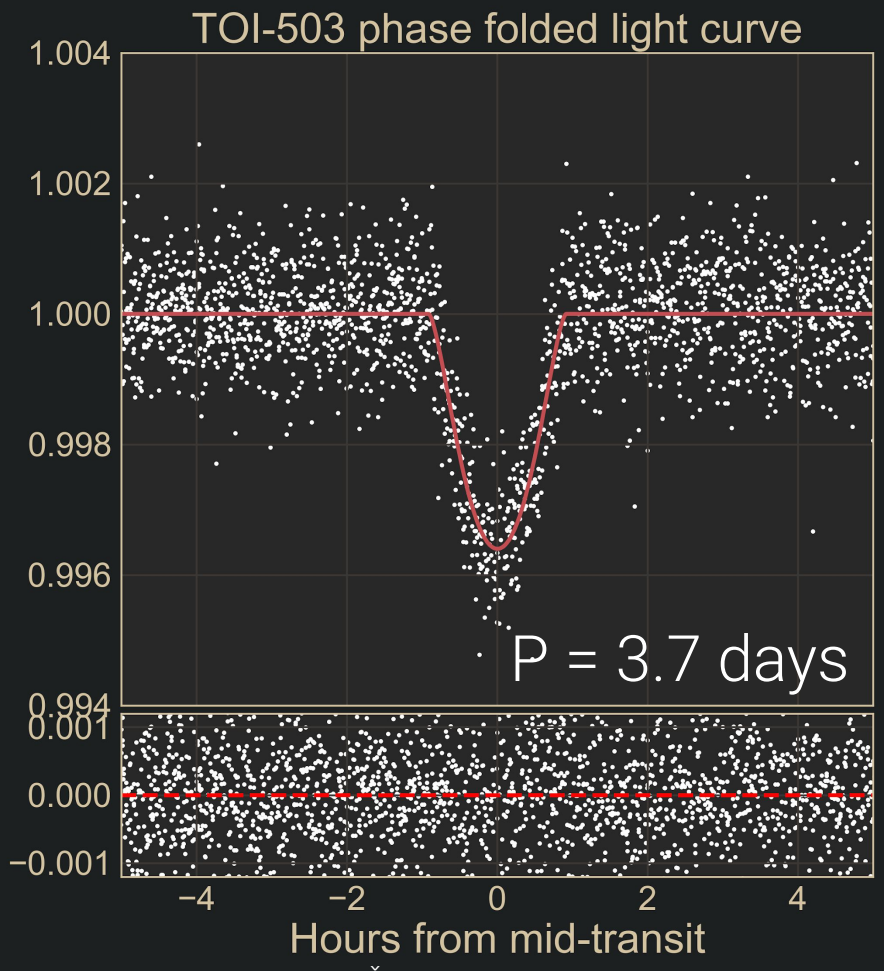


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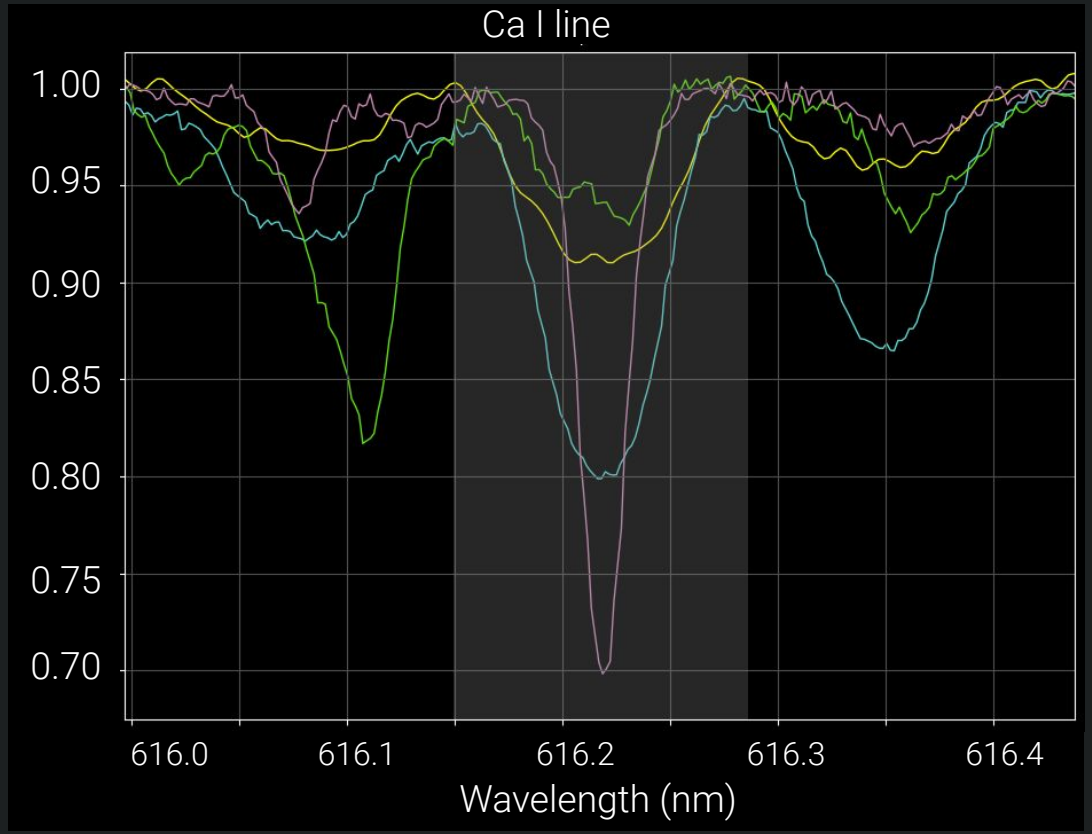
- First Am star known to host a brown dwarf

# The TOI-503 system

- [Fe/H] = +0.6
- [Ca/H] = -0.4




Analysis by Ján Šubjak; poster #20

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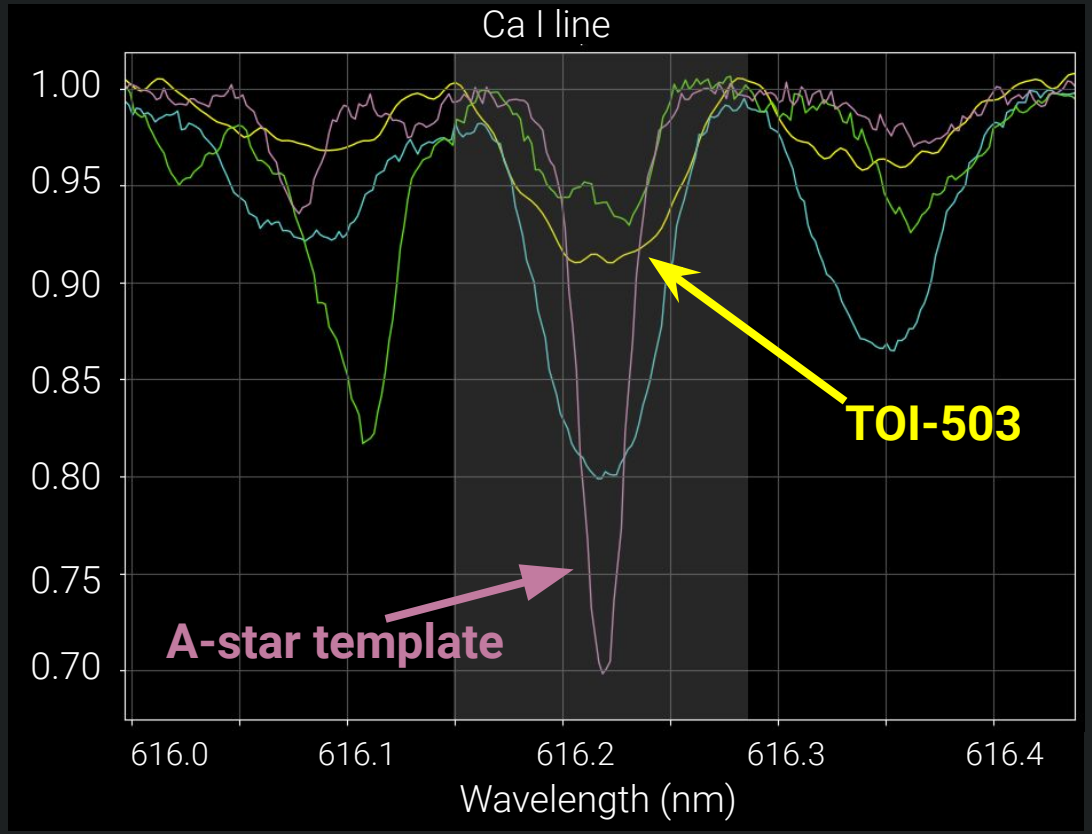


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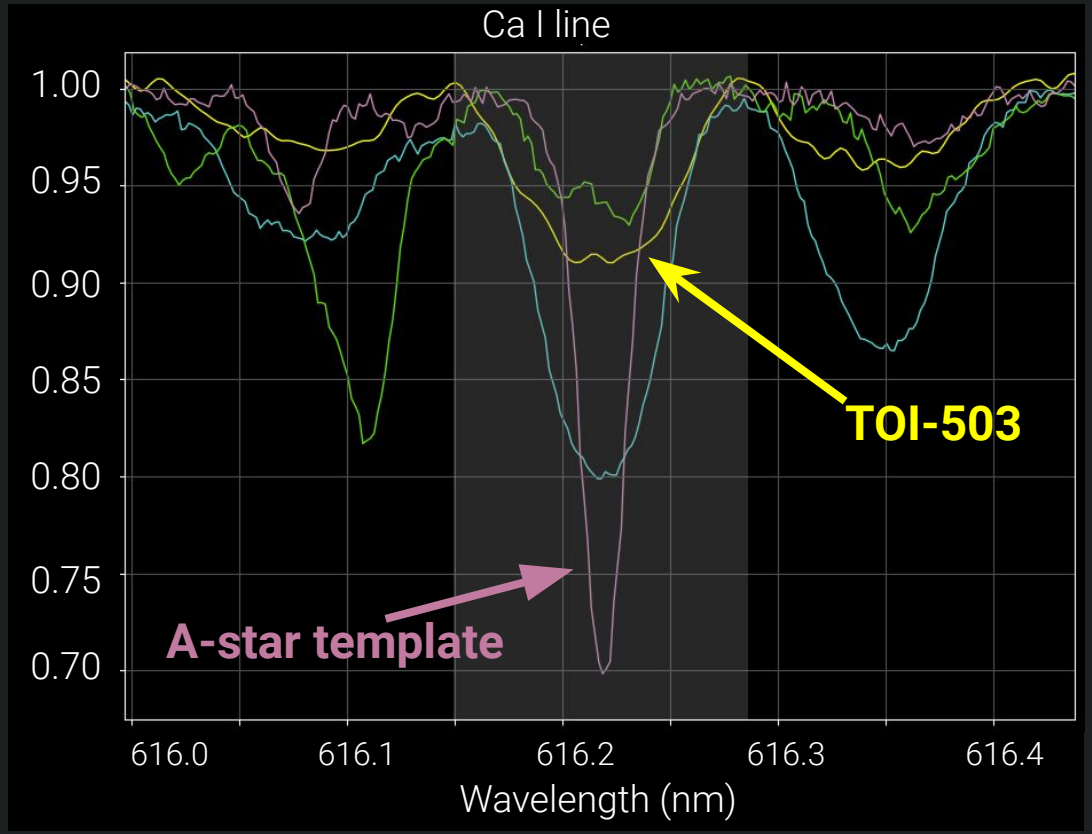
**Depleted in Ca I**

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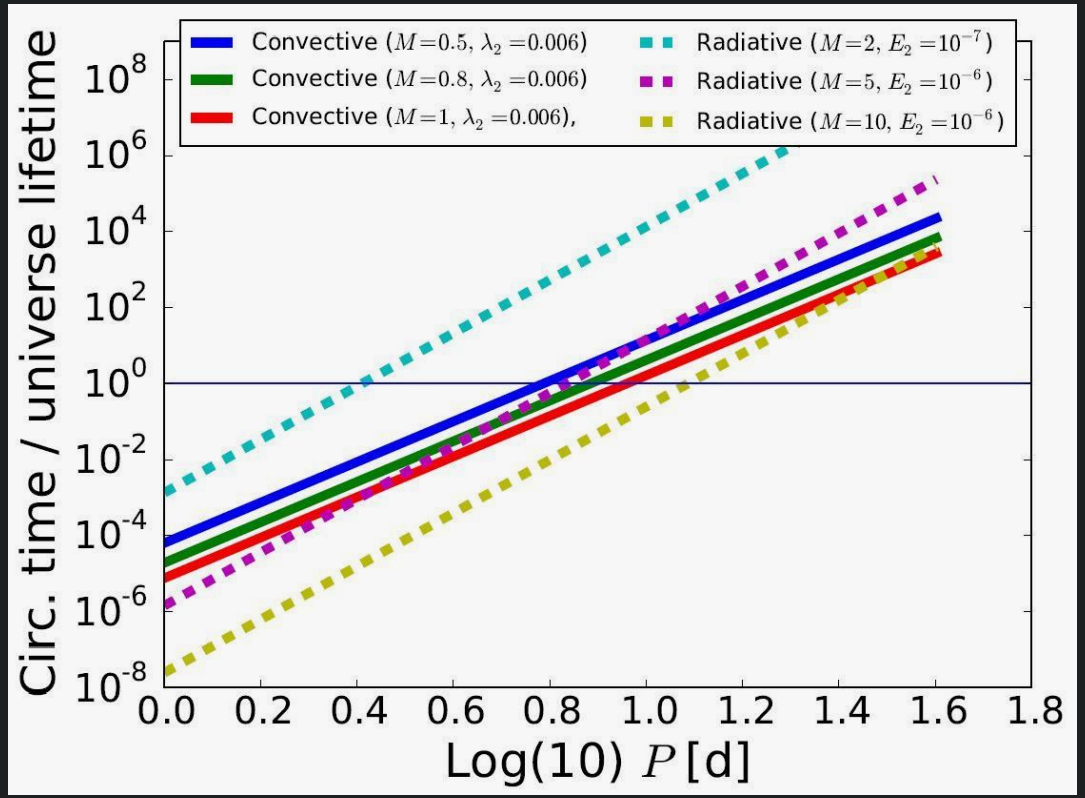


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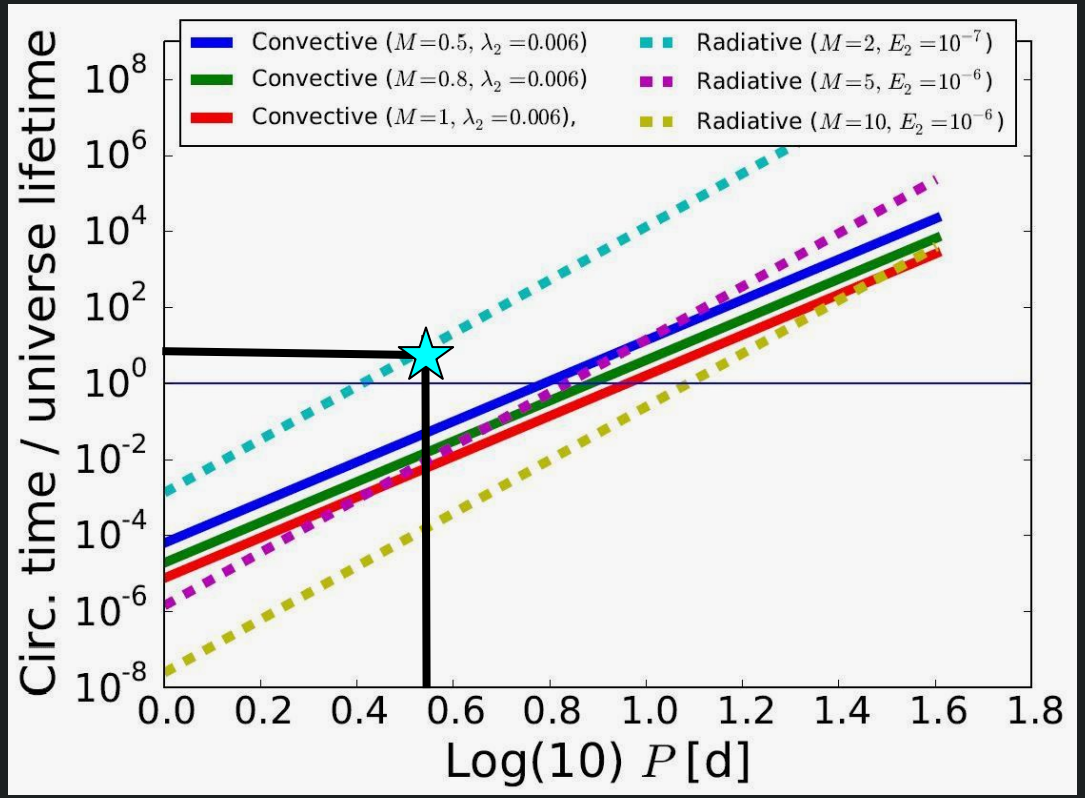


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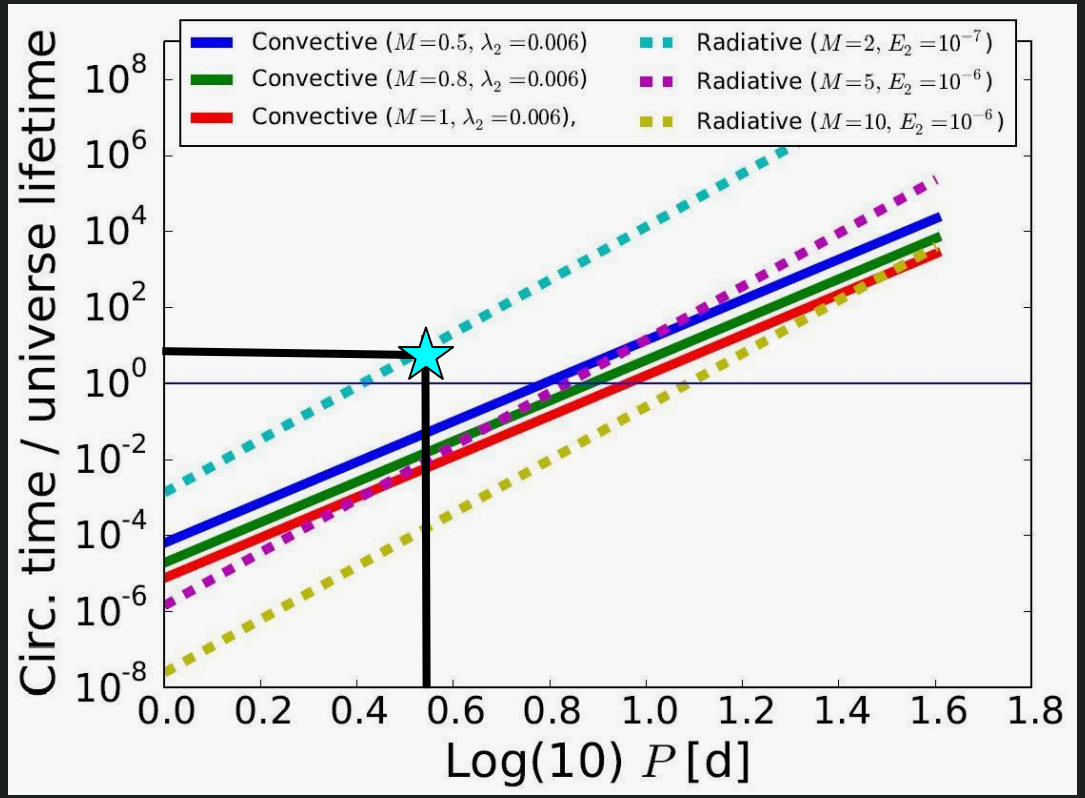
# The TOI-503 system

- Did TOI-503b form in-situ?

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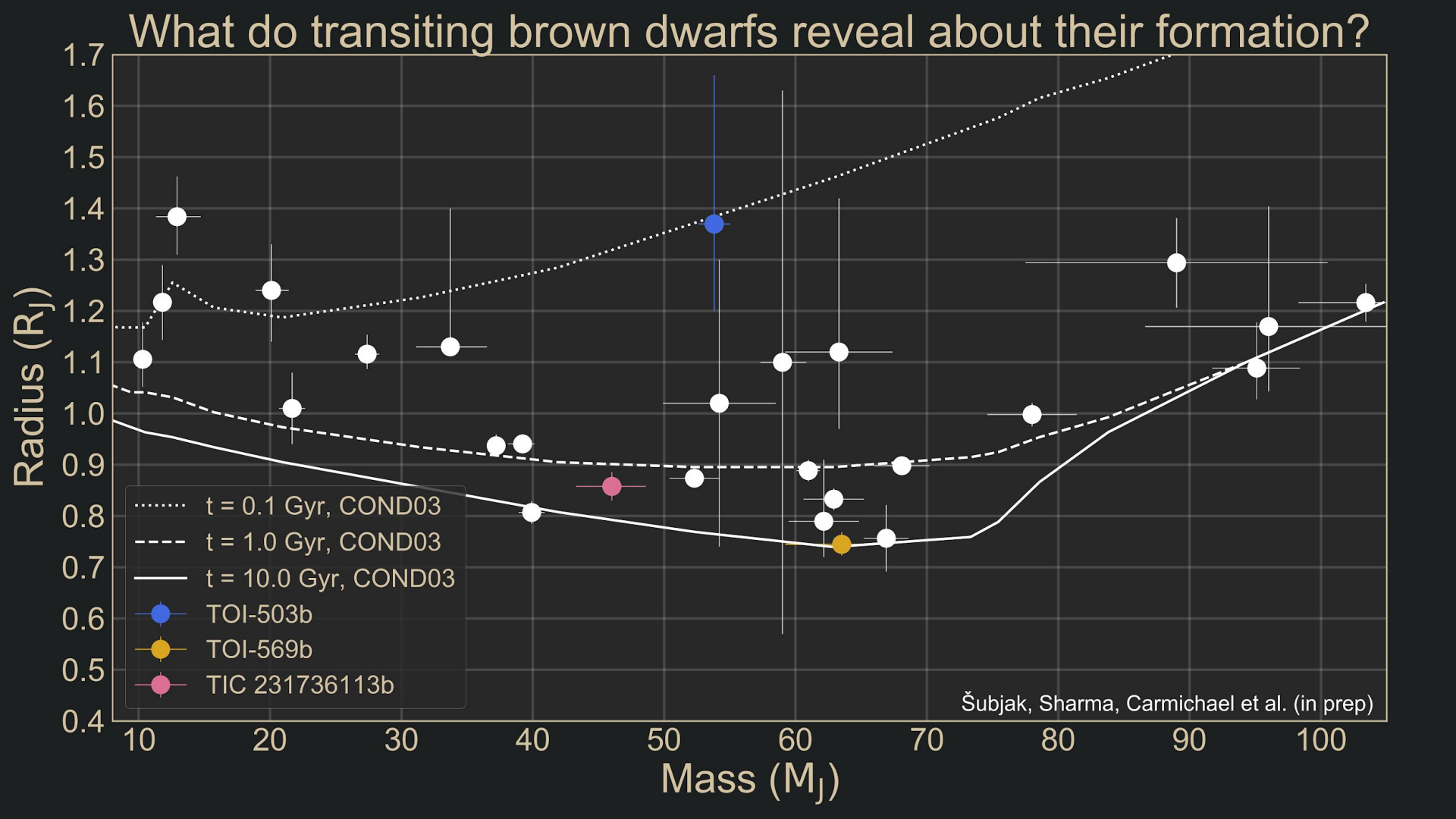
# Final thoughts

- TESS has found 3 new brown dwarfs
- Transiting brown dwarfs tells us about their evolution
- Expect this population to grow for TESS Science Conference II

@Therbaer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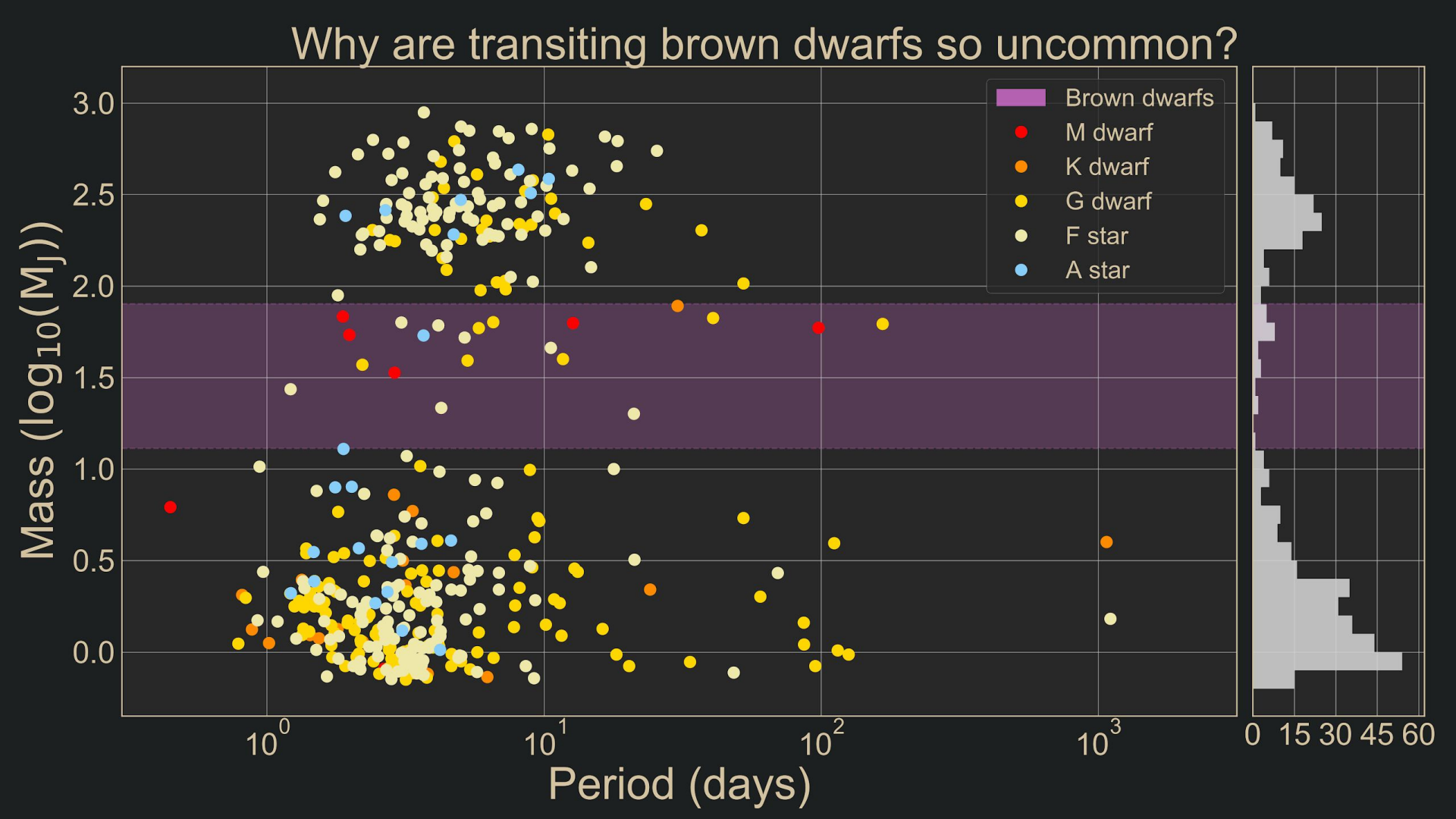
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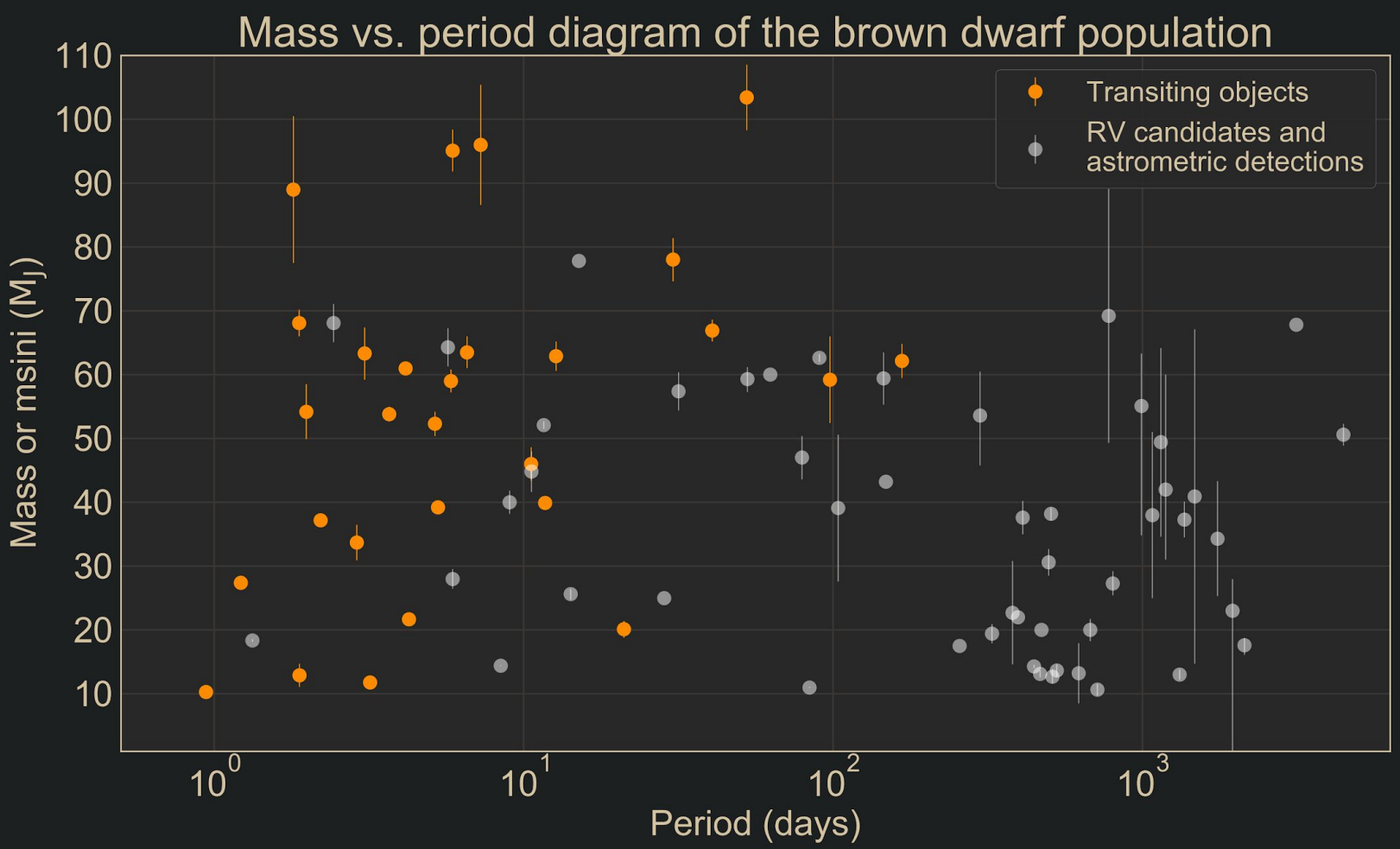
Mass vs. period diagram of the brown dwarf population
Transiting objects
RV candidates and astrometric detections
Mass or msini ($M_J$)
Period (days)
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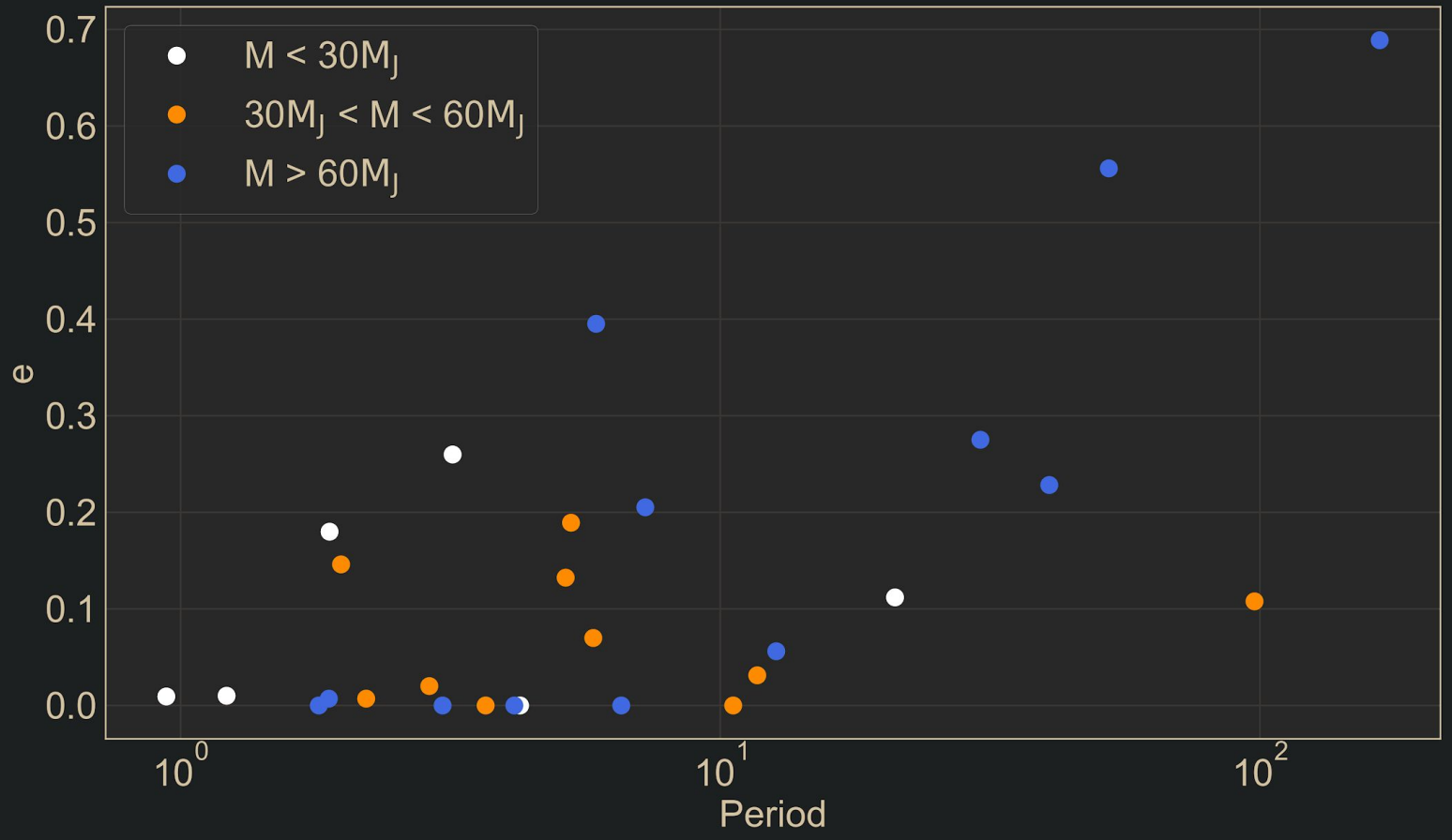
M < 30M_J
30M_J < M < 60M_J
M > 60M_J
e
Period
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
10^0
10^1
10^2

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# EBLM project

exoplanet.eu