

# Uniform search of new *TESS* transiting planet candidates in the Neptunian desert

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Lauren Doyle, Rodrigo Fernando Díaz, Luis Agustín Nieto



**UNIVERSITY  
OF WARWICK**

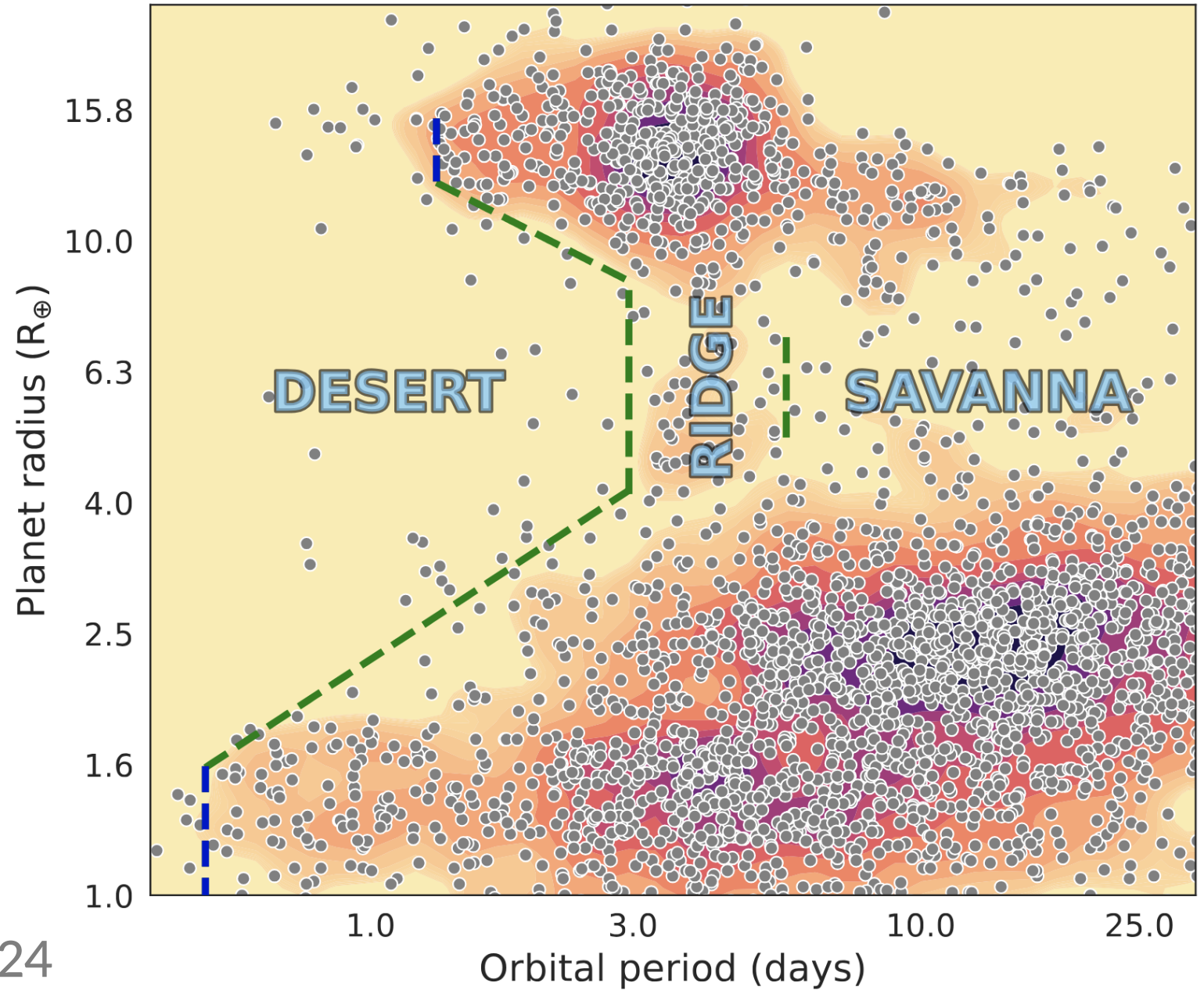


UK Research  
and Innovation



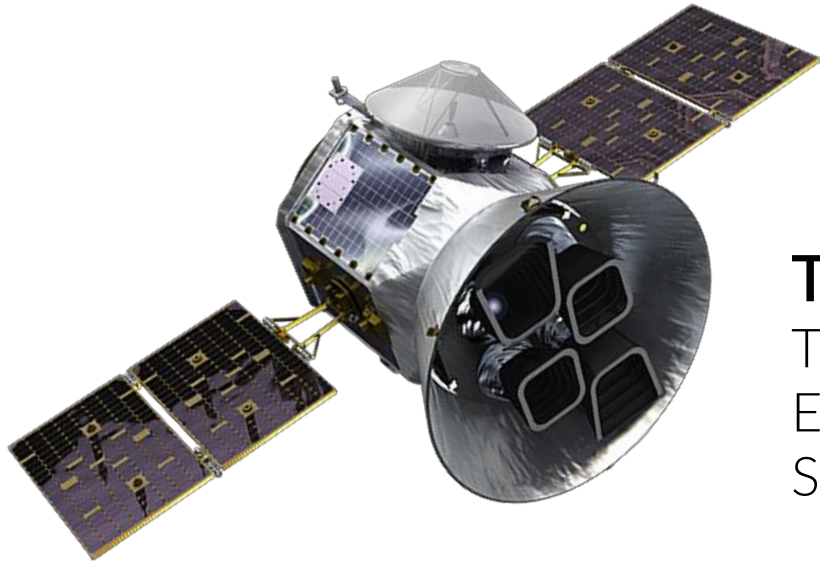
Detection and Dynamics of Exoplanets  
Coimbra, Portugal, July 2025

# Neptunian desert

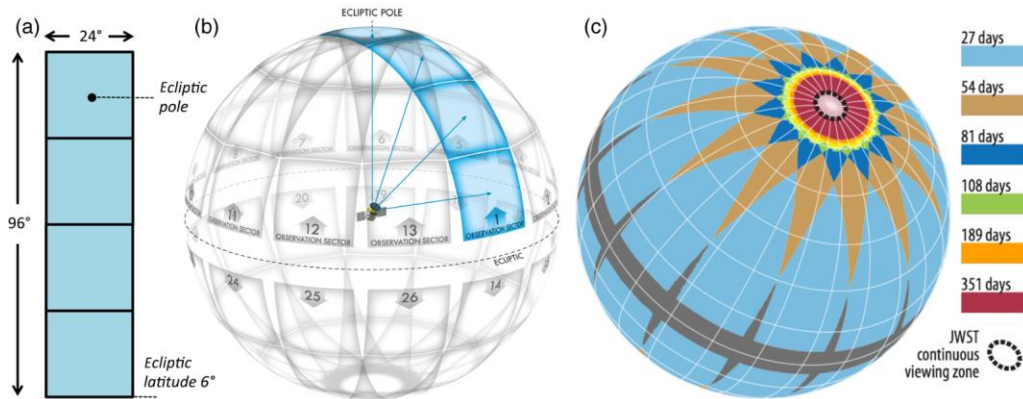


Castro-González et al. 2024

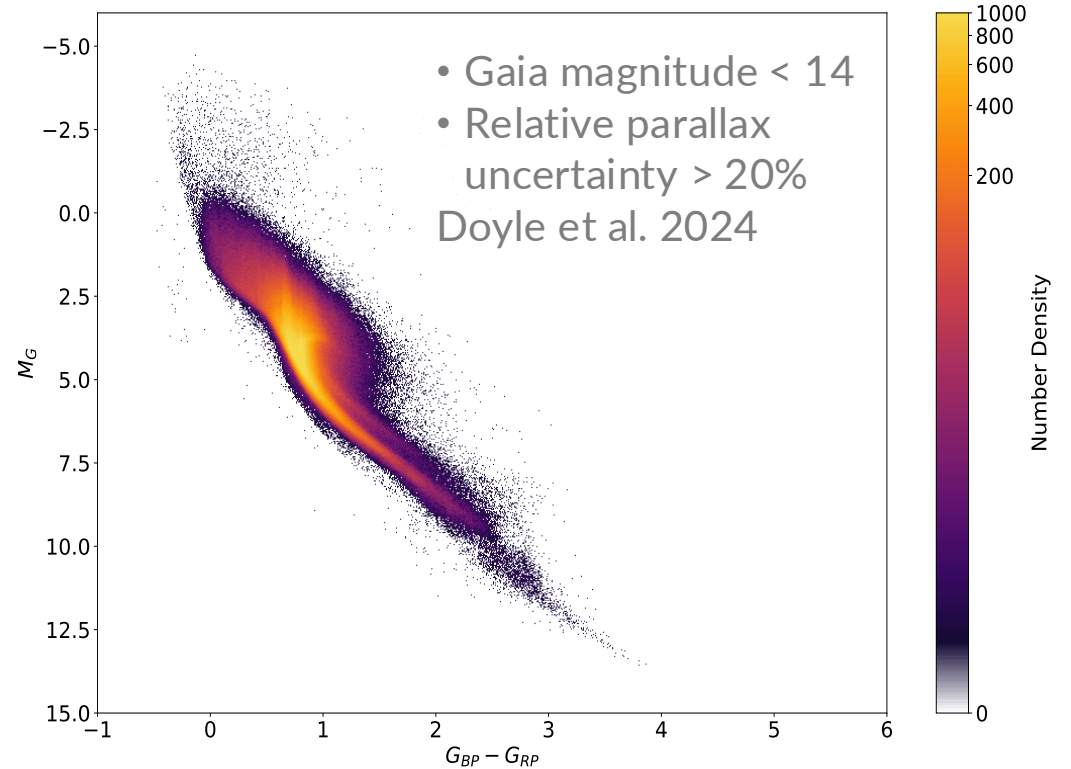
# Stellar sample & Data



**TESS**  
Transiting  
Exoplanet Survey  
Satellite



Ricker et al. 2015



All main sequence stars in the  
**TESS full frame images (FFI) SPOC** light curves  
(sectors 1-55) well-characterised by **Gaia**

- Over **2.3 million** targets
- Several million TESS light curves



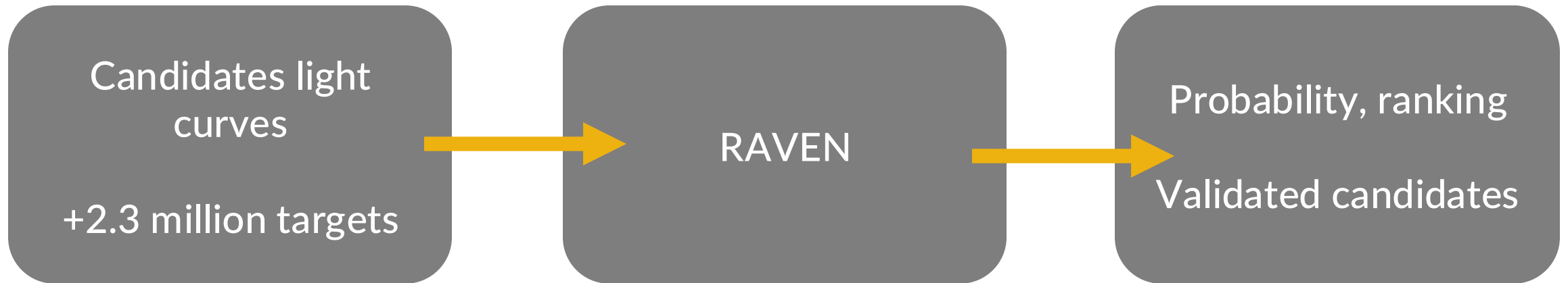
# RAVEN pipeline

Ranking and Validation of Exoplanets

Hadjigeorghiou et al. in prep.

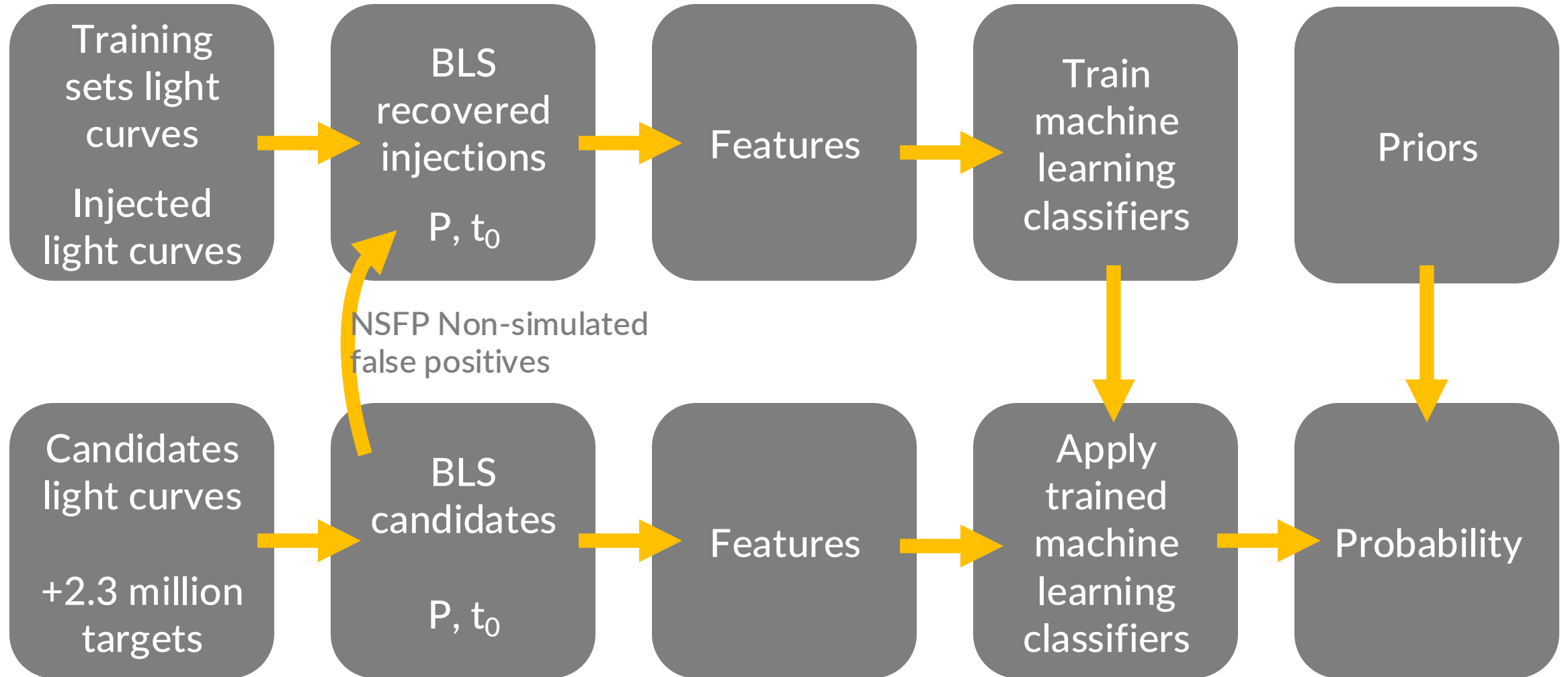


Andreas  
Hadjigeorghiou



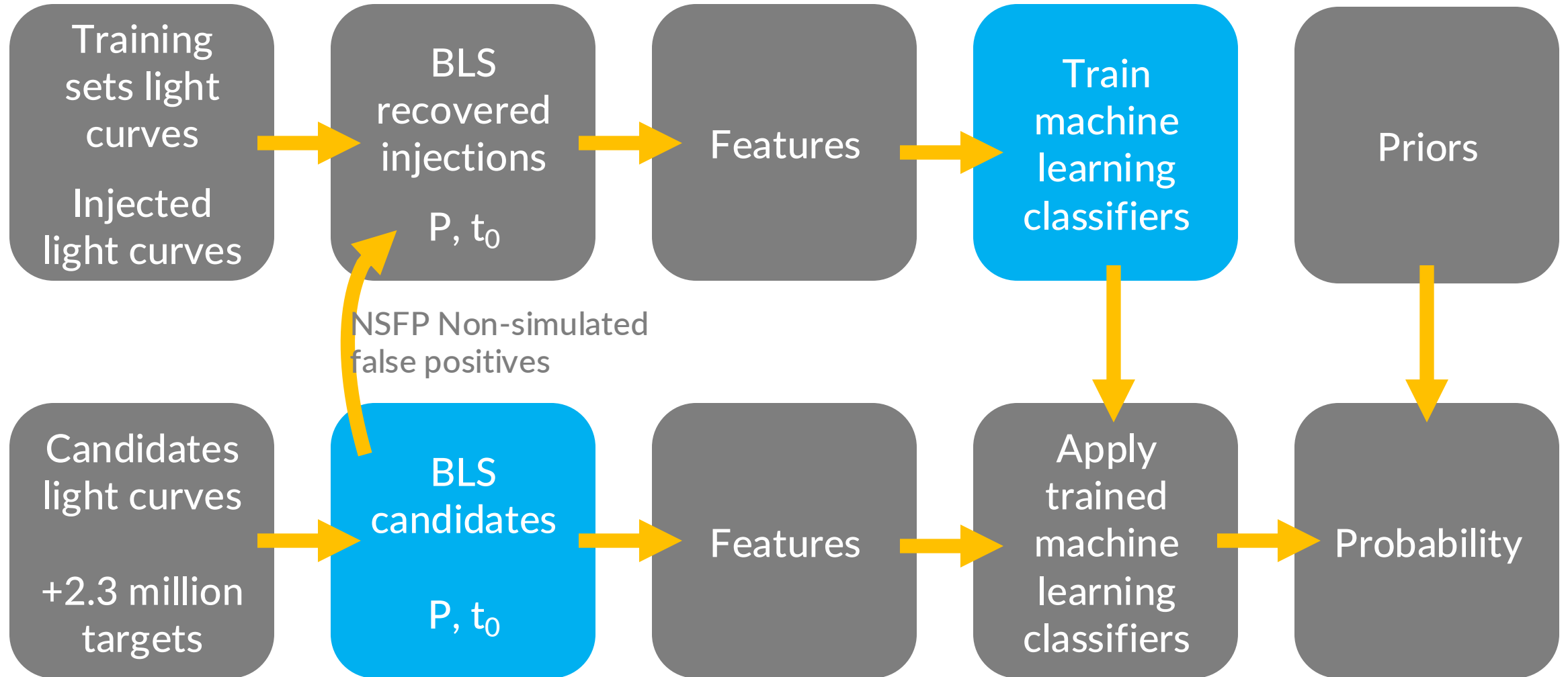
# RAVEN pipeline

RAnking and Validation of ExoplaNets

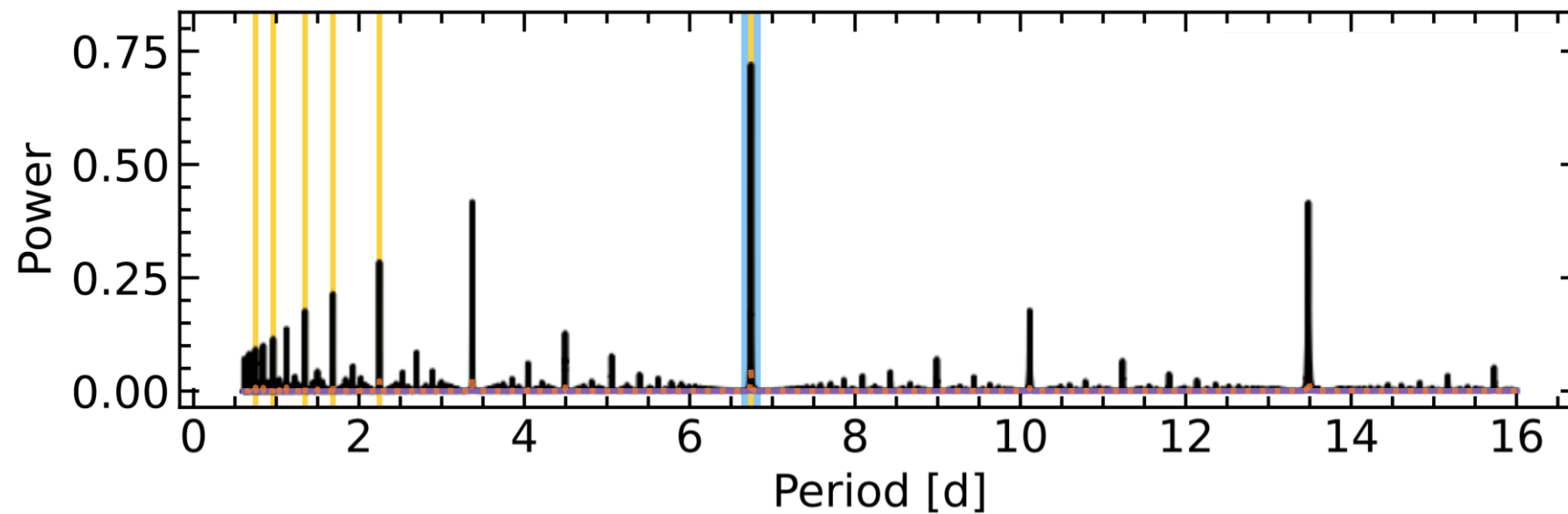
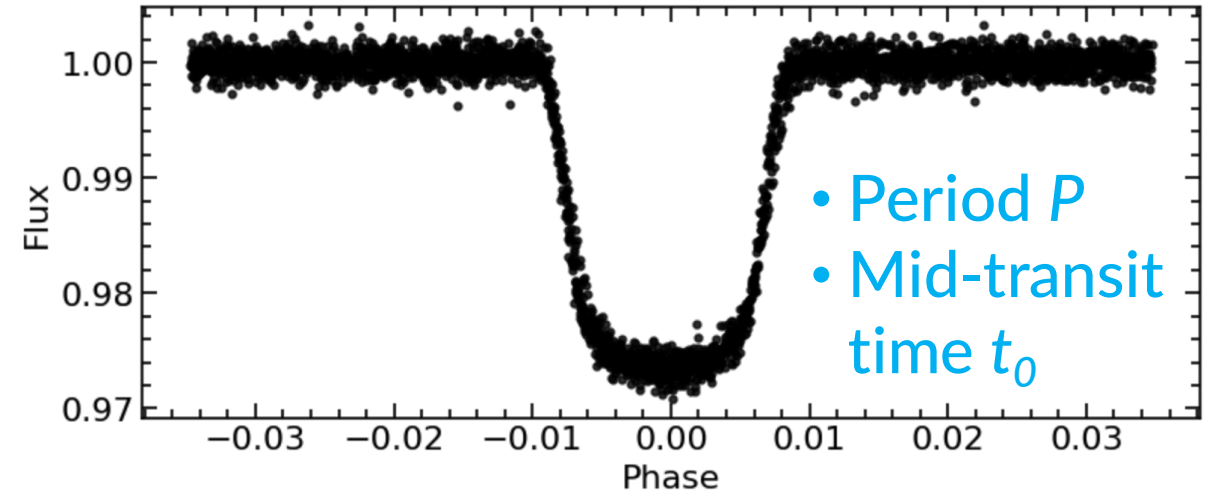
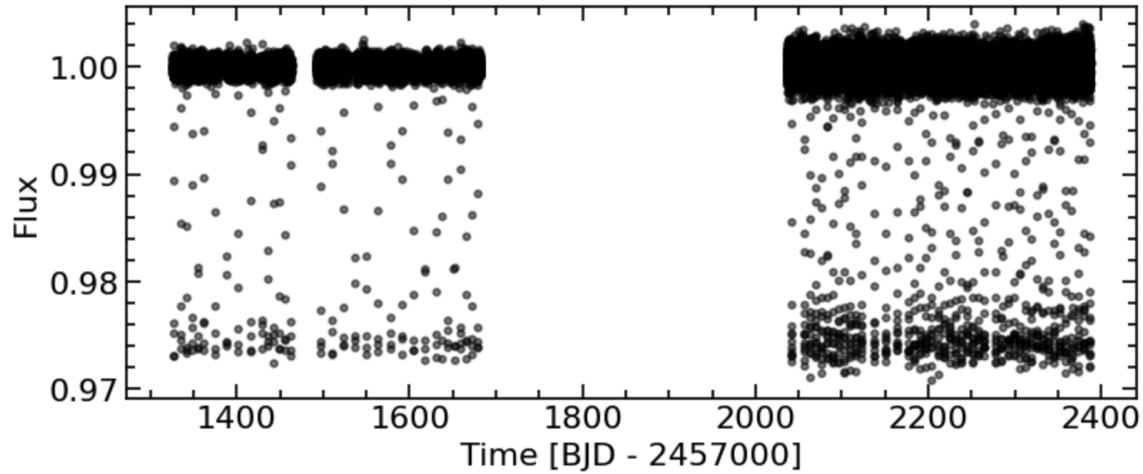


# RAVEN pipeline

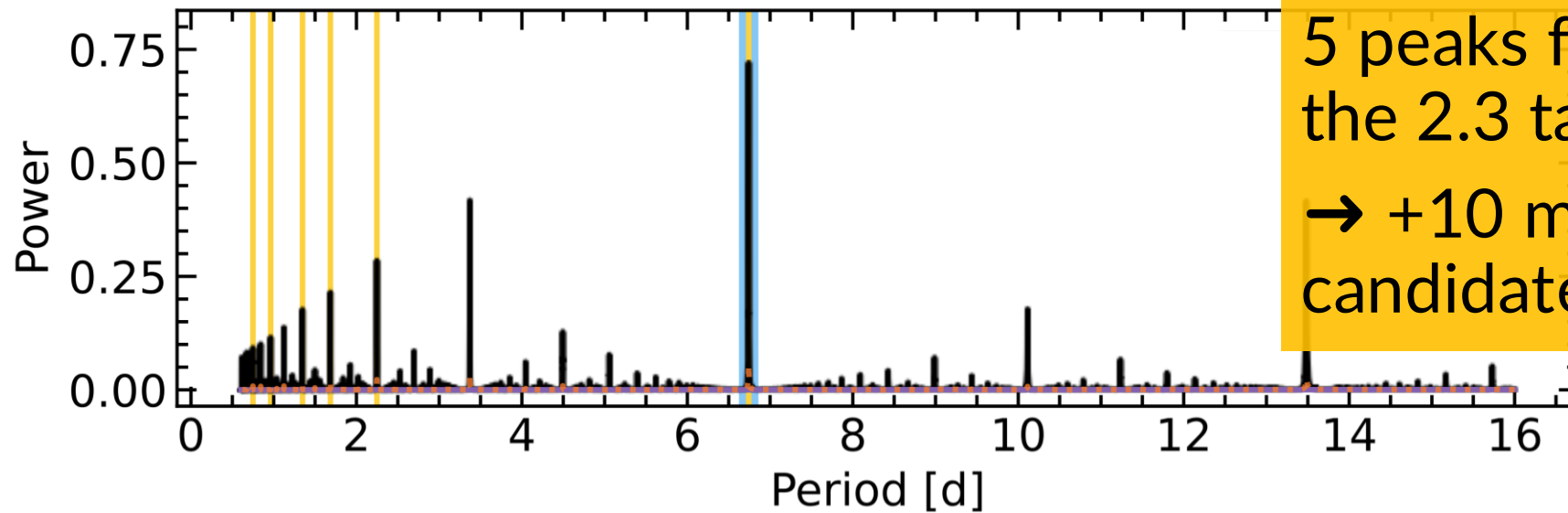
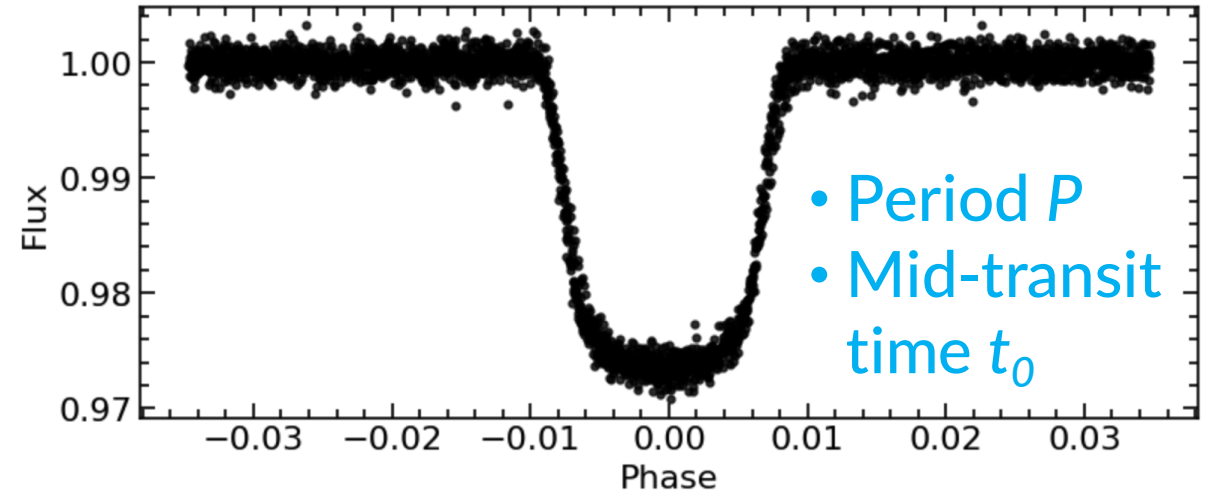
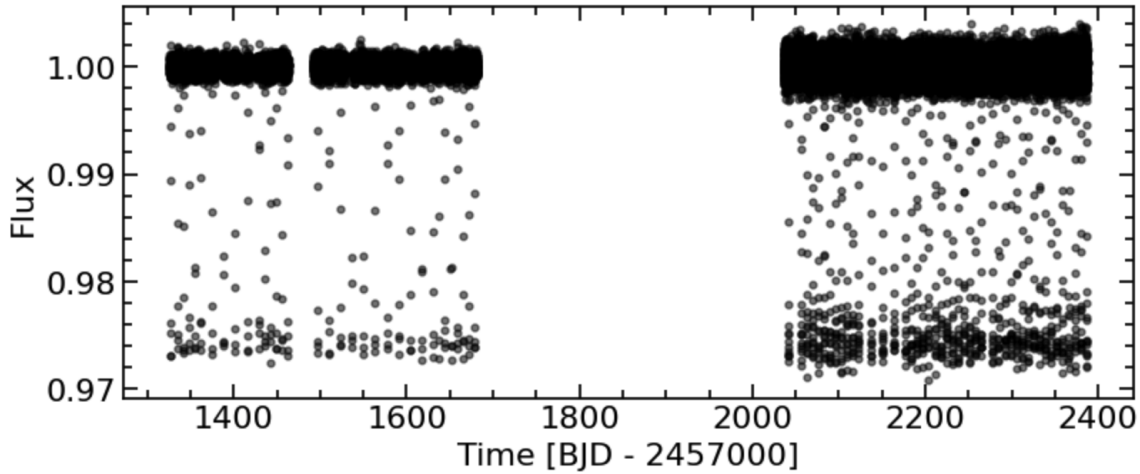
RAnking and Validation of ExoplaNets



# Finding transiting planet candidates: Box Least Squares (BLS)



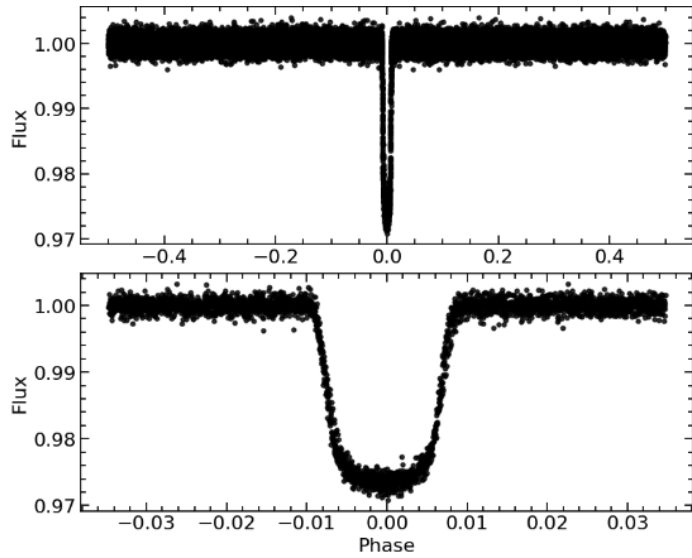
# Finding transiting planet candidates: Box Least Squares (BLS)



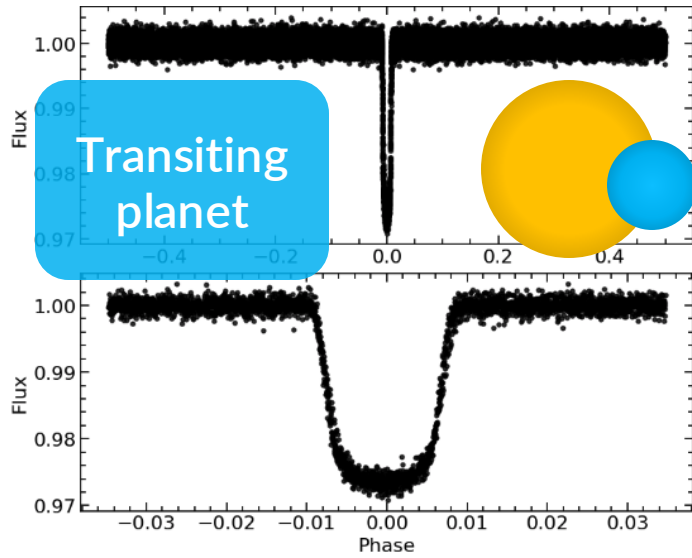
5 peaks for each of the 2.3 targets  
→ +10 million candidates

Period search range:  
0.5 - 16 days

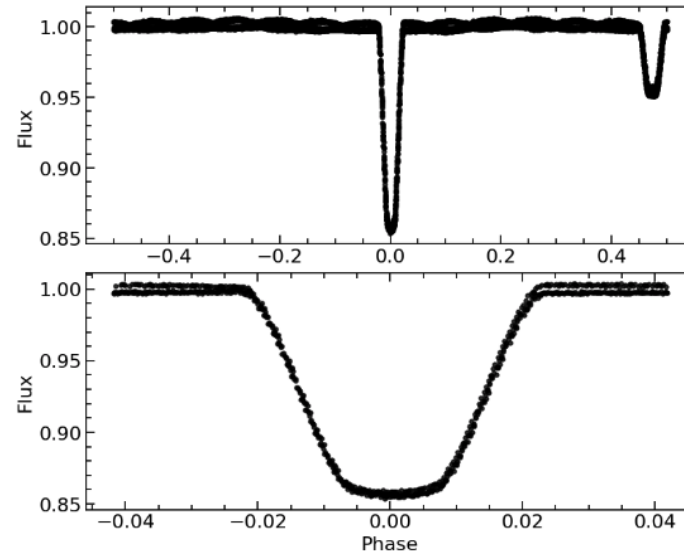
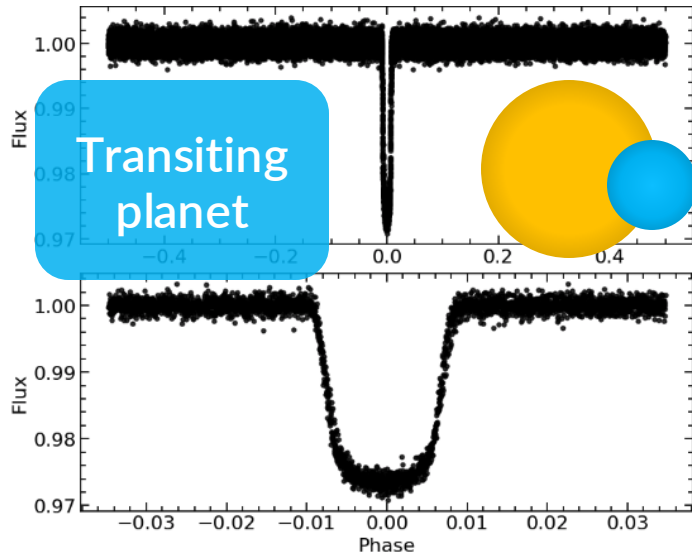
# Detecting true transiting planets



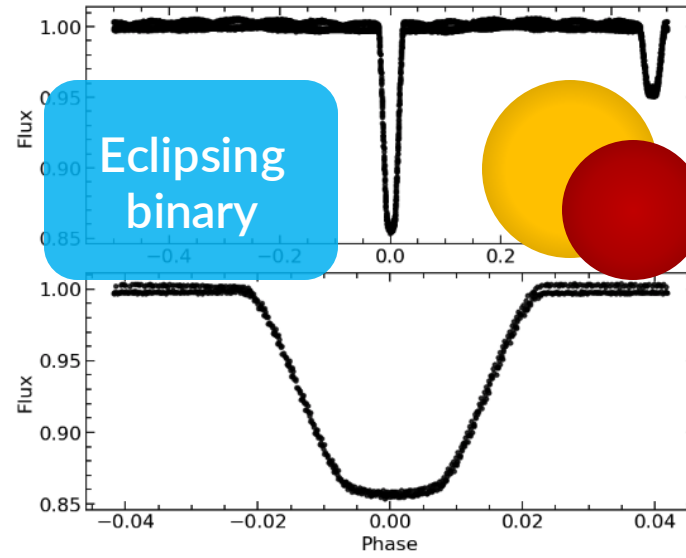
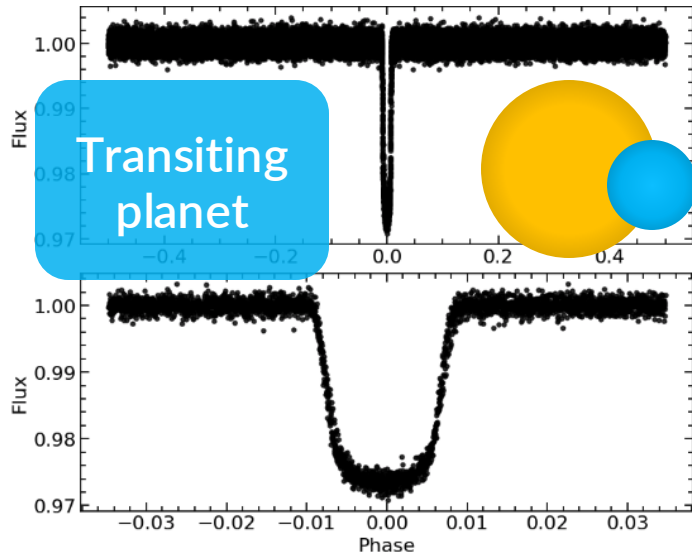
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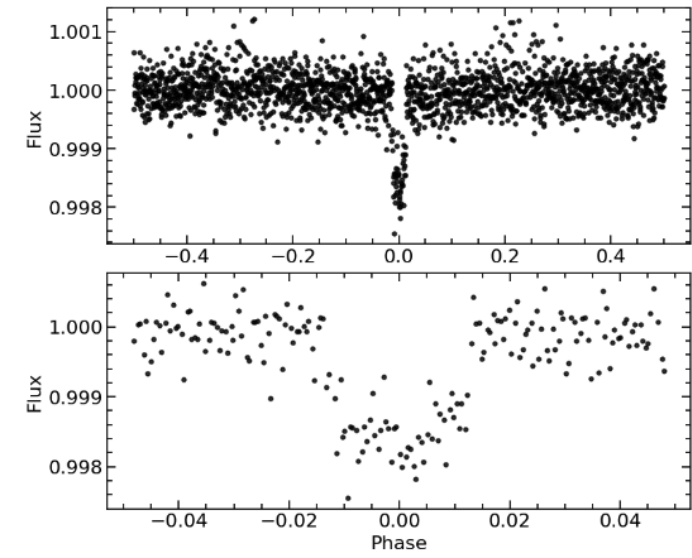
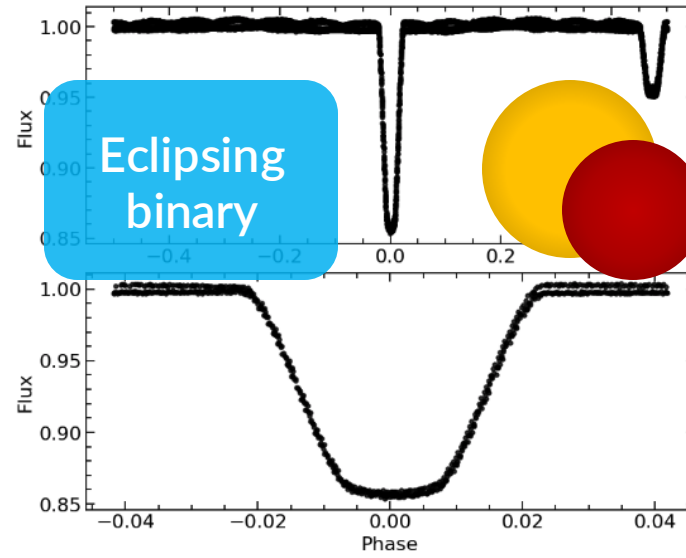
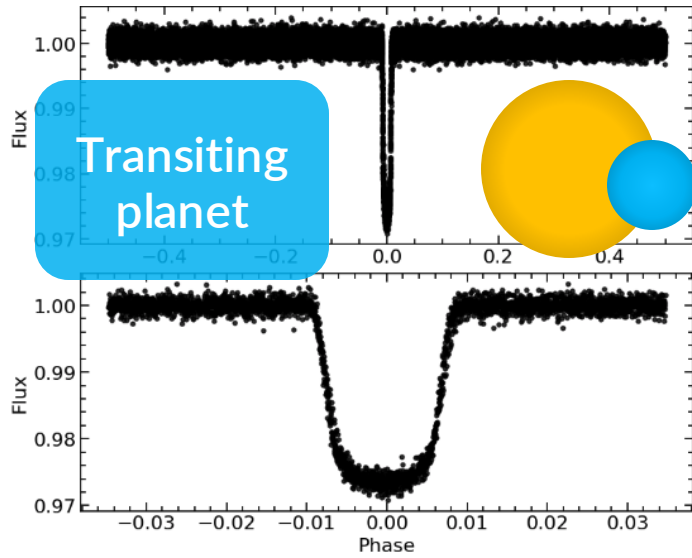
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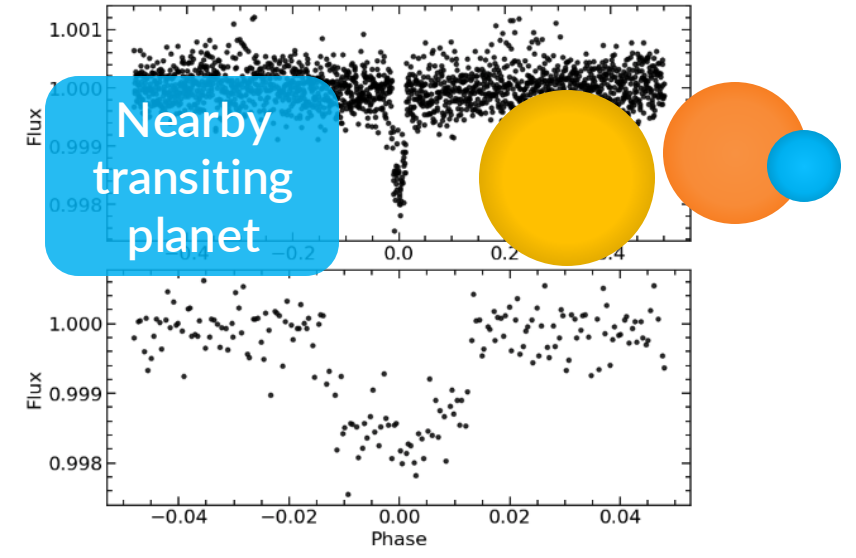
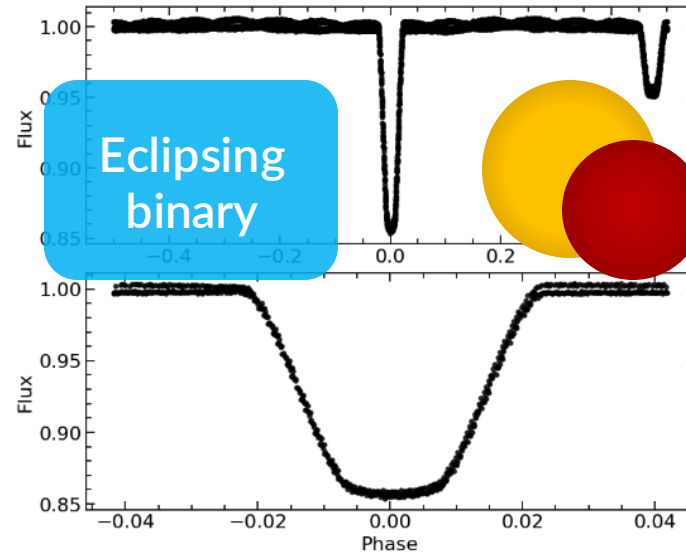
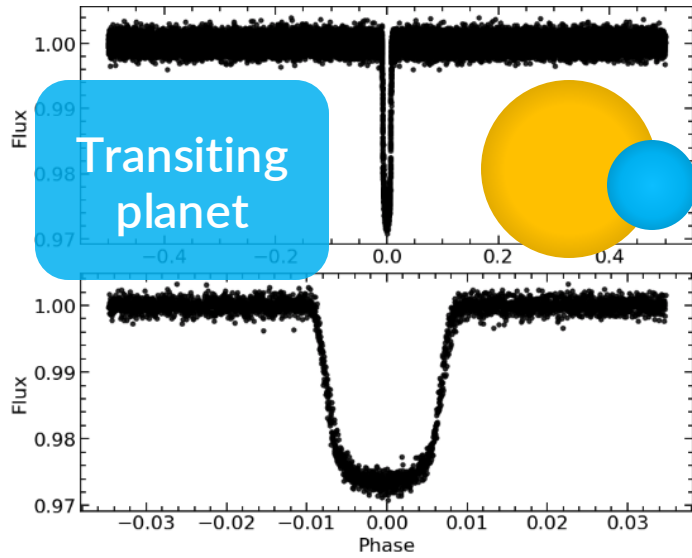
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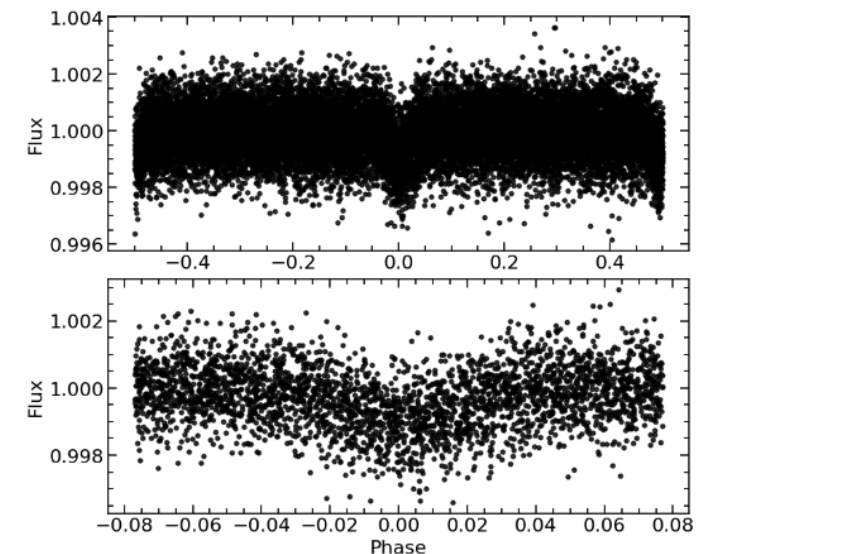
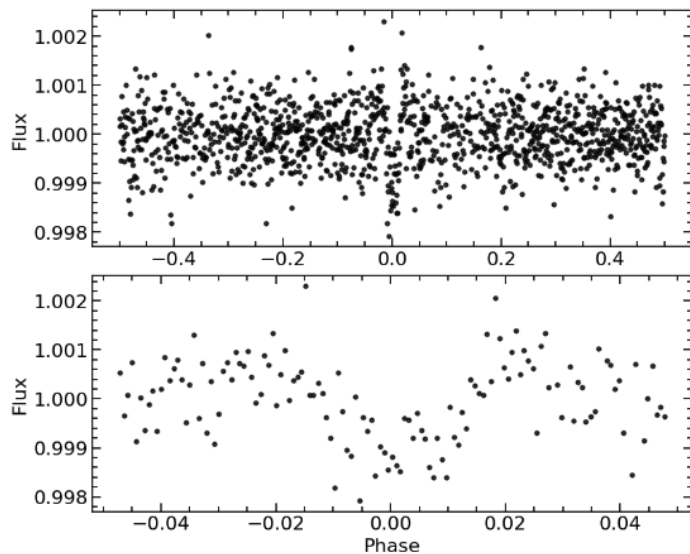
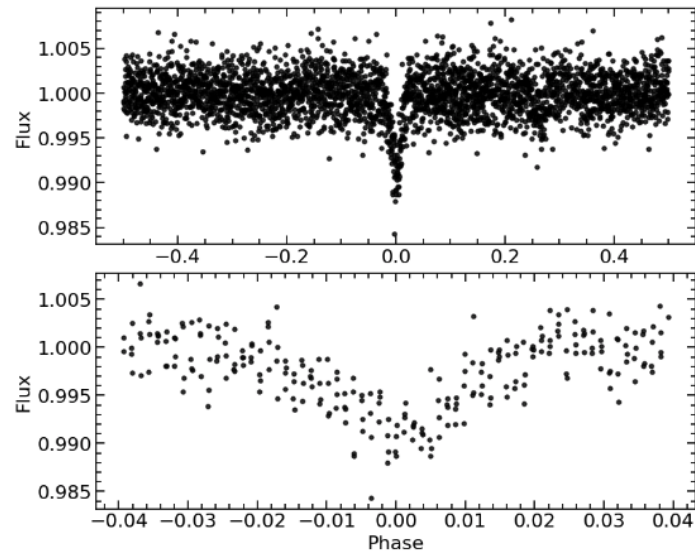
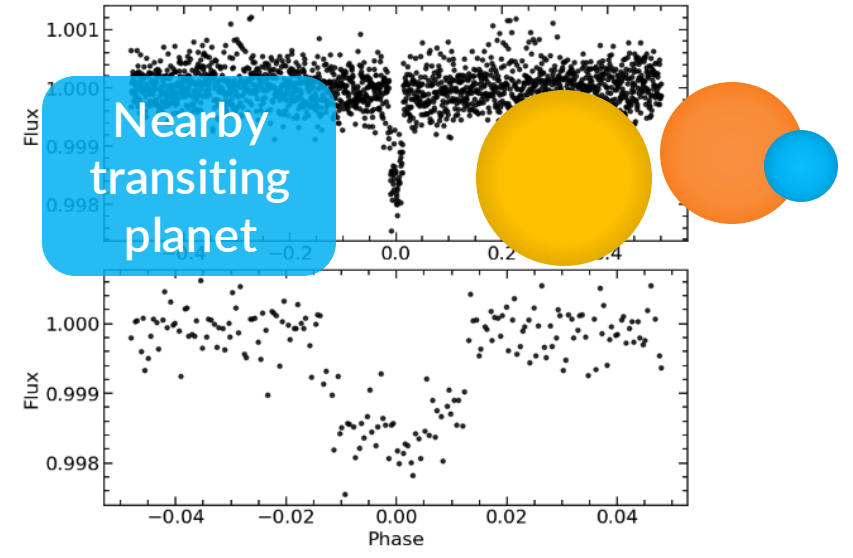
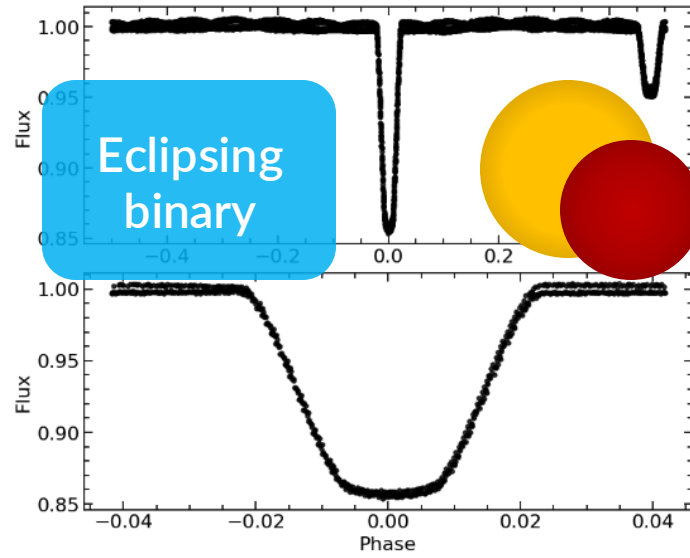
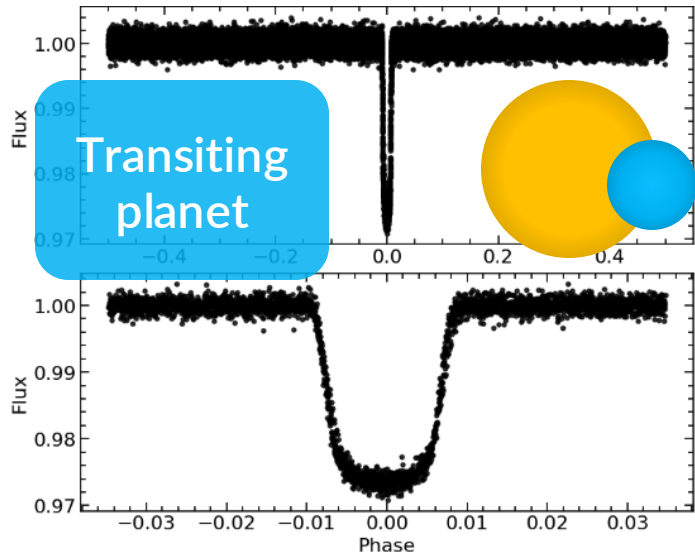
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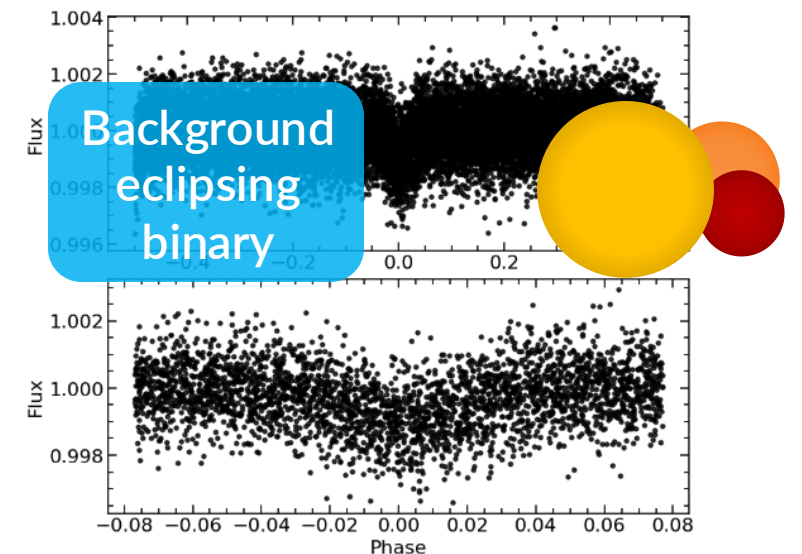
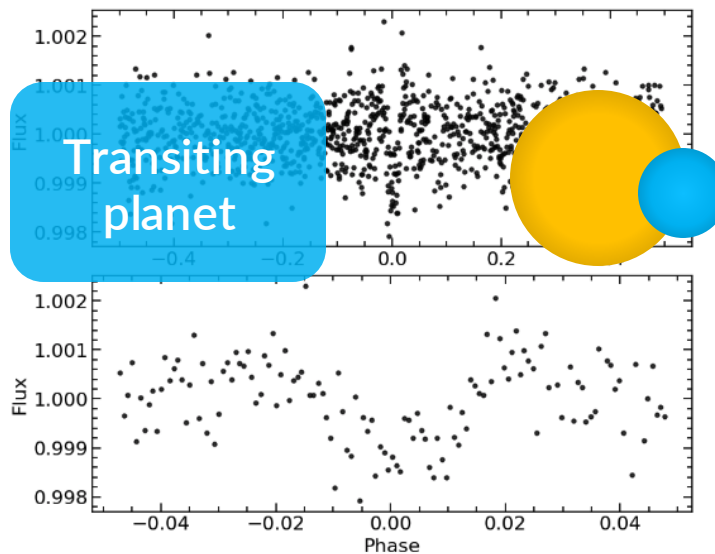
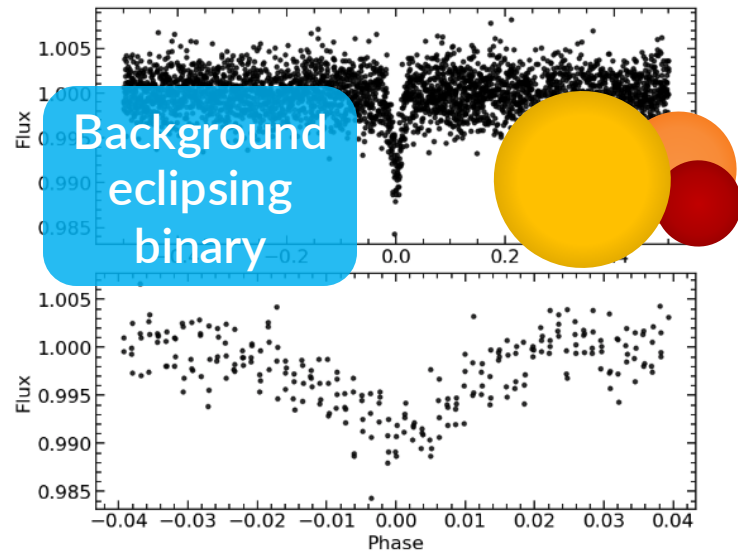
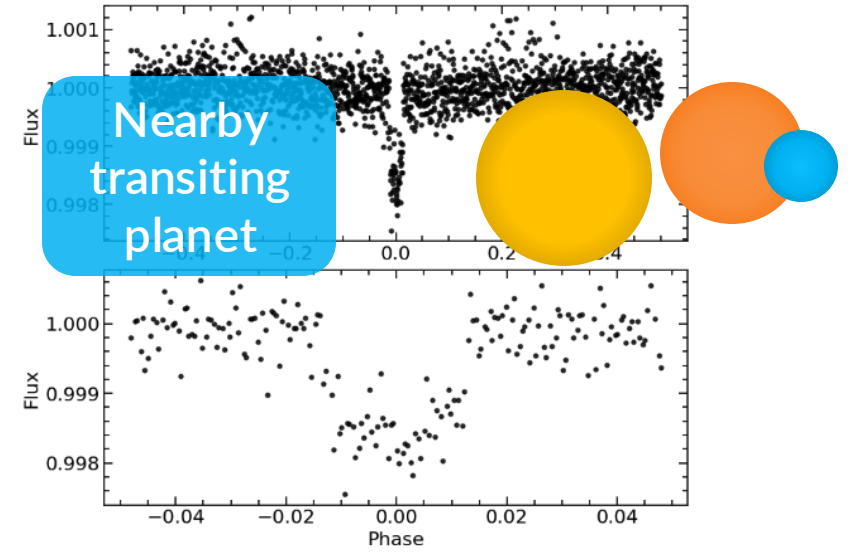
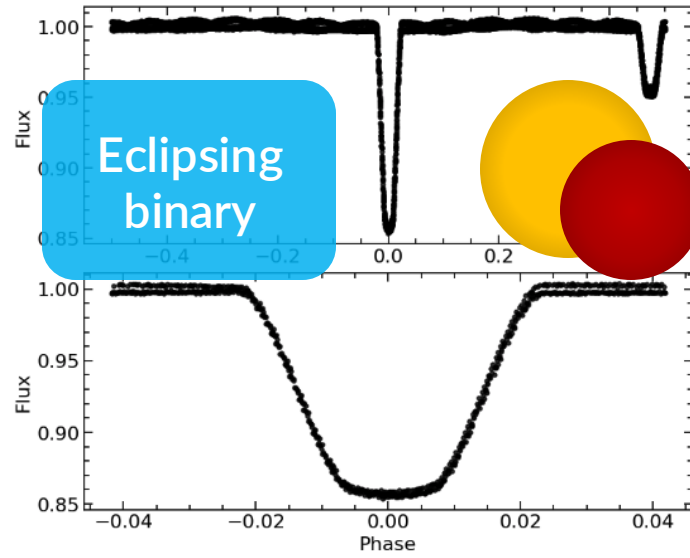
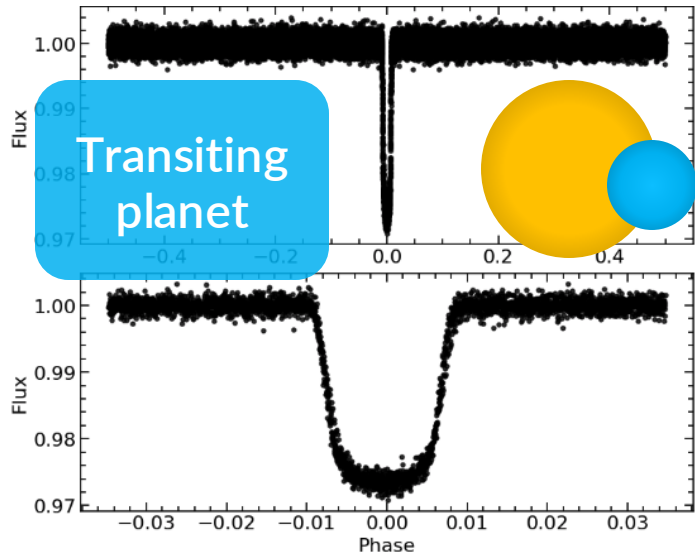
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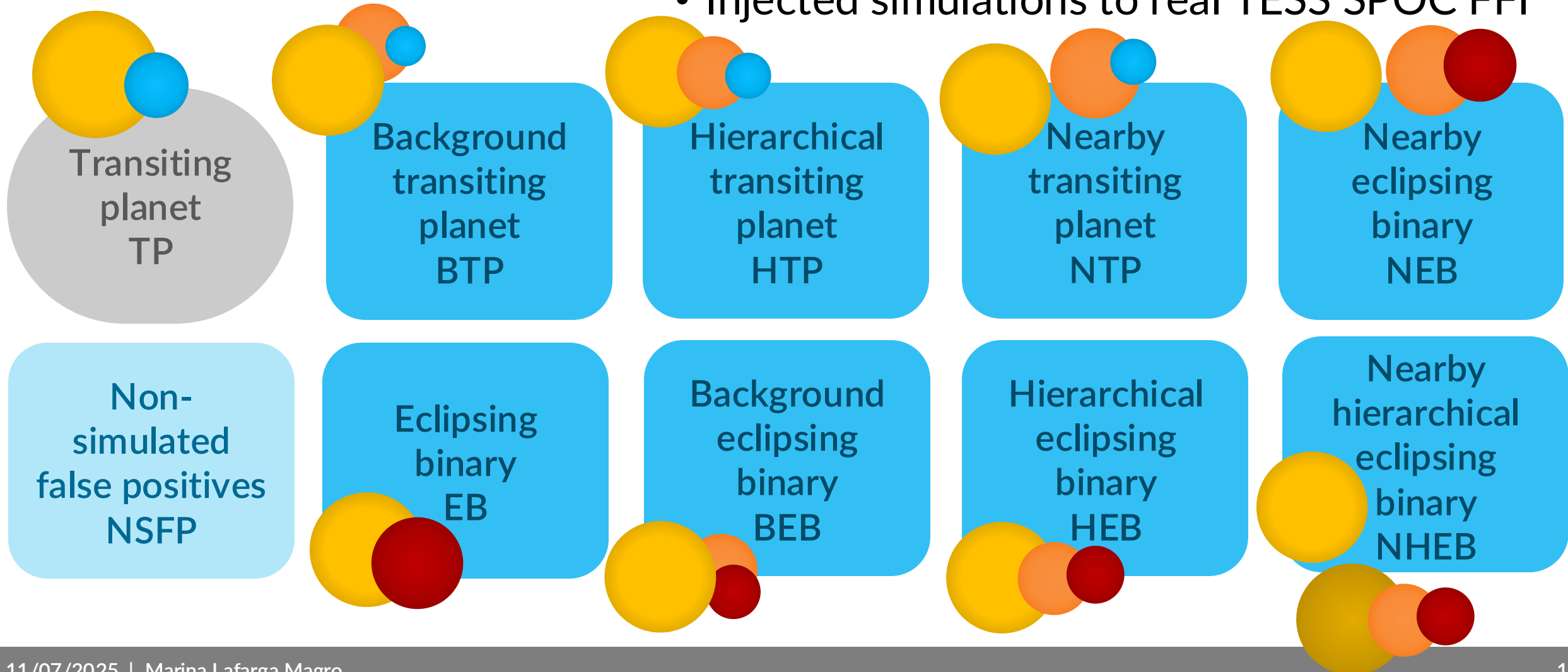


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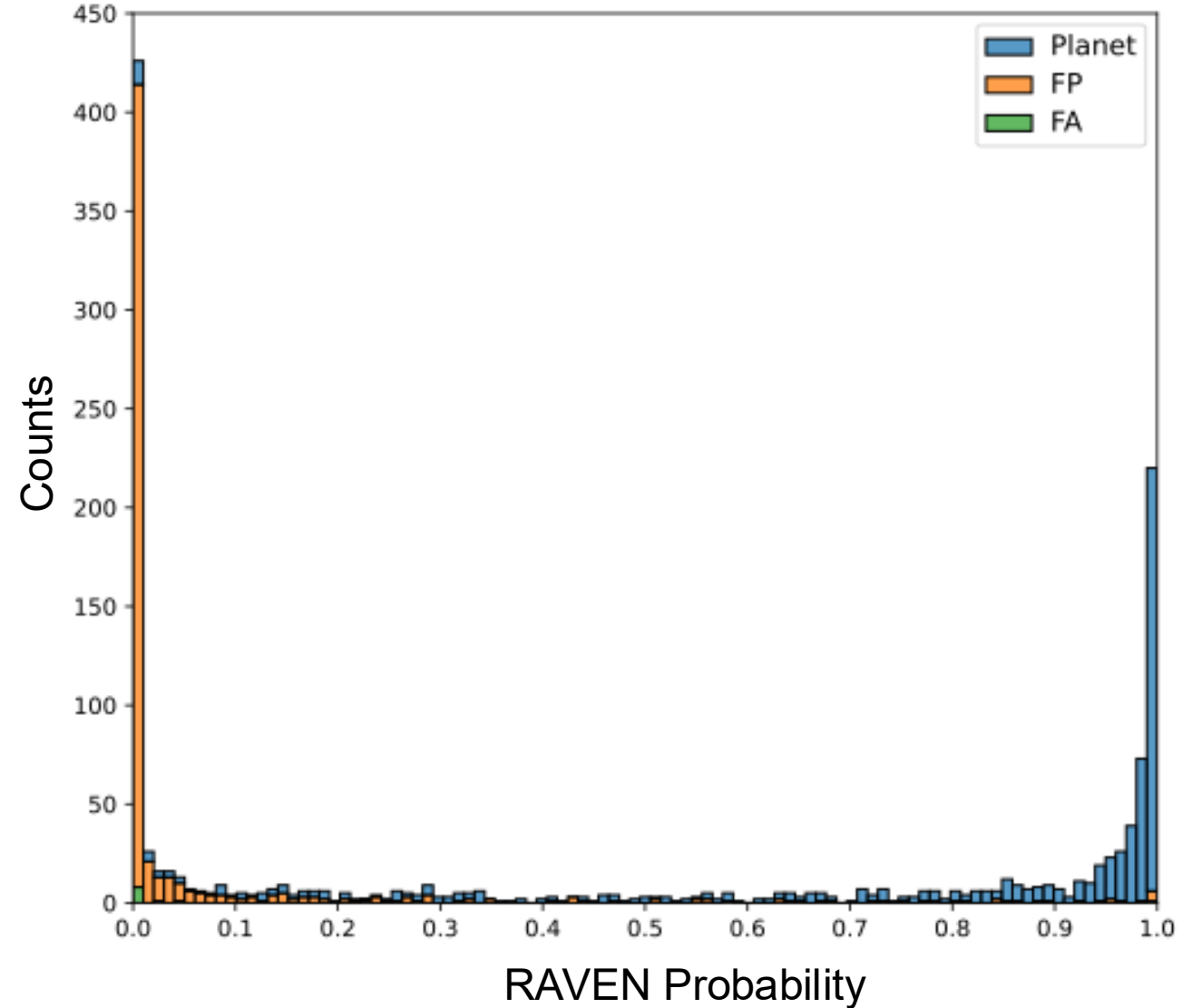
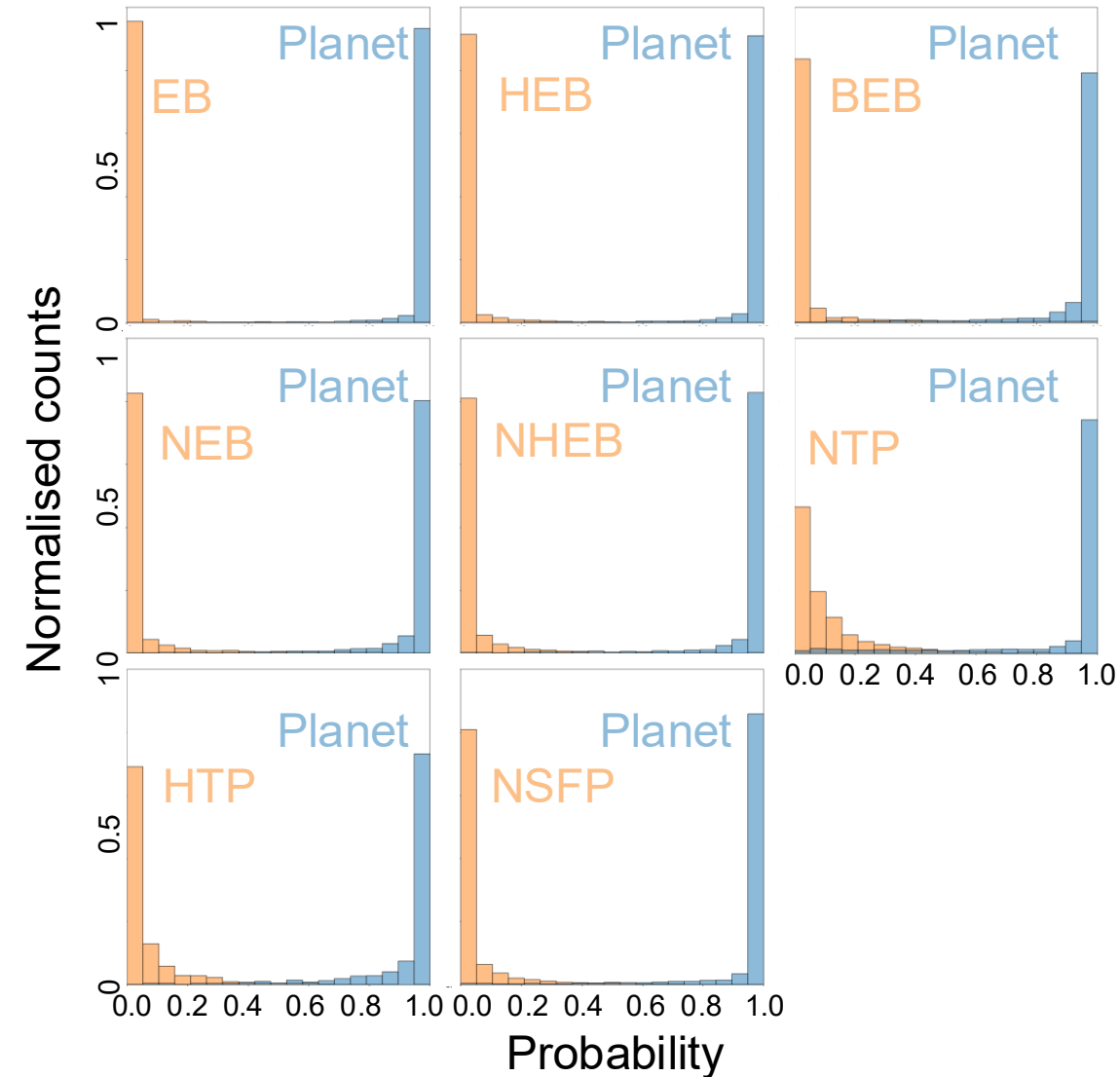
# Machine learning training sets

- Generate simulated events (transiting planets and **false positives**) with PASTIS (Díaz et al. 2014, Santerne et al. 2015)
- Injected simulations to real TESS SPOC FFI



# Machine learning test sets

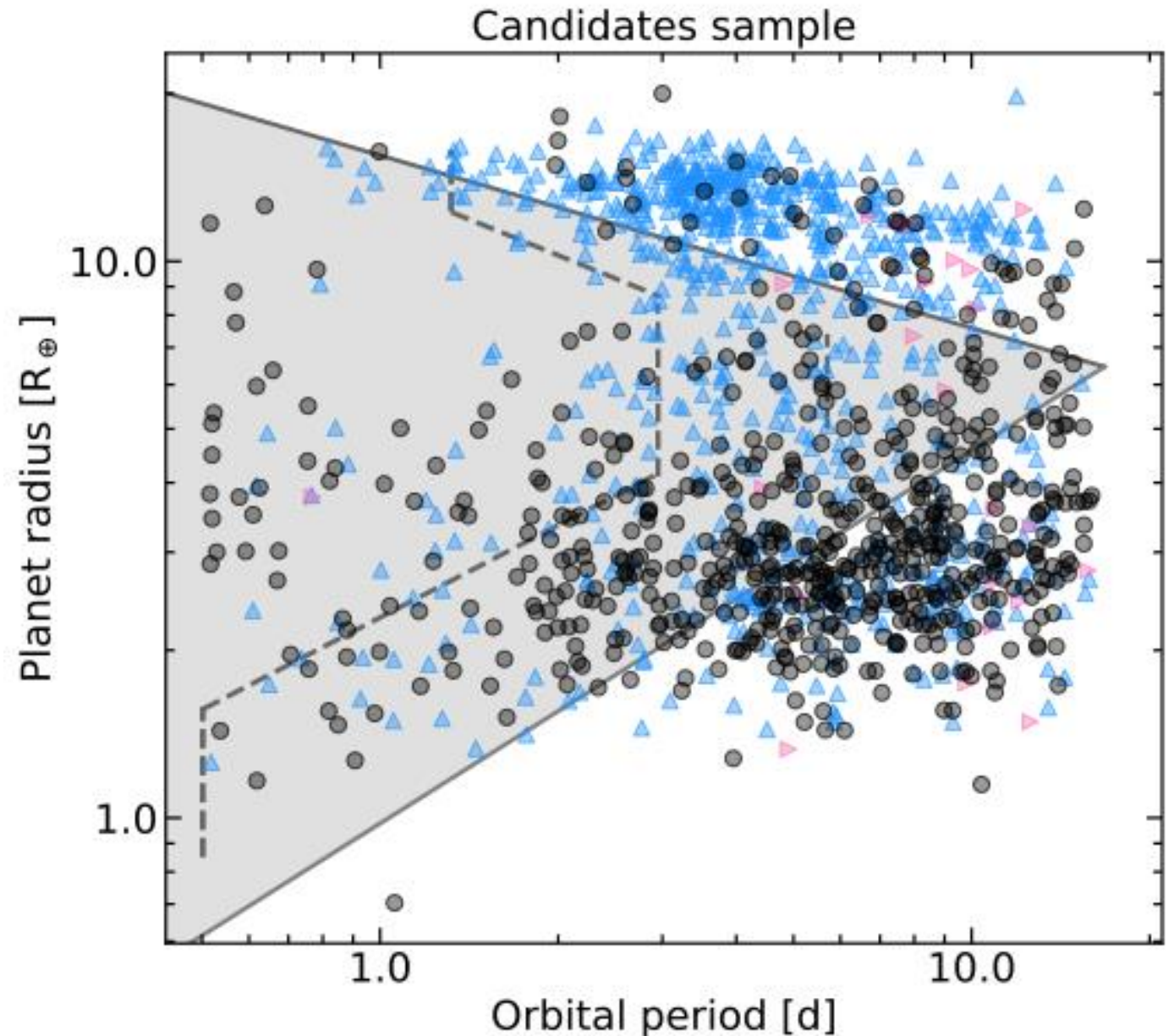
# TESS Objects of Interest TOI



# RAVEN transiting planet candidates

RAVEN probability > 0.9

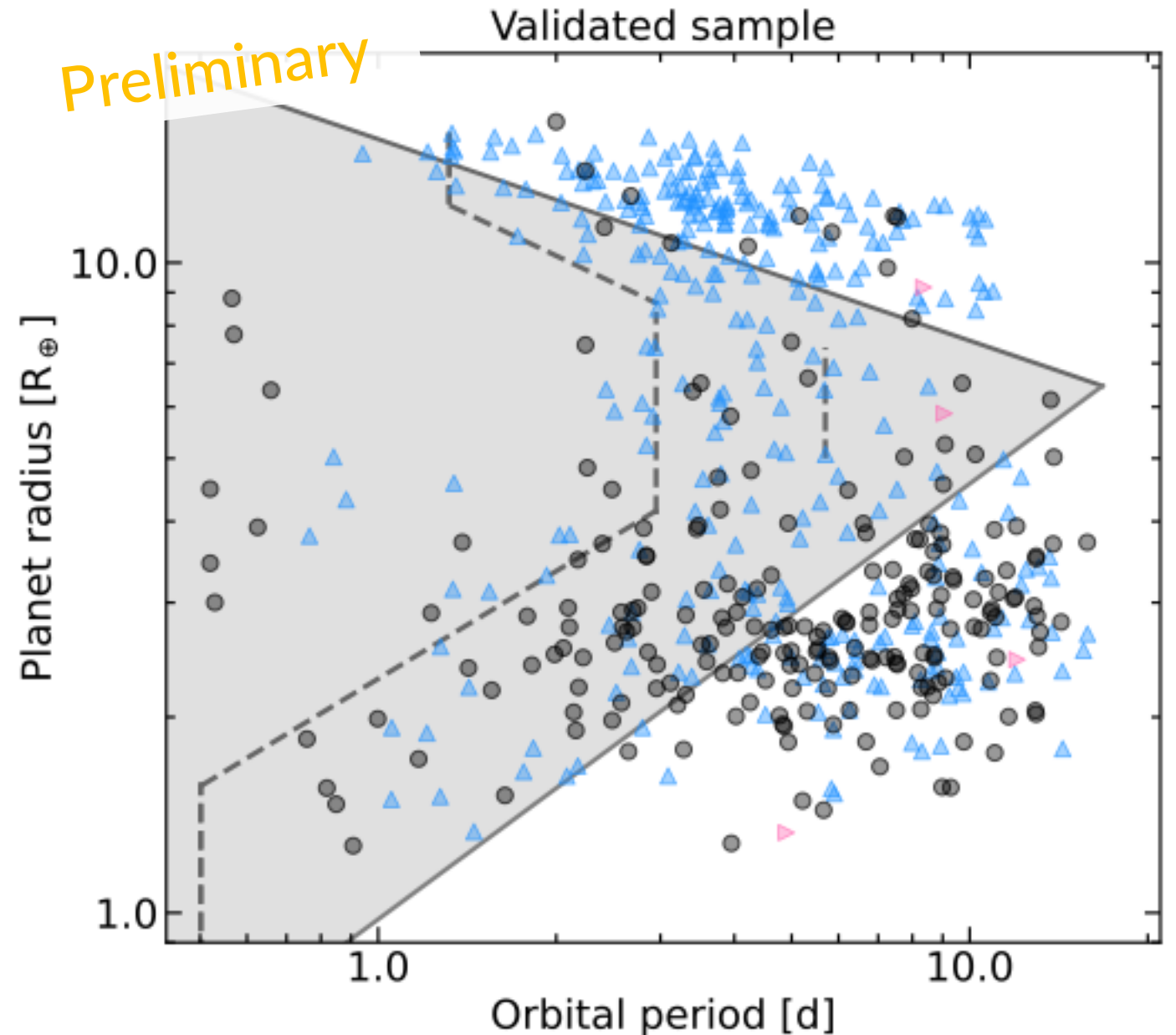
- Non-TOI stars (612)
- ▲ TOI stars, match TOI cand. (725)
- ▶ TOI stars, no match TOI cand. (23)
- Mazeh+2016
- - - Castro-González+2024



# RAVEN transiting planet validated? candidates

RAVEN probability > 0.99

- Non-TOI stars (213)
- ▲ TOI stars, match TOI cand. (319)
- ▶ TOI stars, no match TOI cand. (4)
- Mazeh+2016
- - - Castro-González+2024



# Summary

- Systematic search of transiting planet candidates in TESS light curves in a sample of well-characterised main-sequence stars
- We find ~1300 high-probability candidates
- Aim to validate ~500 candidates (~200 not TOI)

