Quantifying False Positive Probabilities for Transiting Planet Candidates

Timothy Morton (Princeton)

Sagan Workshop
July 20, 2016
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Unsuitable for follow-up

Early spectral type

No RVs at km/s level

Stellar Binaries

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<td>0.03925</td>
<td>3.0300650</td>
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<td>1.4324757</td>
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<td>0.0262</td>
<td>0.01544</td>
<td>0.7365460</td>
<td>0</td>
<td>6.30</td>
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<td>225</td>
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<td>0</td>
<td>84.67</td>
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<td>0.0469</td>
<td>4.0144479</td>
<td>0</td>
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<tr>
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<td>1.17</td>
<td>0.03035</td>
<td>1.6898680</td>
<td>0</td>
<td>167</td>
<td>Bouchy 2004</td>
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<tr>
<td>HD 189733 b</td>
<td>1.140</td>
<td>0.03100</td>
<td>2.21857567</td>
<td>0</td>
<td>205.0</td>
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<td></td>
<td></td>
<td></td>
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</table>
TRES-1 b

• $V = 11.4$
• Follow-up observations:
  • H- and K- band AO imaging
  • Medium-resolution spectroscopy (7 epochs)
  • Multi-color transit photometry (3 facilities, 7 filters)
  • Keck/HIRES RV spectroscopy (8 epochs)
• 80% false positive rate for this survey
Kepler-10 system
- b confirmed by RVs
- c validated with BLENDER

First K2 validations
- 17 planets
- isochrones and vespa introduced/released

Kepler-9 system
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- First Kepler habitable-zone planet
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Fressin+ corroborate low FP rate

TDM & Johnson predict >90% reliability

Kepler-4b-7b announced

TDM: automated validation procedure

First public Kepler candidate catalog

700+ multi-KOIs validated

1200+ Kepler validations

100+ K2 validations
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Kepler-22b

Borucki et al. (2011):

- Imaging from 3 different facilities (seeing-limited, speckle, AO)
- Keck/HIRES spectroscopy at 17 epochs
- 17 hours of *Warm Spitzer* observation to measure transit color dependence
- BLENDER analysis
2009

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light curve shape

Simulate representative populations
Hierarchical EB Scenario
Transiting Planet Scenario
BEBs

K00007.01: Probability of scenario: 0.000
Constraints:
secondary depth < 1.24e-05
odd-even < 1.11e-05

\[ f_{pl,V} = 0.000 \]
FPP: < 1 in 1e6
Planets

K00969.01: Probability of scenario: 0.126
K00969.01: Probability of scenario: 0.248
Constraints:
secondary depth < 5.44e-05
odd-even < 0.000127

\[ f_{pl,V} = 48.681 \]
FPP: 1 in 1
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2016

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TDM: automated validation procedure

2009
2010
2011
2012
2013
2014
2015
2016
**VESPA**

**DOI**: 10.5281/zenodo.16670

Validation of Exoplanet Signals using a Probabilistic Algorithm—calculation of false positive probabilities for transit signals.

For usage and more info, check out the documentation. [Note: be aware that the documentation is out of date (though not totally useless).]

**ISOCHRONES**

**DOI**: 10.5281/zenodo.37647

Provides simple interface for interacting with stellar model grids.

**Installation**

Install with `pip install isochrones` or by cloning the repository and running `python setup.py install`.
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2014
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2015
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2016
Kepler Candidates
From the DR24 Catalog (2015)

Previously confirmed/validated
(984)

More likely imposter
(707)

Newly validated
(1,284)

More likely planet
(1,327)
Exoplanet Discoveries Through the Years

As of May 10, 2016

- 1,284 Newly Validated Planets
- Previous Kepler/K2 Discoveries
- Non-Kepler Discoveries

Number of New Planets

Discovery Year

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