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Designing optimal exoplanet mass measurement surveys in the era of TESS

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APF observing

- Obs Time
- Target Priority
- Night Sky
- Location Data
- Target Quality

See Burt et al. 2015
Make use of a posteriori knowledge from TESS transits.

V \text{mag} : 11.5
Spectral Type: F8V
Period: 2.99d

rms = 363 ppm
4R_e
0.9R_J
2.58hr
\[ M_0 = \rho \left( \frac{R^\oplus}{R} \right) C = \eta \text{ Normal} \sim \frac{M^\oplus}{M} \]
Simulating an RV survey

3 year simulated APF survey, beginning after TESS looks at northern hemisphere.

40% of the telescope's time in whole night segments.

Models seeing/weather based on previous years of data.
Time varying prioritization schemes

Simulating an RV Survey

- Uniform
- Random
- In quadrature
- Out of quadrature
Calculating RV values

Final RV value for that observation

Instrumental noise floor + Internal uncertainty

Noise signature for star

Instantaneous true RV for star
Phase Coverage

Burt+ 2018

Random

Uniform

Out of quad

In quad

Phase

Number of Observations

0 0.00 0.25 0.50 0.75 1.00

0 200 400 600 800 1000

0 0.00 0.25 0.50 0.75 1.00

0 200 400 600 800 1000

0 0.00 0.25 0.50 0.75 1.00

0 200 400 600 800 1000

0 0.00 0.25 0.50 0.75 1.00

0 200 400 600 800 1000
Mass measurements

Burt+ 2018
\[ N_k = \frac{1}{Nb} \]
Uniform and random observing schemes perform the best in terms of the number of measured planet masses. No observing scheme reaches higher semi-amplitude significance values ($K/\sigma_K$) significantly faster than the others.
Additions to the M-R diagram

Burt+ 2018
Easier to reach K/σ > 3 cutoff
Easier to reach

K/σ > 3 cutoff
\[
\left( m_0 = \sigma \left( \frac{\oplus R}{R} \right) c = n \right) \text{ Normal } \sim \frac{\oplus M}{M}
\]
\[
\begin{pmatrix}
\mathcal{O}_0 = \mathcal{O} \\
\langle \frac{\Theta}{\mathcal{R}} \rangle \land \mathcal{C} = \mathcal{H}
\end{pmatrix}
\sim \frac{\Theta}{\mathcal{W}}
\]
\[ \frac{K}{\sigma} > 3 \]

No cut

Burt+ 2018
Burt+ 2018

No cut

$[K/0 > 3]$
Groups who aim to analyze empirical mass-radius distributions produced by RV followup should include mass measurements of all planets in their sample. Performing population analyses with significance cuts will consistently produce biased results in the extracted M–R relation.
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