DETECTING UNRESOLVED BINARIES IN EXOPLANET TRANSIT SURVEYS WITH SPECKLE IMAGING

Rachel Matson
NASA Ames
KEPLER/K2 PLANET VALIDATION

- Photometric contamination from nearby sources
- High-resolution imaging to detect nearby stars
- Constrain probabilistic validation
- Accurate planetary radii

Cameron 2012
Funded by NASA Exoplanet Program to validate and characterize exoplanet candidates from Kepler/K2, TESS, and RV-discovered exoplanets. Available at Gemini and WIYN.

<table>
<thead>
<tr>
<th></th>
<th>WIYN</th>
<th>Gemini</th>
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<tbody>
<tr>
<td>Typical magnitude limit (V)</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Typical contrast limit (Δm)</td>
<td>6.5</td>
<td>7 – 9</td>
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<tr>
<td>Diffraction limit at 467nm</td>
<td>0.034″</td>
<td>0.015″</td>
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<tr>
<td>Diffraction limit at 562nm</td>
<td>0.040″</td>
<td>0.017″</td>
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<tr>
<td>Diffraction limit at 716nm</td>
<td>0.051″</td>
<td>0.022″</td>
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<tr>
<td>Diffraction limit at 832nm</td>
<td>0.060″</td>
<td>0.026″</td>
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SPECKLE IMAGING

(a) 692nm

(b) 880nm

Wittrock et al. 2016

1 arcsec
• **Furlan et al. 2017:** ~30% of host stars have companions < 4"

• **Hirsch et al. 2017:** Planet radii underestimated by 1.17 (1.65)

• **Bouma et al. 2018:** Occurrence rates of planets < 2R<sub>E</sub> could be overestimated by as much as 50%.
MAGNITUDE DIFFERENCE OF COMPANIONS

- **Fractional Transit Depth** (Morton & Johnson 2011):
  - $0.01 \sim \Delta M = 5$
  - $10^{-4} \sim \Delta M = 10$
- **Planet Radii Correction Factor** (Ciardi et al. 2015):
  \[ X_R = \frac{R_P \text{ (true)}}{R_P \text{ (obs)}} \]
SEPARATION OF COMPANIONS

- **KEPLER PLANETS ~ 150 - 1000PC**
- **TESS PLANETS < 500PC**

*arXiv: 1811.0218*
**SUMMARY**

- **Speckle imaging detects companions within 0.02 – 1.0\" and Δm < 10**
- **Validate planets, derive accurate planet parameters & occurrence rates**
- **Show that, in general, planet hosts are equally likely to be binary as field stars**
- **For more information see Nic Scott’s poster (#55)**