Search for companions with PIONIER: “the exozodi sample”

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Context: why searching for companions in the exozodi sample?

- Stars especially chosen to be WITHOUT companions
- Hard to know if the IR excess is caused by a disk or a companion
- Possibility to extract/refine some statistics?
- Lot of data available ➔ just need a student to search in...
The use of single mode fibers:
- FWHM estimated to 400 mas;

Overlapping of the fringe packets associated to the star and the companion:
- $B \approx 100$ mas;

Good spectral sampling:
- Period $\sim \frac{\lambda^2}{B\Delta \theta} > 4\Delta \lambda$
- $B = 40 \text{m} \approx 85$ mas

Use 100 mas as a FoV.
Which method to use?

- Compute a binary model
- Compare model and data for each position \((x, y)\) and for each contrast \(r\) in a given range \(\Rightarrow\) a cube \(\chi^2(x, y, r)\)
- Doing this for CP, V2 and both

\[
\chi^2_{comb} = \sum_k \left( \frac{V_{mod,k,\lambda}^2 - V_{data,k,\lambda}^2}{\sigma_{V^2,k,\lambda}} \right)^2 + \sum_k \left( \frac{CP_{mod,k,\lambda} - CP_{data,k,\lambda}}{\sigma_{CP,k,\lambda}} \right)^2
\]

- Minimizing the cube
- Same method as O.A (2011) BUT...

- Discriminate between disks and companions
  - if detection in the combined chi square + in CP and in V2 \(\Rightarrow\) companion
  - if detection in V2 only \(\Rightarrow\) disk
  - if detection in CP only \(\Rightarrow\) false positive or (?)
  - better systematic rejection of the false positive (if detection in the closure phase but not in the square visibility, then the combined chi square shows generally no detection)
Which criterion of detection?

$3\sigma$, $4\sigma$, something else?

$3\sigma$ seems OK... But...
A word on the PIONIER sensitivity?

Graphs showing contrast upper limit at 3 sigma for CP, V2, CP+V2.
Are there some new companions?

HD16555

V2

CP

V2+CP
Are there some new companions?

YES! 4 confirmed, 1 to be explored in more details (tbd with S. Borgniet)

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Significance (cp+v2) -σ</th>
<th>Significance cp -σ</th>
<th>Significance v2 -σ</th>
<th>Best position In the FoV δθ (mas)</th>
<th>α (deg)</th>
<th>Best fit Contrast -- (%)</th>
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</thead>
<tbody>
<tr>
<td>HD4150</td>
<td>17-12-12</td>
<td>4.11</td>
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<td>22.52</td>
<td>29.25</td>
<td>43.84</td>
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<td>350.65</td>
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<td>106.20</td>
<td>8.04</td>
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<td>106.03</td>
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</table>

To be explored: HD224392
The case of HD224392

26-07-2012 - detection level : 12.53σ - H band

09-08-2013 – detection level : 5.96σ - K band... But where is the companion exactly?

Maybe the extent of the detection shows a disk?
How could we conclude about the binaries in our neighborhood?

- De Rosa et al. 2013: 33.8±2.6% of A type star are binaries on a range of separation: 30-10000 AU (~0.4-140 arcsec)
- This study: 4 out of 101 stars were unknown binaries within 100 mas
- All of the detections were A type stars: 4 out of 30 A type stars were binaries (~13%) ➔ Complete the survey of De Rosa
- The percentage of A type binaries in our neighborhood still needs to be refined
- Thanks to the sensitivity of PIONIER (~1% in contrast), we can conclude than the detection limit in terms of spectral type would be an M0 around A0 star to M7 around A5 star
Thank you for your attention!
CP/V2-Detection (HD16555)
CP/V2-NON detection (HD3302)
CP/V2-FP detection (HD28355)