Statistics of hierarchical multiplicity of nearby solar-type stars

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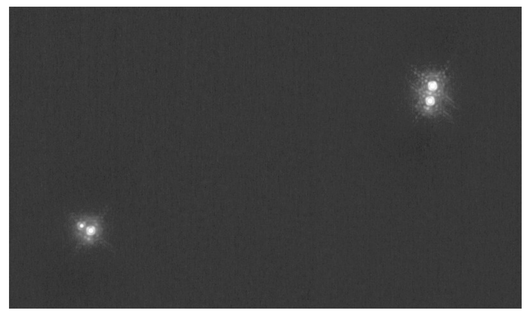


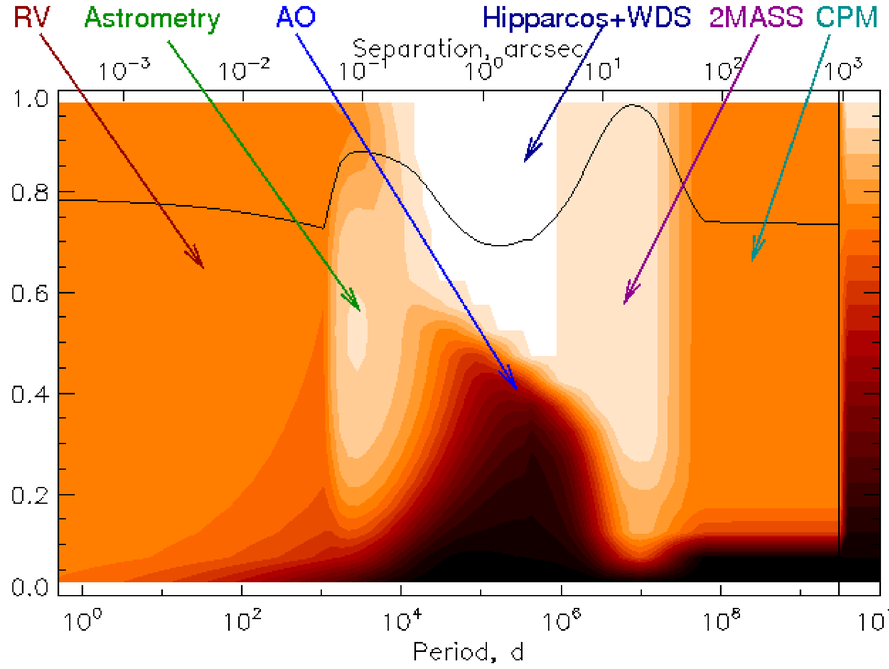
HIP 43947: is it typical?

Abstract

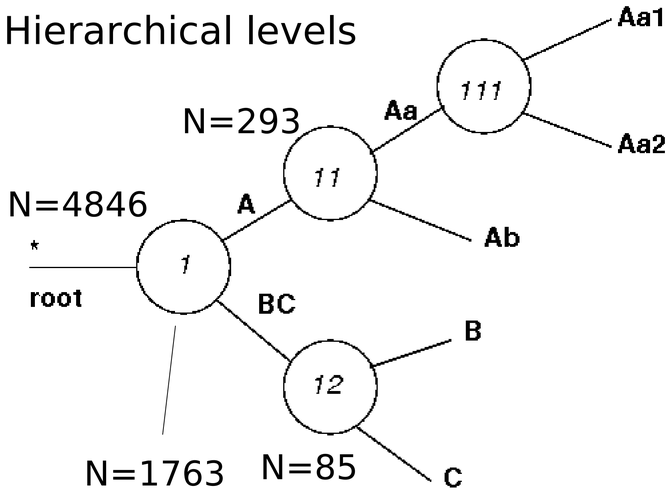
The sample of 4846 F,G dwarfs within 67 pc of the Sun is used to study the unbiased statistics of hierarchical multiple systems. The selection effects are known and taken into account. The fraction of systems with ≥3 companions is 14%. Model of the joint distribution of periods and mass ratios at different hierarchical levels is developed. Sub-systems are slightly more frequent in the components of wide binaries than among all targets, suggesting a mixture of binary-rich and binary-poor populations in the field. Simultaneous presence of sub-systems in both components of wide pairs shows that 2+2 quadruples form frequently.

Formation of multiple stars
- Fragmentation
  - Prompt
  - Disk
- Orbit decay (migration to short P)
- Dynamical decay (disruption)

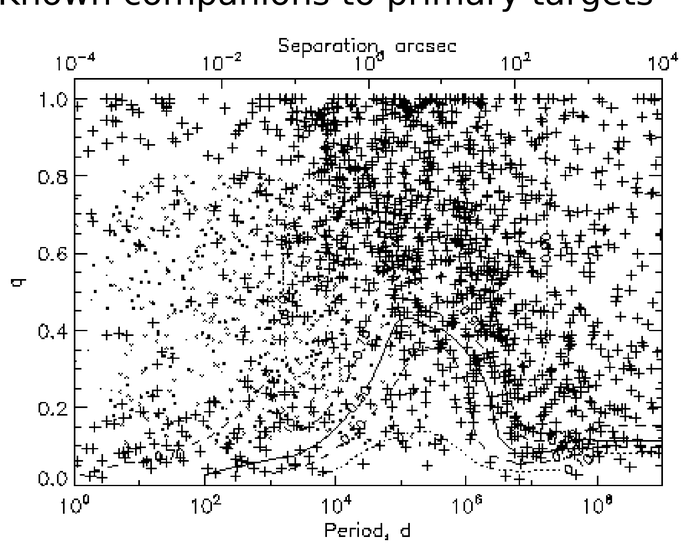
Completeness of companion detection to primary stars (all periods and mass ratios) is ~78%. Only ~20% of sub-systems in the **secondary** companions are known, although they seem to be as frequent as in the primaries. Survey of secondary companions with RoboAO (1.5m, Palomar) is in progress.

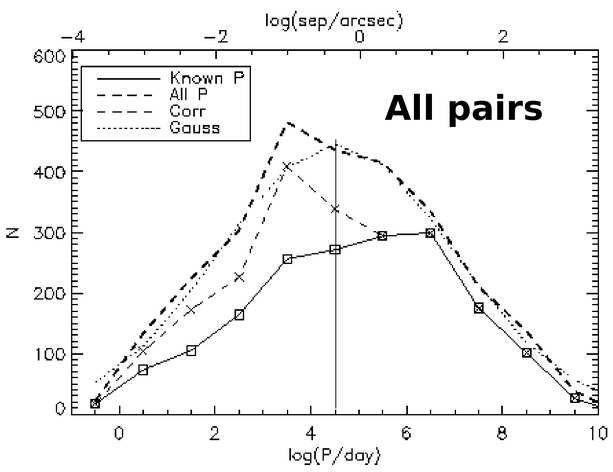


Hierarchical levels



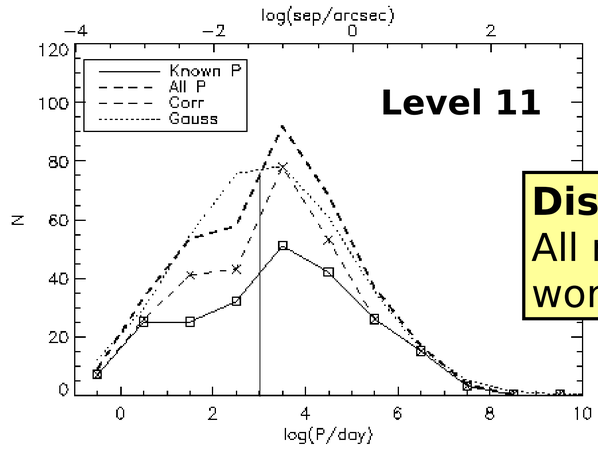
Known companions to primary targets



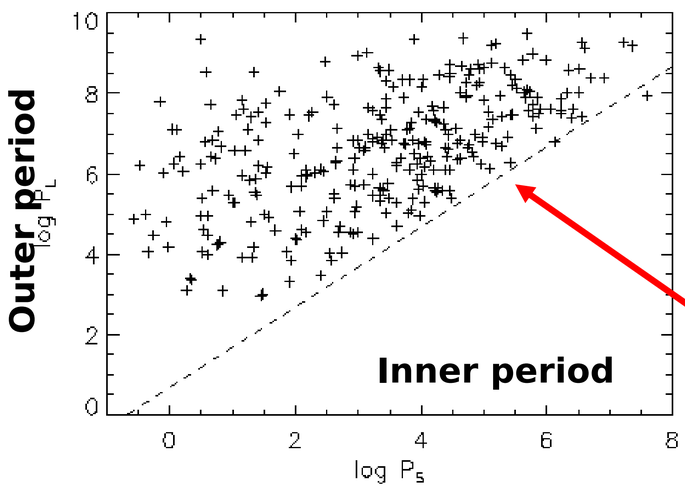


Histograms of log (P)

Fraction of triples:
(corrected)
Level 11: 10%
Level 12: 8% (4% have 11)
Total (11 or 12): 14%
2+2 (11 & 12): 4%



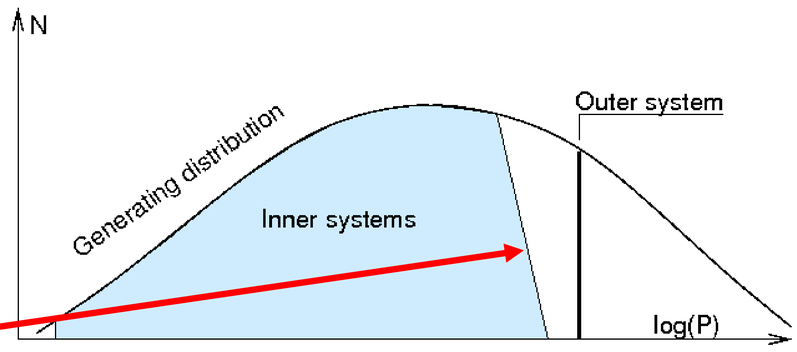
Disclaimer:
All results are preliminary, work in progress



Quasi-independent multiplicity?

The distributions of P,q of outer (level 1) and inner (levels 11,12) systems are similar. So, draw all sub-systems from the same ***generating distribution***, retain only dynamically stable outcomes?

Dynamical stability: $\log(P_L/P_S)>0.7...1.7$



Generating distribution:

1. f(x=log P) is a truncated Gaussian (median x_0=4.9, σ=2.4)
2. f(q)=q^β with β~0 (uniform) at all P
3. ε=0.47, but $\langle\varepsilon^2\rangle/\langle\varepsilon\rangle^2$ =1.2

It works, but requires two corrections:

1. Stochastic binary frequency ε (the triple fraction is ε^2). Sub-systems in wide binaries are more likely, hinting that the field is a mixture of binary-rich (large ε, many triples) and binary-poor populations.
2. About 45% of level-12 systems also have level-11, they are 2+2 quadruples. The correlations between levels 11 and 12 means that **2+2 quadruples form frequently**. Some subsystems then merge, some decay dynamically after formation.