Gaia and binary stars

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Gaia: performances

80 1-D measurements in 5 ans, ~6 per visibility period

Accuracy : ~60 µas/measurement for V = 6 to 12 mag

Expected number of binaries with astrometric orbits : a few millions (G < 20) !

For what purpose ?

What can we do with millions of binaries ?

Binarity statistics :

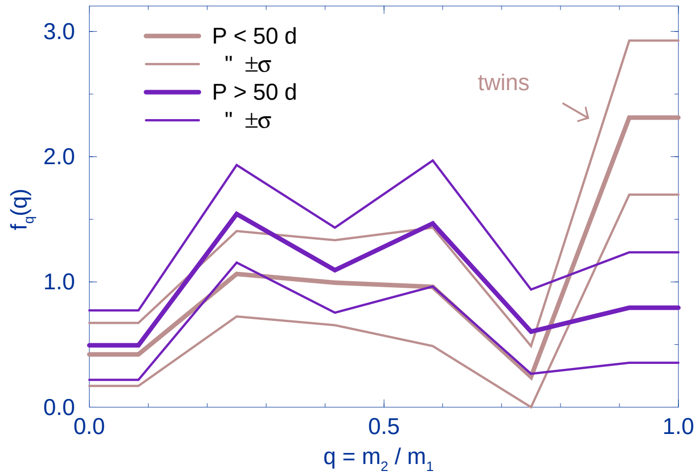
- *for P < 10 years, f(q=$\mathcal{M}_2/\mathcal{M}_1$) is well known for G-K dwarfs only.*

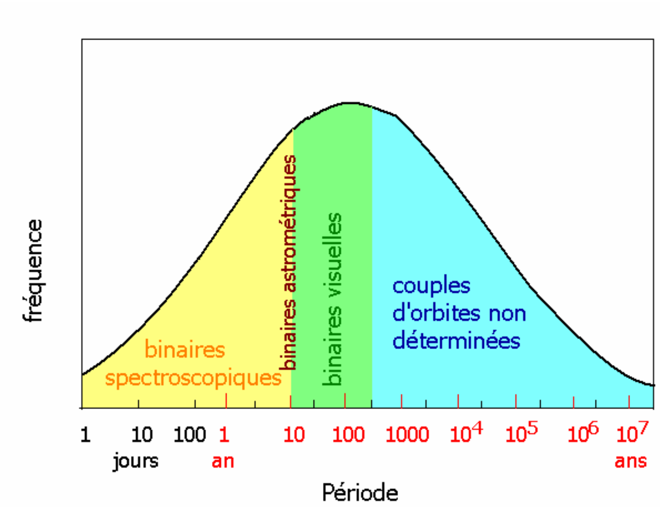
- *f(log P) for G-K dwarfs*

➢ *Derivation of f($\mathcal{M}_2/\mathcal{M}_1$), f(log P), %, as a function of $\mathcal{M}_{Total}$*

Masses :

➢ *Derivation of accurate $\mathcal{M}$✫*





Masses from Gaia astrometry..

1. Resolved binaries

$q = M_2/M_1 = a_1/a_2$

$M_1 = a_1^3 (1+q)^2 / (q^3 \varpi^3 P^2)$

Minimum separation: 0.1 " .. on the scanning axis

Masses from Gaia astrometry..

2. Unresolved astrometric binaries + SB2 orbits from OG measurements.

SB2: P, e, T_0, ω, .., $M_1 \sin^3 i$, $M_2 \sin^3 i$

AB: P, e, T_0, ω, .., i

$\Rightarrow M_1, M_2$

Pb : masses with 1 % errors ?

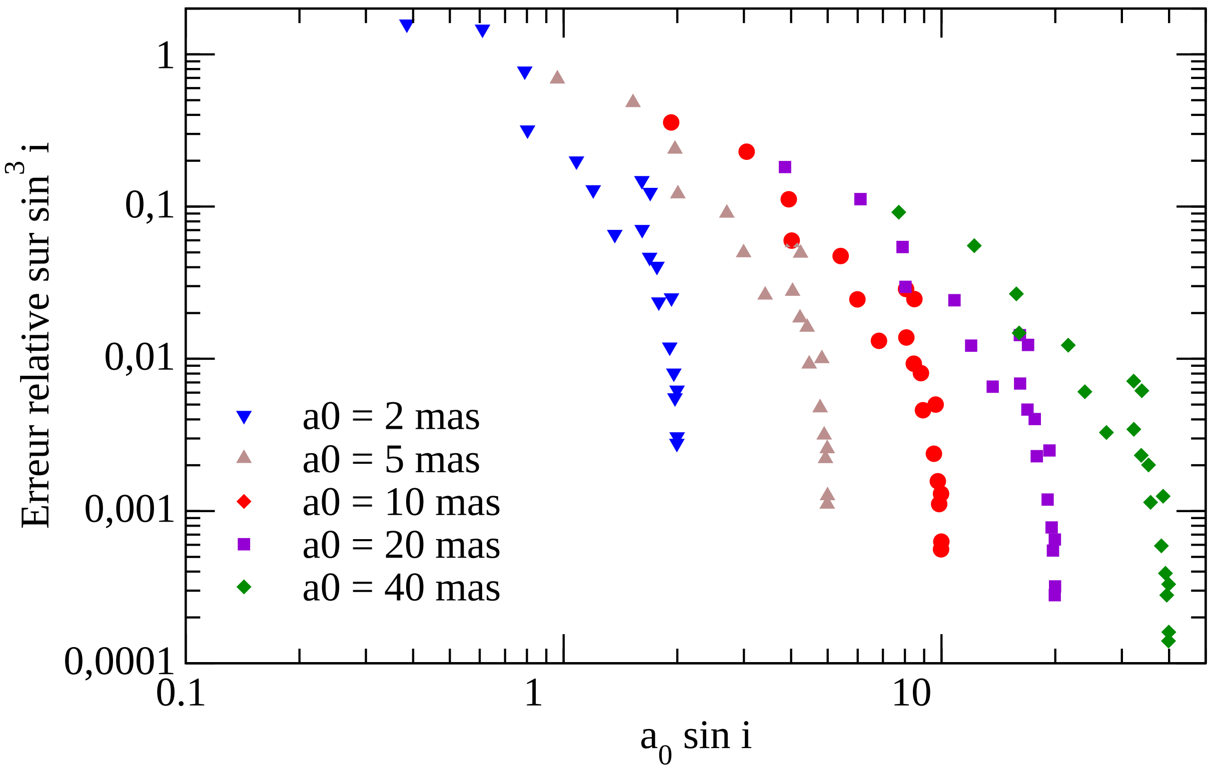
Errors of the inclinations

Astrometric $sin^3 i$ are accurate when :

- a_0 large
- sin i ~ 1

⇓

no a priori estimation of the errors



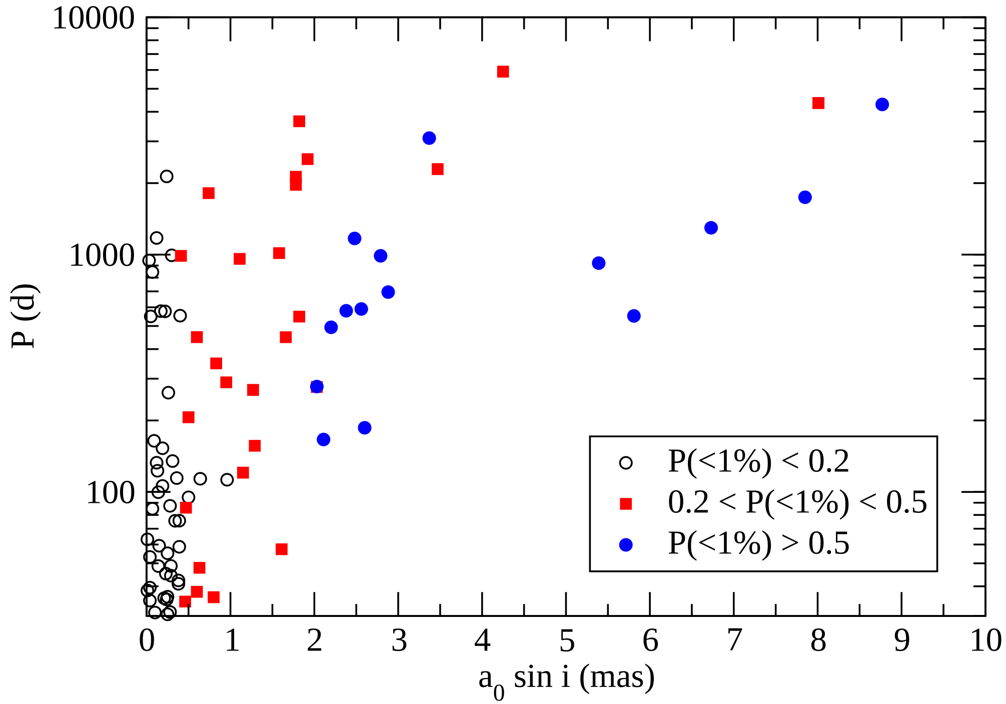
Targets for masses with 1 % - errors

SB2

$M_1 \sin^3 i$ & $M_2 \sin^3 i$ known
(+ P, e, T_0, ω, ϖ, μ)

Luminosity ratio: $q^{7.3/2.5}$

Inclinations : $f(i) = \sin i$



Selection of SB2 with a 50% probability to get $\sin^3 i$ with an error <1% : 20 SB2 HIP, F-G-K, V>6 mag, δ>-5°

Targets for masses with 1 % - errors

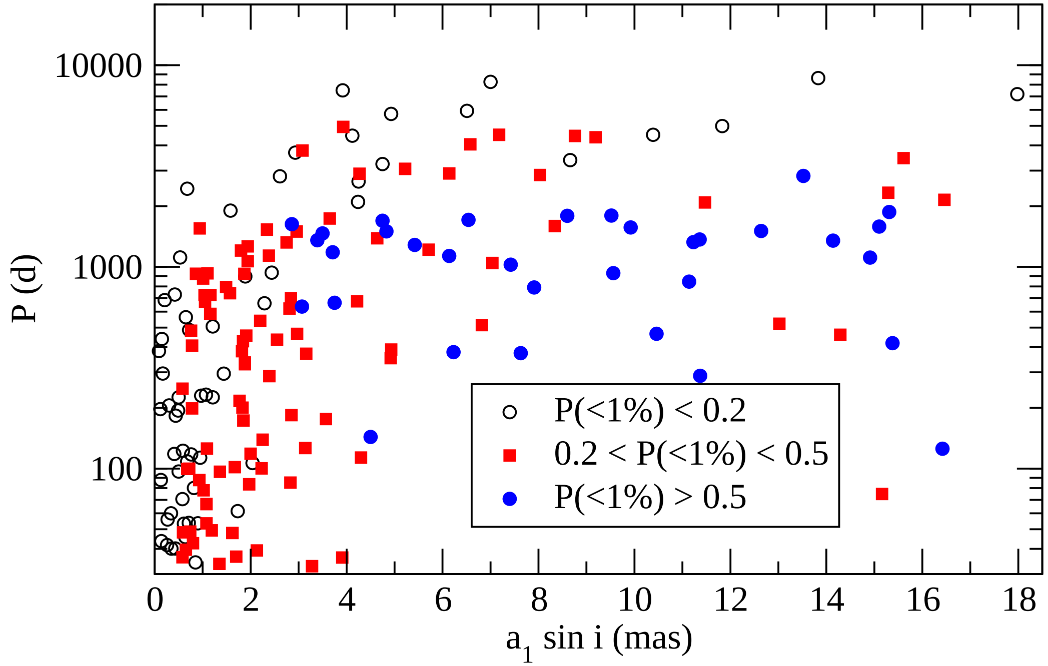
SB1

May become SB2 when $q > 0.3$..

$f_M / M_1 = q^3 \sin^3 i / (1+q)^2$ known (+ P, e, T_0, ω, ϖ, μ)

Luminosity ratio : $q^{7.3/2.5}$

Inclination : $f(i) = \sin i$



Selection of SB1 with a 50% probabillity to get $\sin^3 i$ with an error < 1% : 44 SB1 HIP, F-G-K, V>6 mag, δ>-5°, $q_{min} > 0.3$

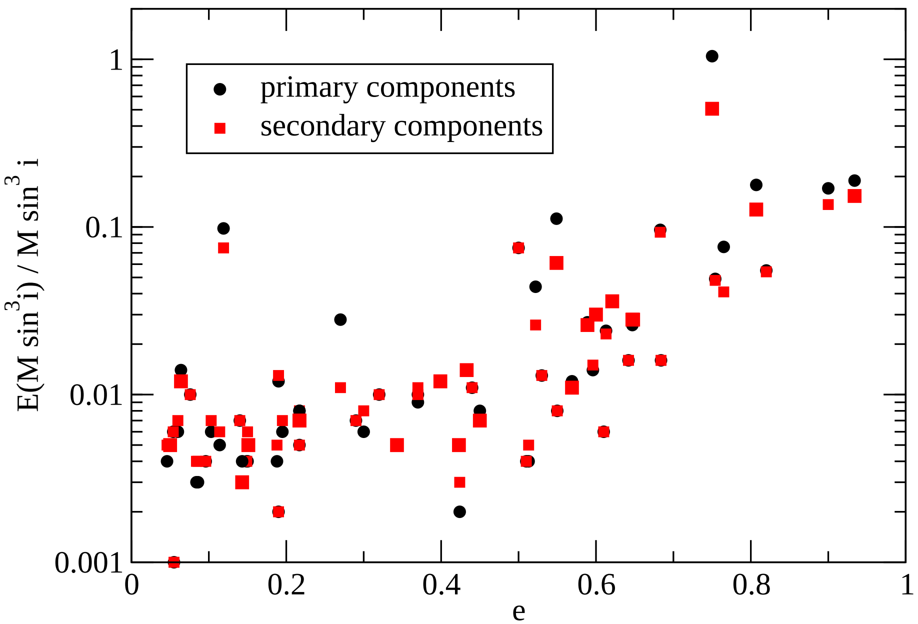
$M_{1,2}\sin^3 i$ with 1 %

Simulation of ~14 RV measurements (2011-2017), ± 50 m/s

$\sigma(\Delta M\sin^3 i) / M\sin^3 i < 1$ % when $e < 0.6$

Explanation:

$$\frac{\Delta(M\sin^3 i)}{M\sin^3 i} = \frac{3\, e\, \Delta e}{1 - e^2}$$



⇒ 15 SB to be removed, except if the periastron are well observed when e > 0.6 !

Conclusion

A few dozens of binary components should get masses with 1 % accuracy, if their SB orbits are ameliorated with OG telescopes *(observations should begin asap ..).*

Much more stars should become SB after the Gaia mission, and the derivation of their AB orbits ...