The mass-ratio distribution of spectroscopic binaries along the main-sequence

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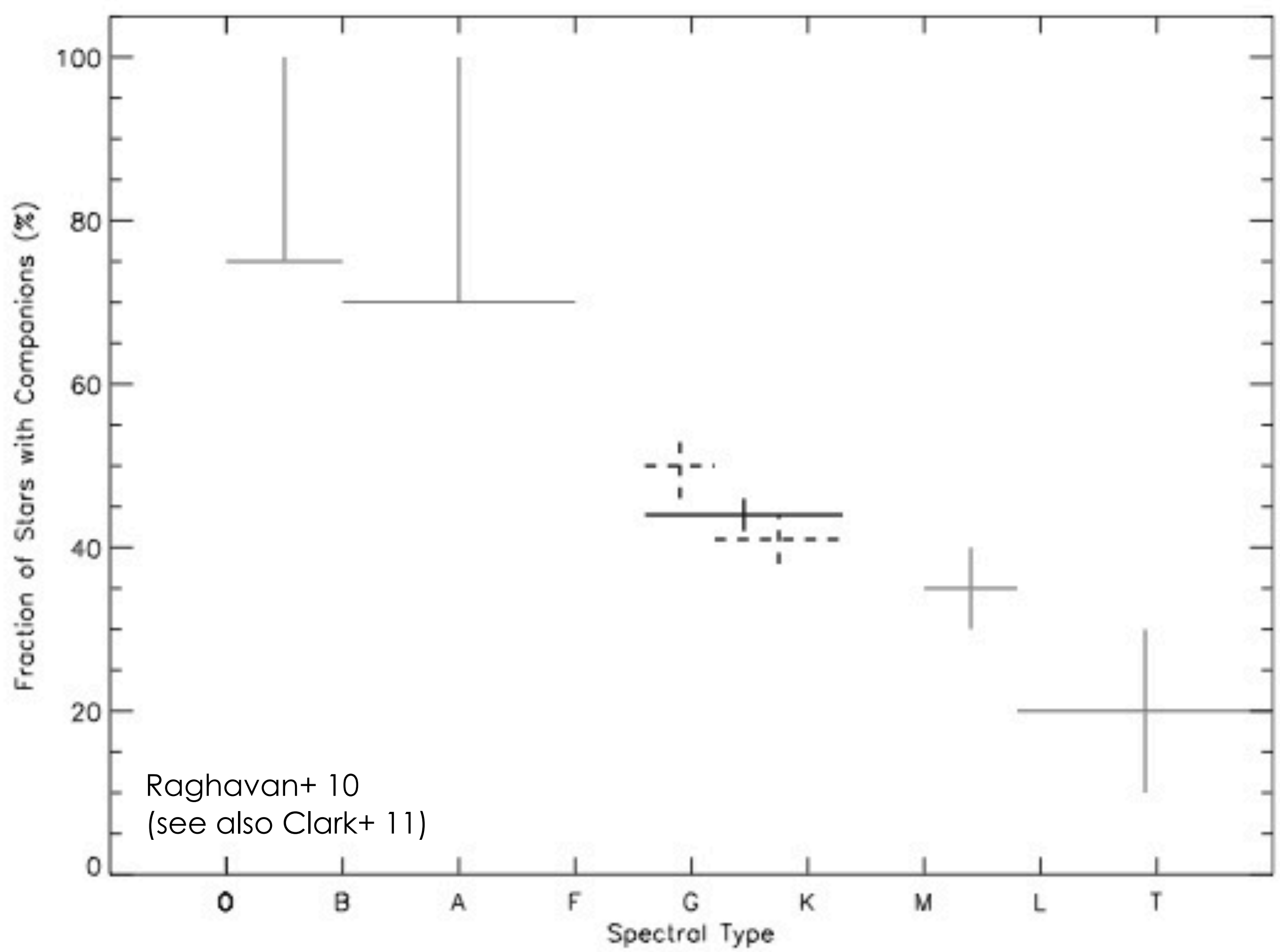
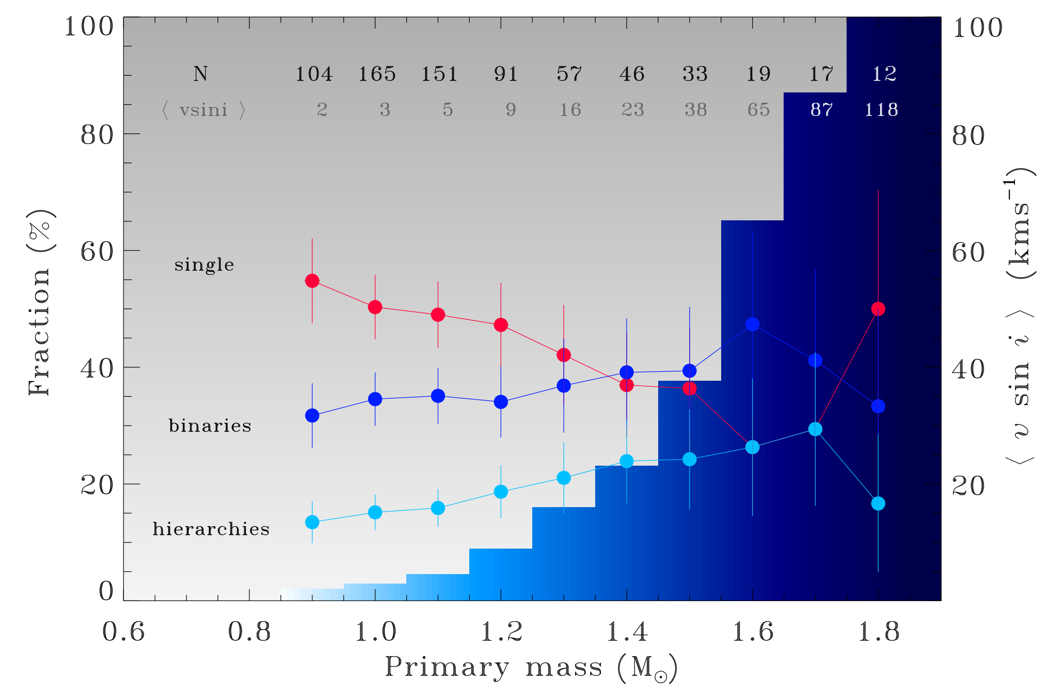
An update of Boffin & Pourbaix 2017
using Gaia DR2

Multiplicity is function of Primary Mass, M_A



Raghavan+ 10
(see also Clark+ 11)

Mass of primary, M_A



Fuhrmann + 17

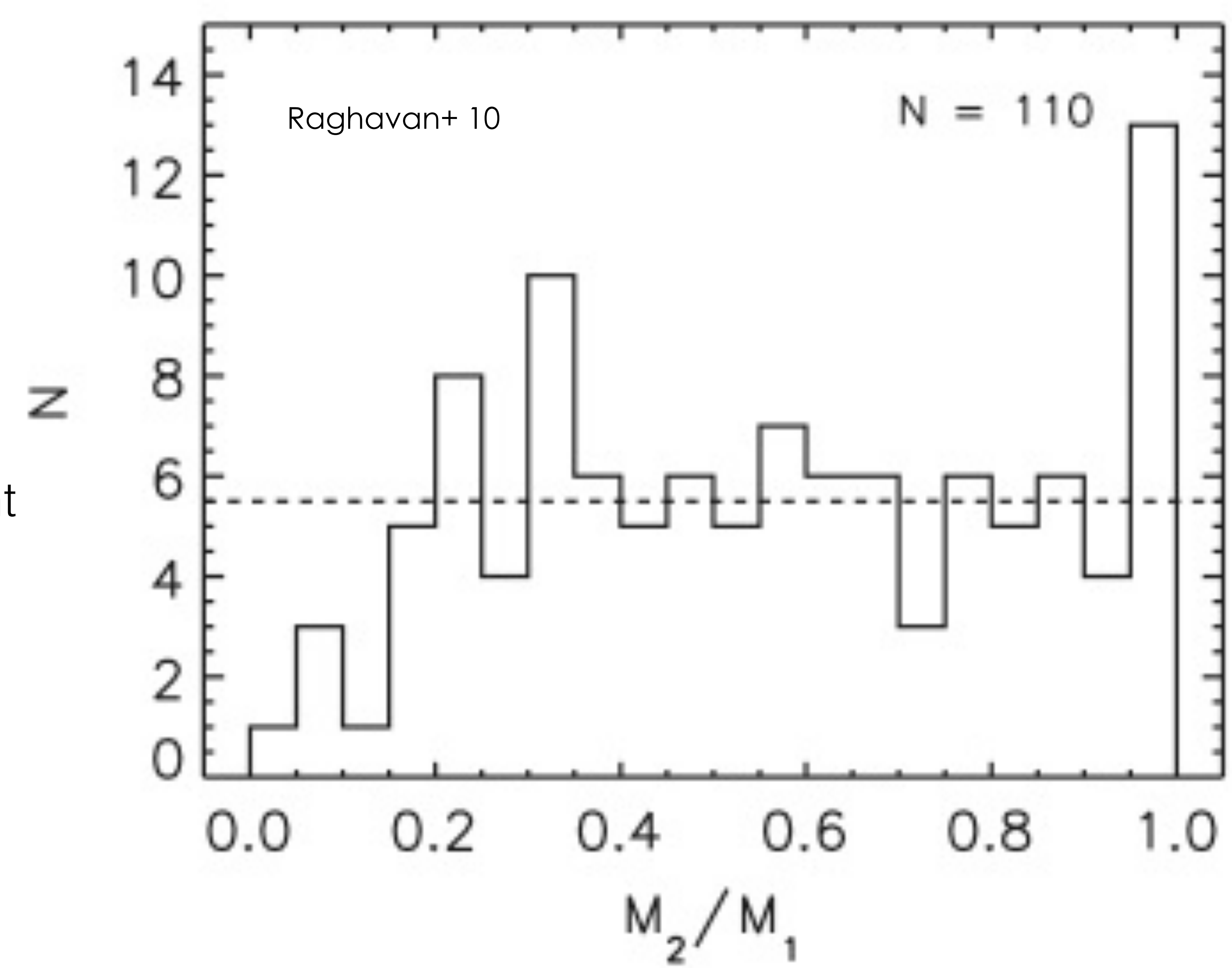
But is this the full story?

What about stars that are secondaries?

What about mass ratio distribution?

Binary formation mechanisms?
e.g. random pairing, f(q) constant

Evolution of binary systems? e.g.
twins population?



454 stars within 25 pc; F6-K3 SpT
Roughly flat distribution for q E [0.2 – 0.95]
Deficiency of low-mass companions
Excess of twins (?)

Does f(q) depend on M_A?

S_B^9 : 9th spectroscopic binary catalogue

Cross-correlated Gaia DR2 with the S_B^9 catalogue to select all binary systems containing a main sequence primary, for which $\sigma_{\varpi} < \varpi / 10$.

2926 systems: 1948 SB1; 978 SB2

S_B^9 sample

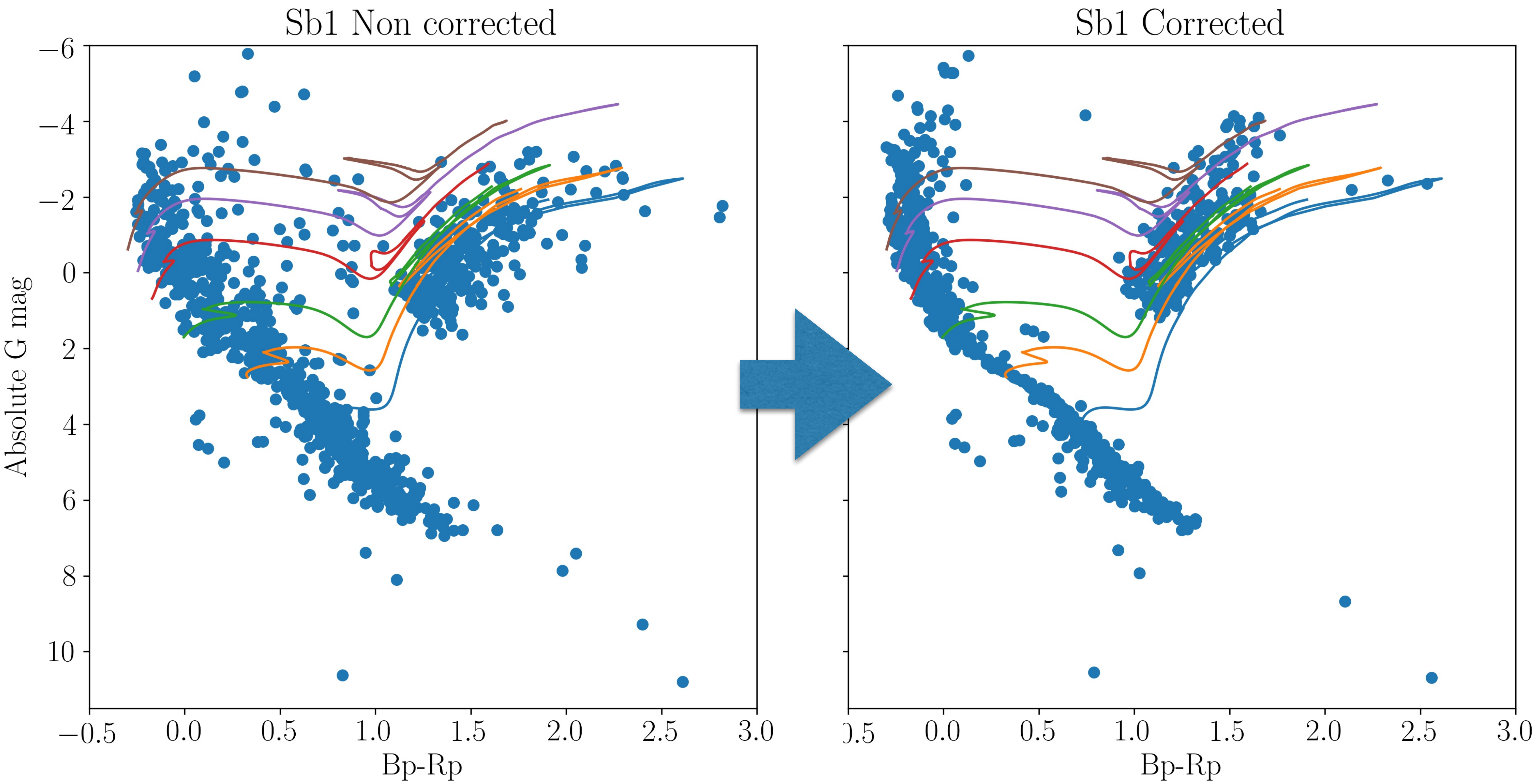
Cross-correlated Gaia DR2 with the S_B^9 catalogue to select all binary systems containing a main sequence primary, for which $\sigma_\varpi < \varpi / 10$.

Used ϖ, G, Bp-Rp and Ag to create CMD diagram

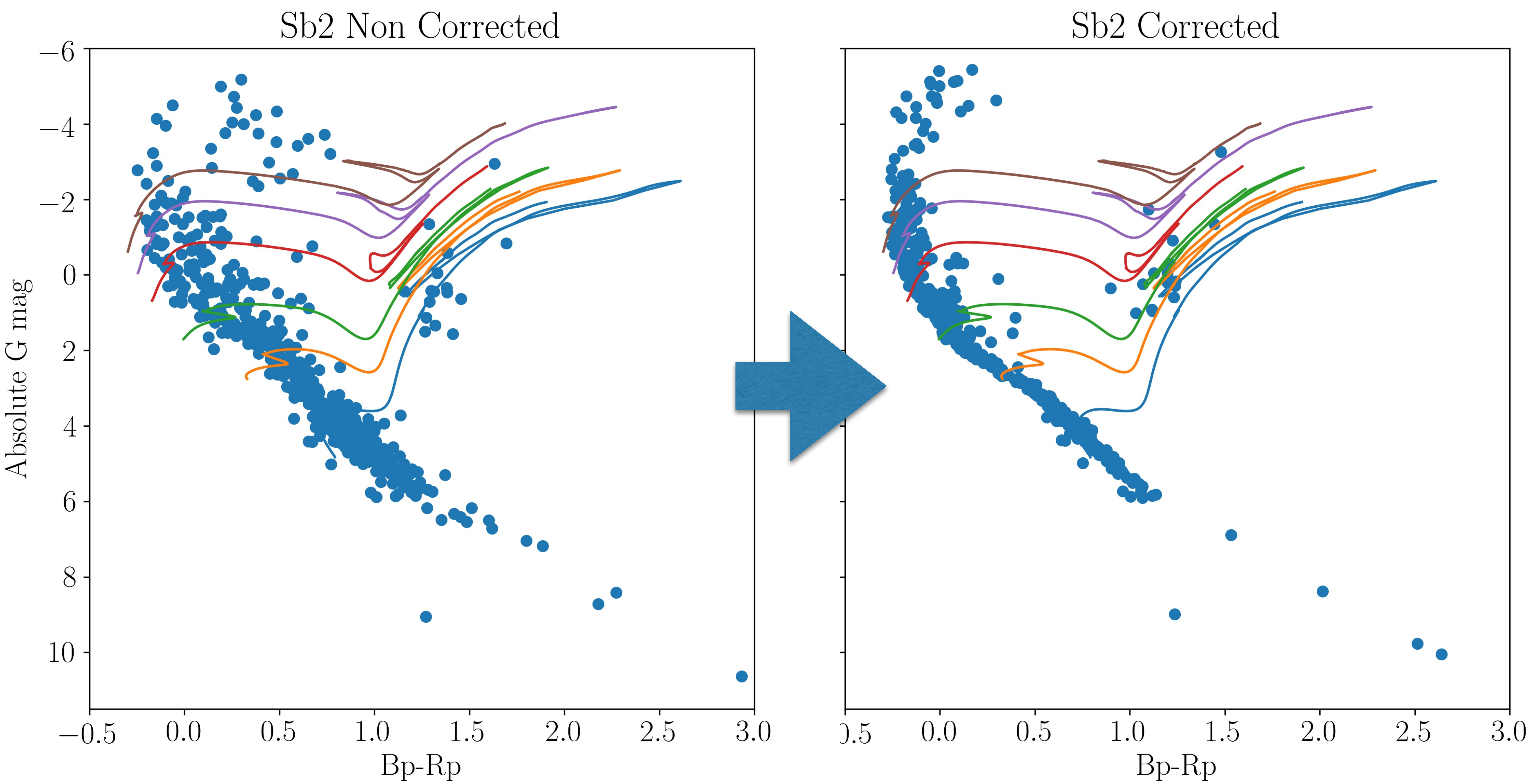
SB1: 1948 systems
1143 with Ag
1067 with $\sigma_\varpi < \varpi / 10$
738 on MS

SB2: 978 systems
567 with Ag
534 with $\sigma_\varpi < \varpi / 10$
488 on MS

Importance of Extinction - SB1



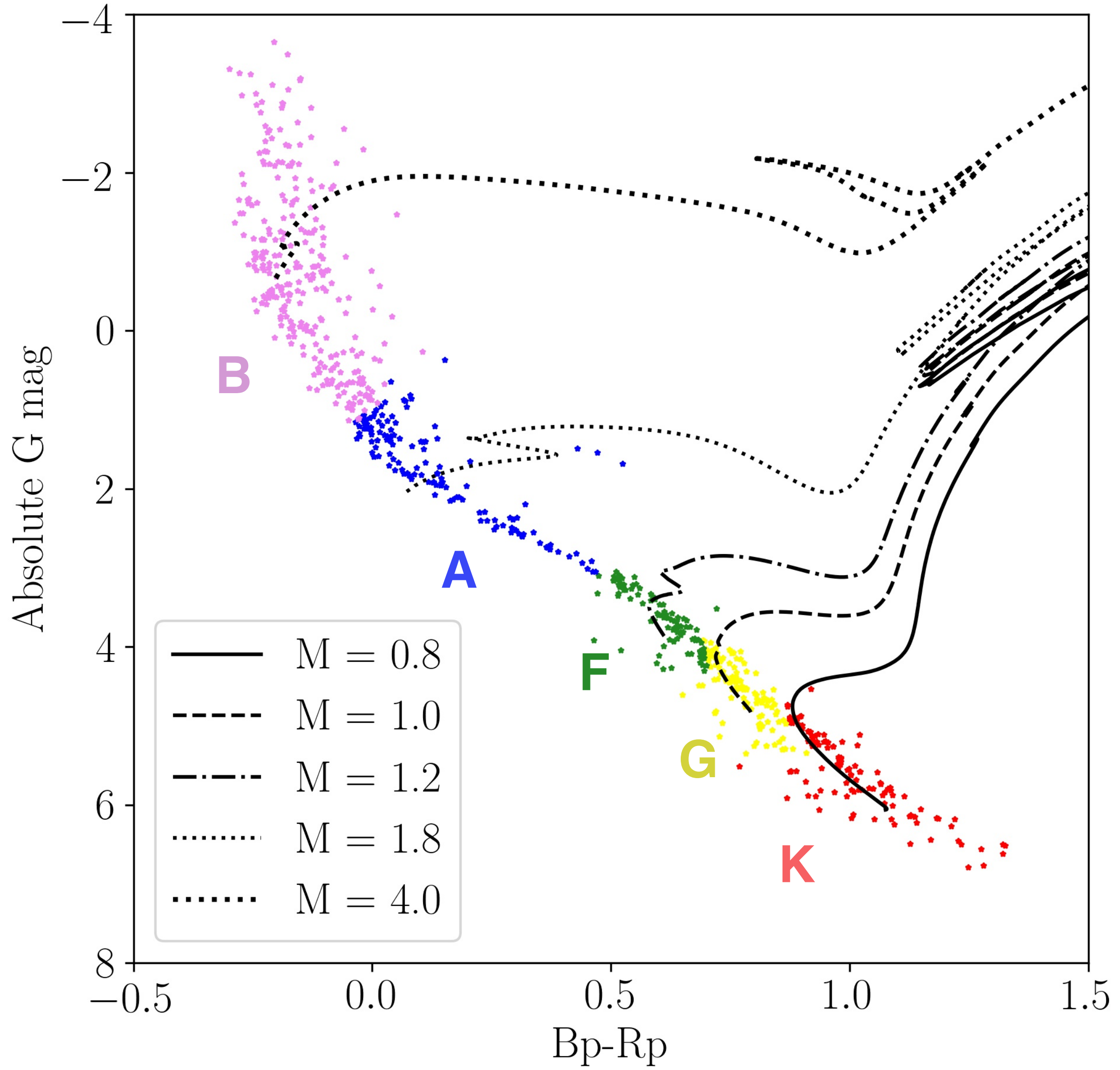
Importance of Extinction - SB2



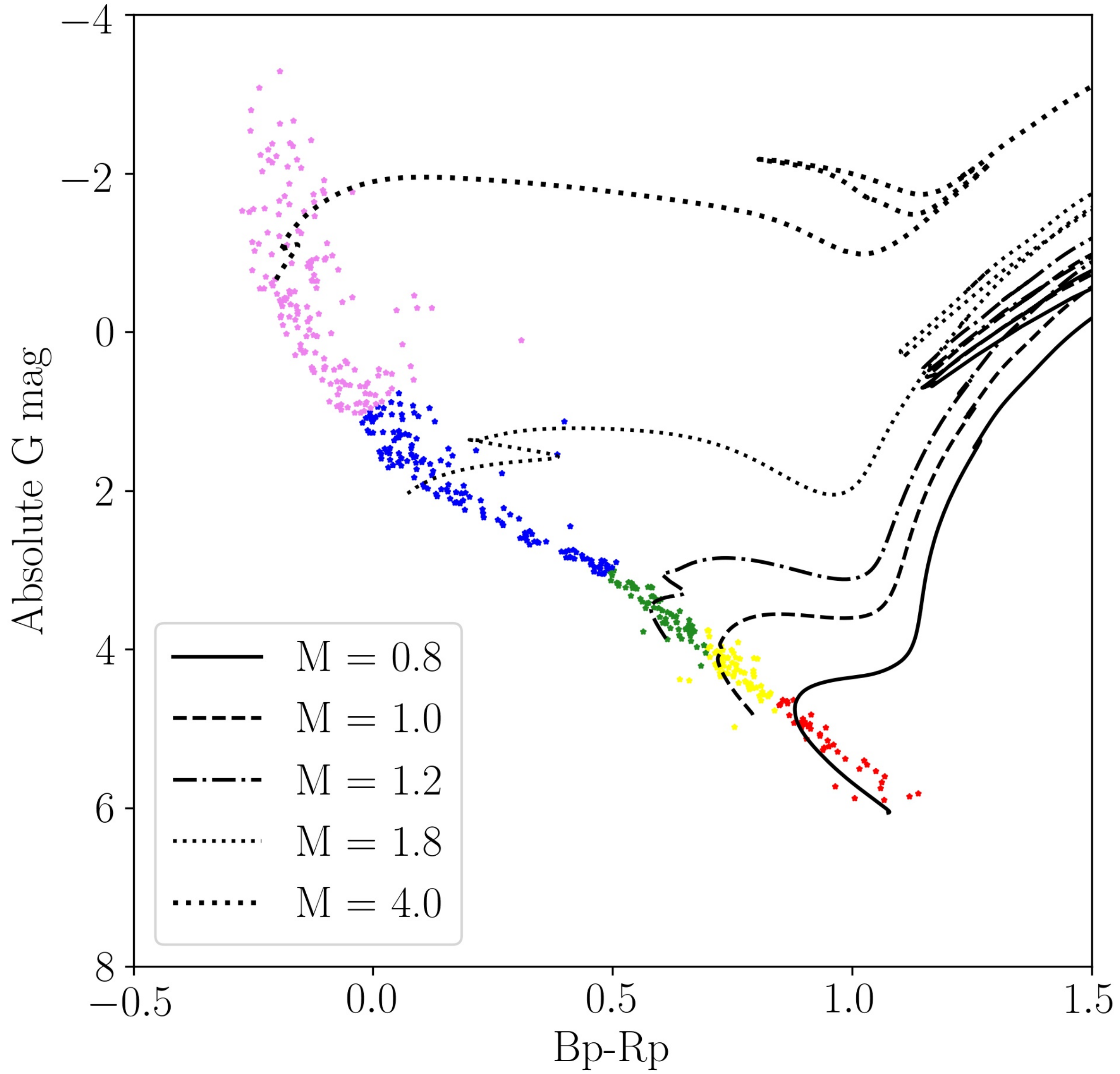
Final sample
Only Main-sequence stars

K	M = 0.74 ± 0.06 M⊙
G	M = 0.95 ±- 0.05 M⊙
F	M = 1.18 ± 0.08 M⊙
A	M = 1.81 ± 0.28 M⊙
B	M = 3.82 ± 1.18 M⊙

SB1: 738 systems



SB2: 488 systems



$S_B{}^9$ sample

Cross-correlated Gaia DR2 with the $S_B{}^9$ catalogue to select all binary systems containing a main sequence primary, for which $\sigma_\varpi < \varpi / 10$.

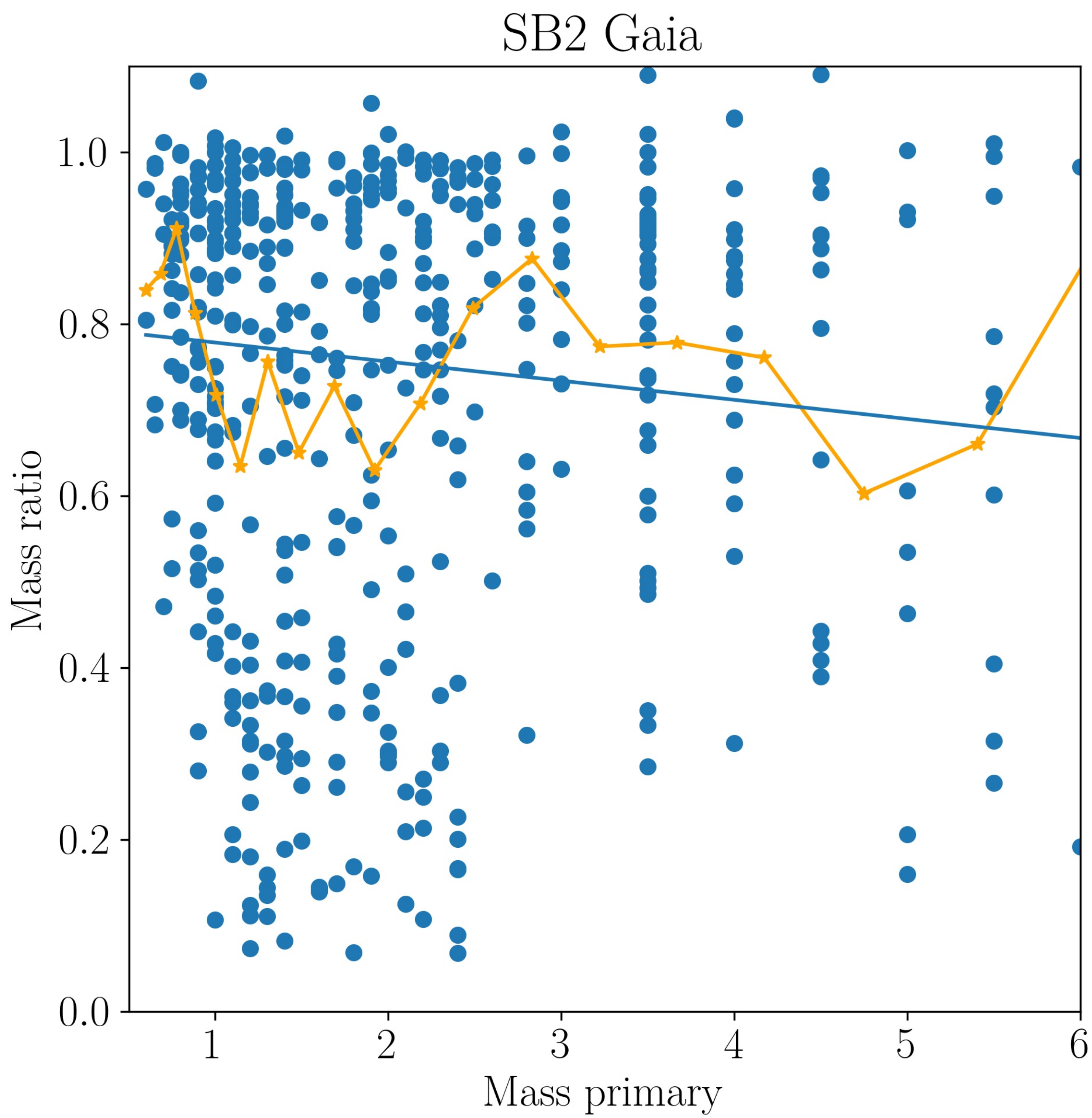
Used G, Bp-Rp and Ag to create CMD diagram

Interpolate BASTI tracks to get masses of primary

	SB1	SB2
K	116 (101)	41 (26)
G	117 (103)	67 (34)
F	99 (84)	65 (23)
A	131 (91)	151 (64)
B	275 (200)	164 (97)

Spectroscopic binaries: mass ratio

SB2: *q* is given



Spectroscopic binaries: mass ratio

SB2: q is given

SB1:

$$f(M) = \frac{(M_B \sin i)^3}{(M_A + M_B)^2} = \frac{K_A^3 P}{2\pi G}(1-e^2)^{3/2}$$

Observables

M_A: Mass primary
M_B: Mass secondary
i: unknown inclination

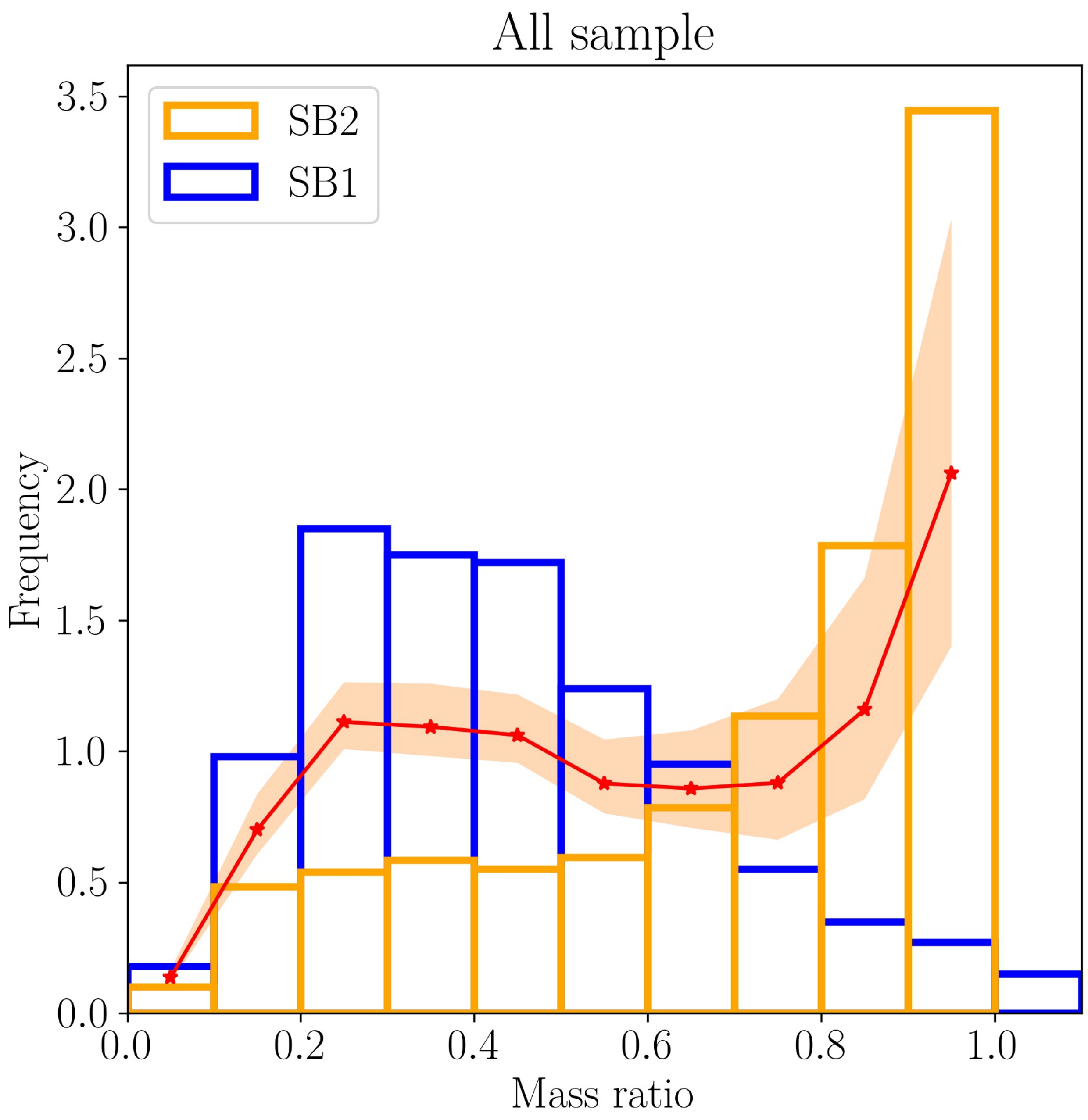
Can get $q=M_B/M_A$ as a function of M_A

As we can **assume *i* is randomly distributed**, one can determine the distribution of *f(q)* *with the Lucy-Richardson algorithm*

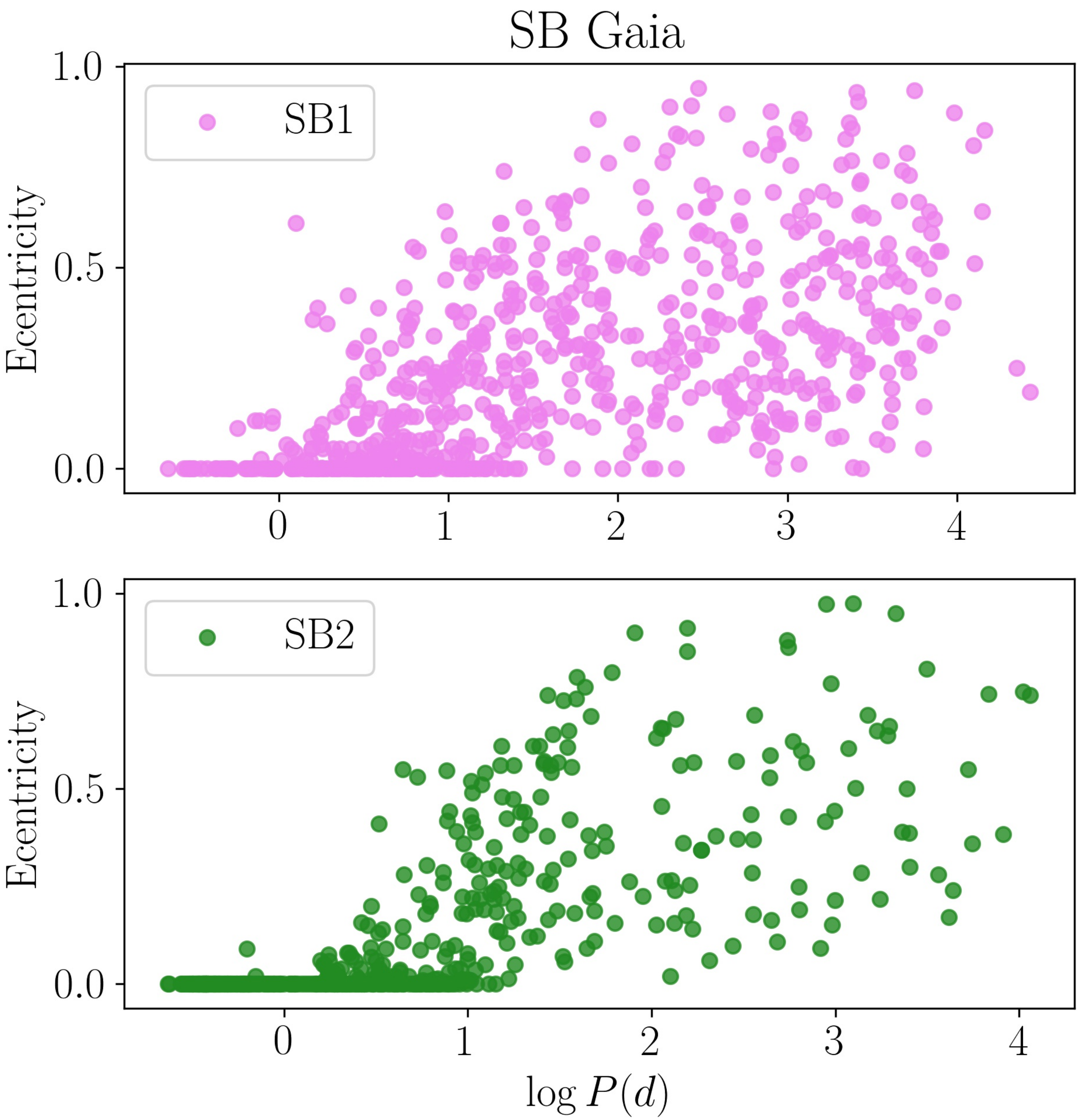
Boffin+ 92, Mazeh & Goldberg 92

Use Gaia to get M_A

Mass ratio distribution



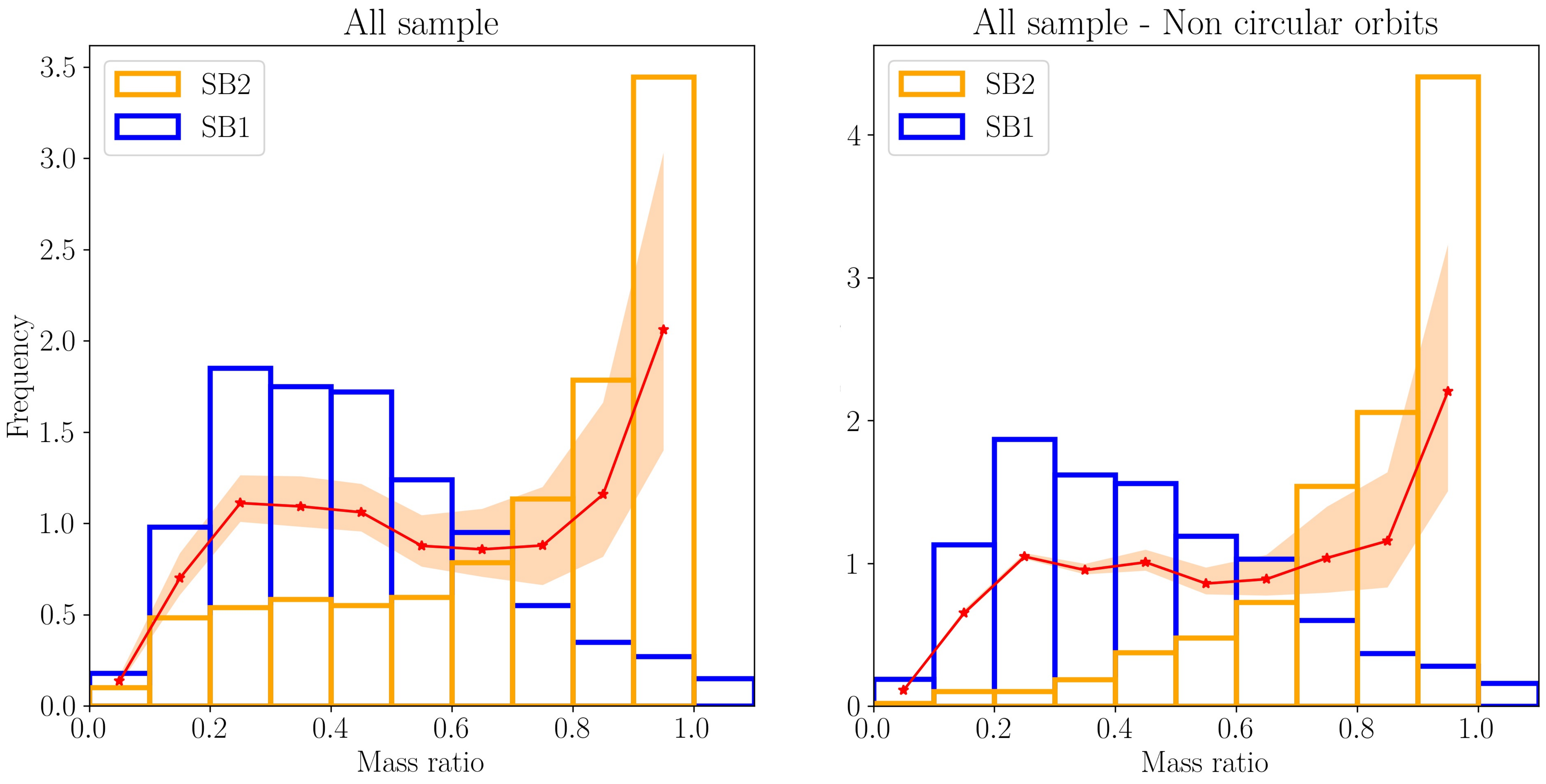
Mass transfer systems?



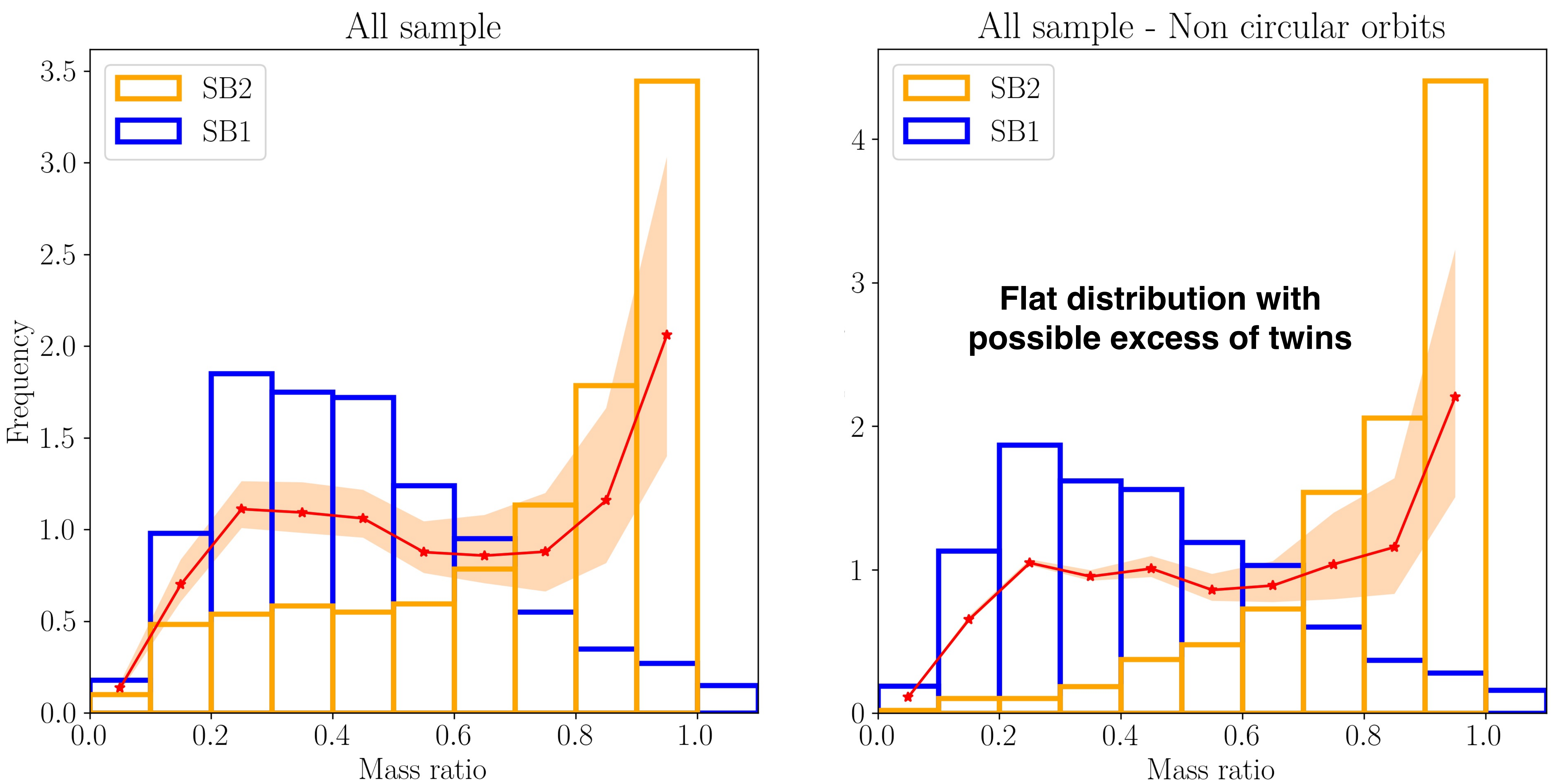
Circular orbits could be result of

- Normal tidal evolution
- Mass transfer processes (hidden WDs)

Mass ratio distribution

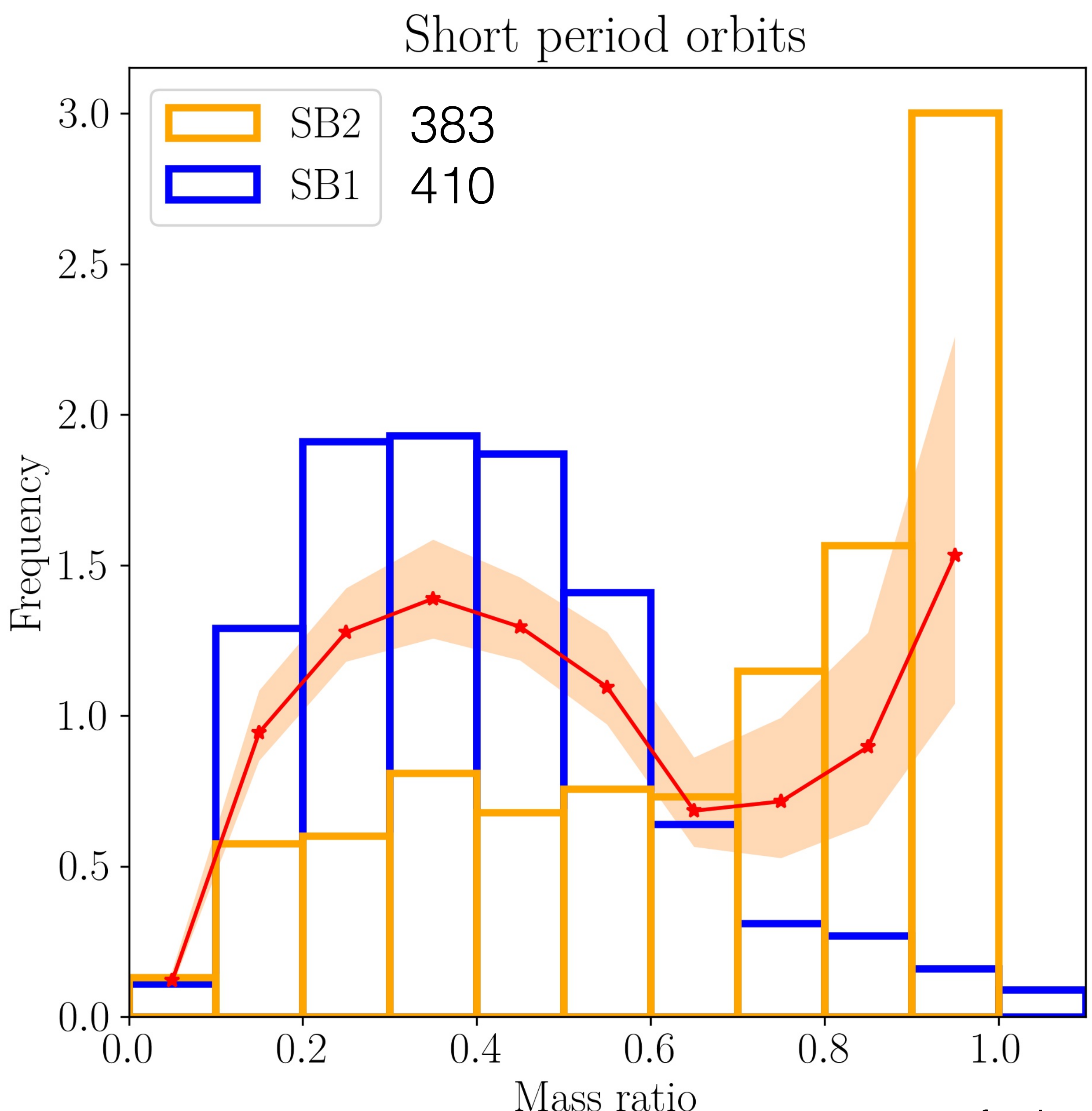


Mass ratio distribution

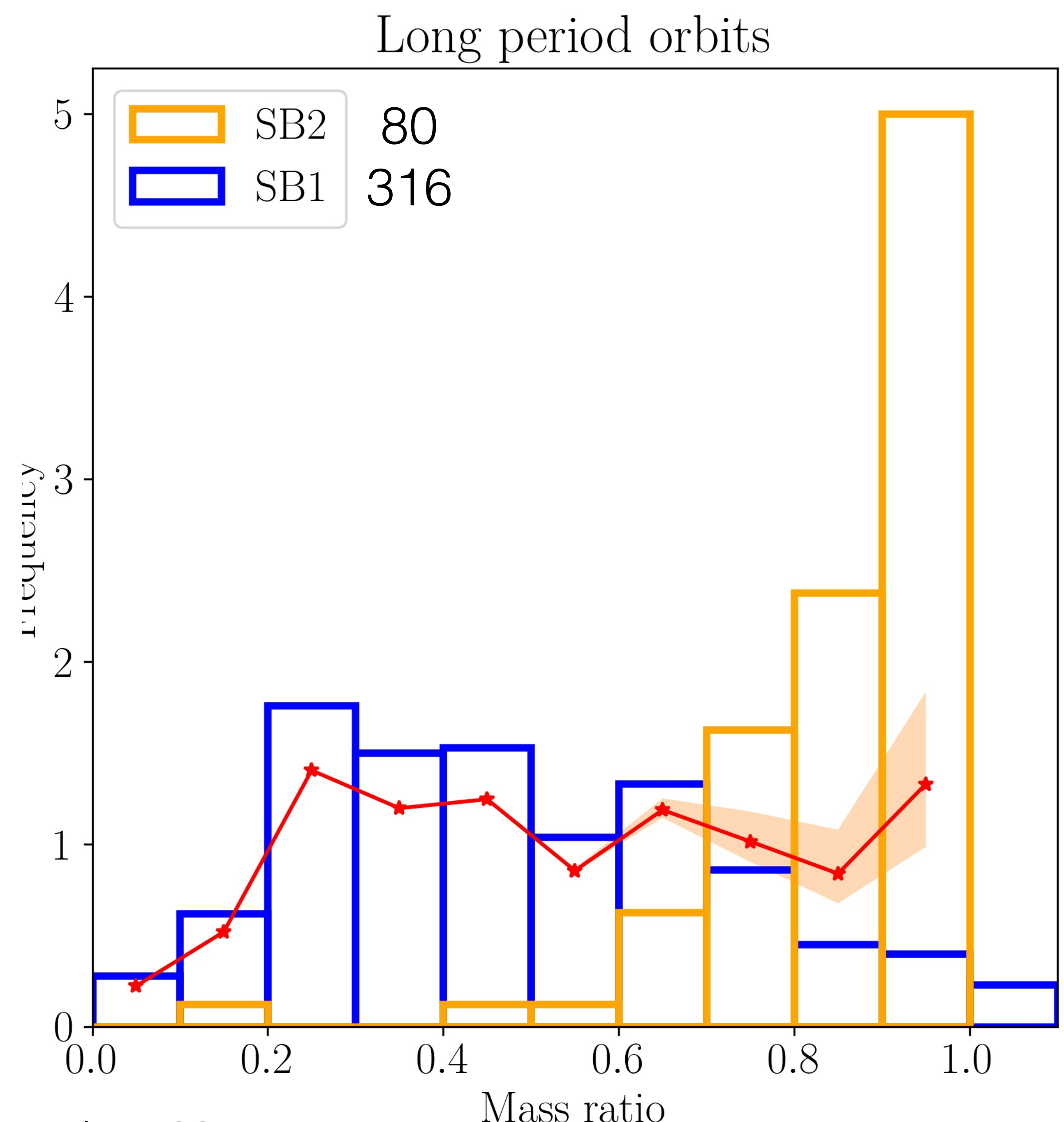


Effect of orbital period

P < 50 d

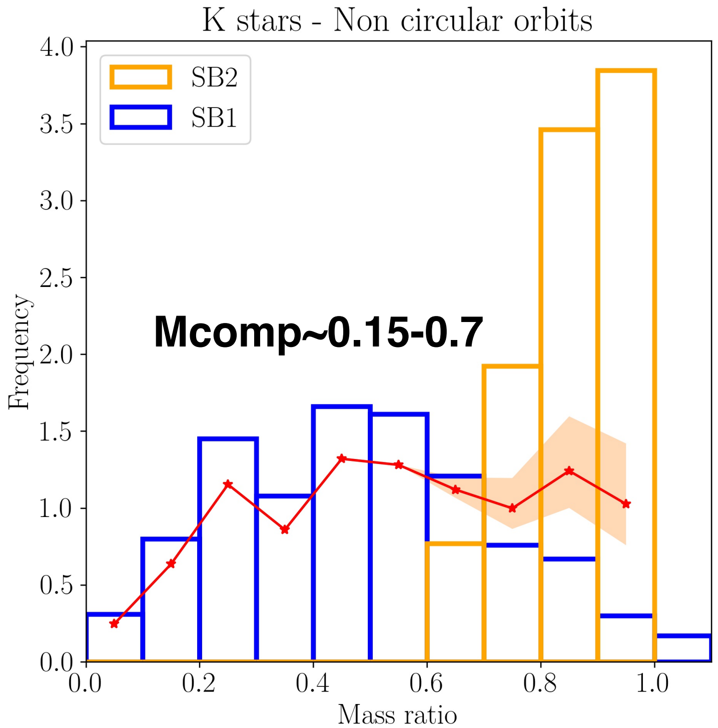


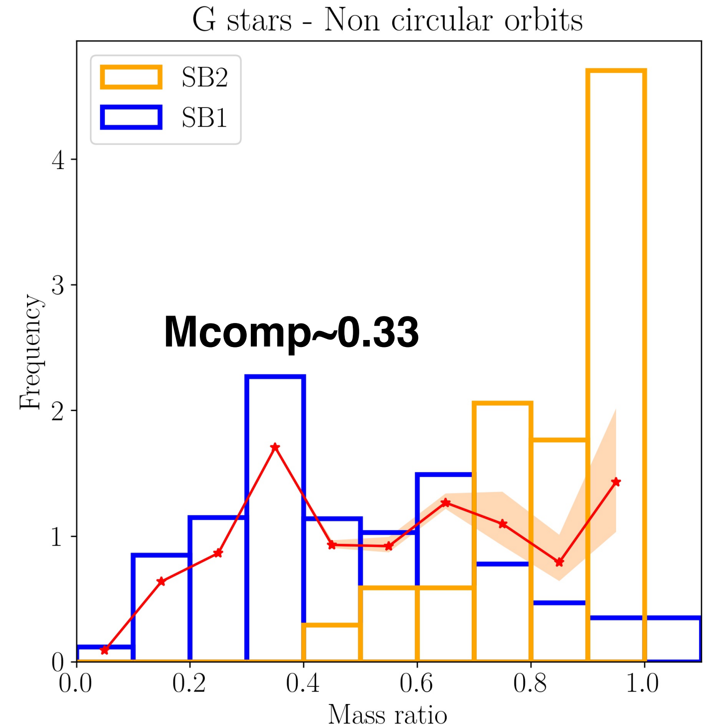
P > 50 d

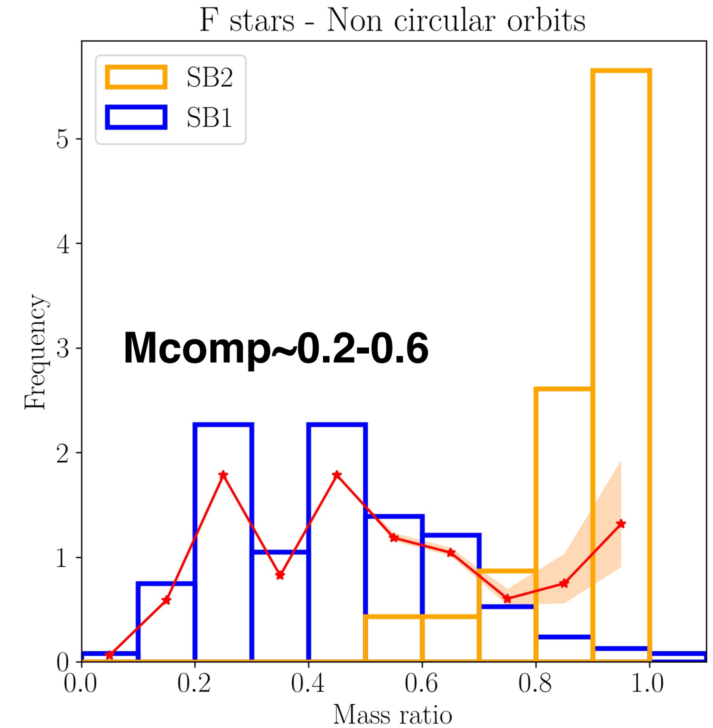


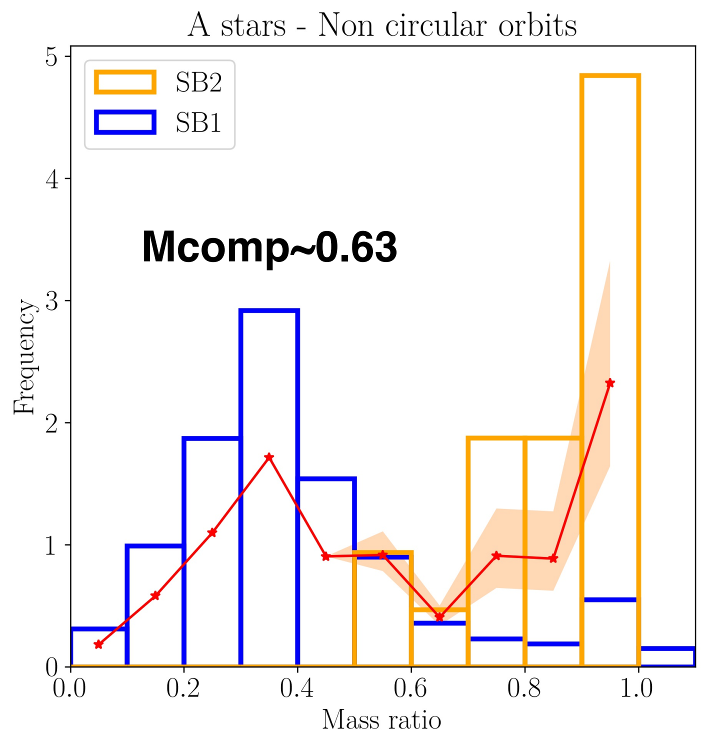
cf. also Halbwachs+ 03

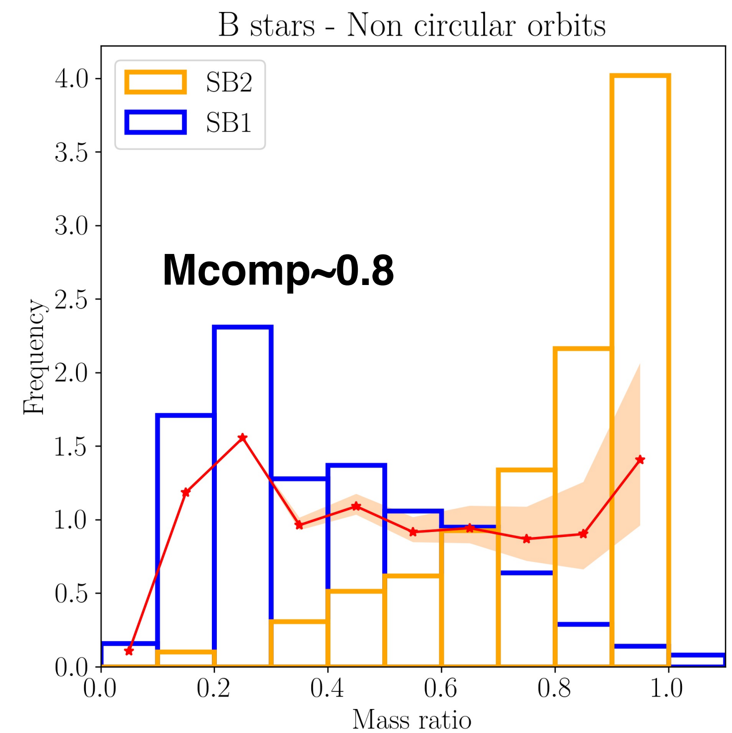
Gaia DR2 - MRD as fn of primary mass



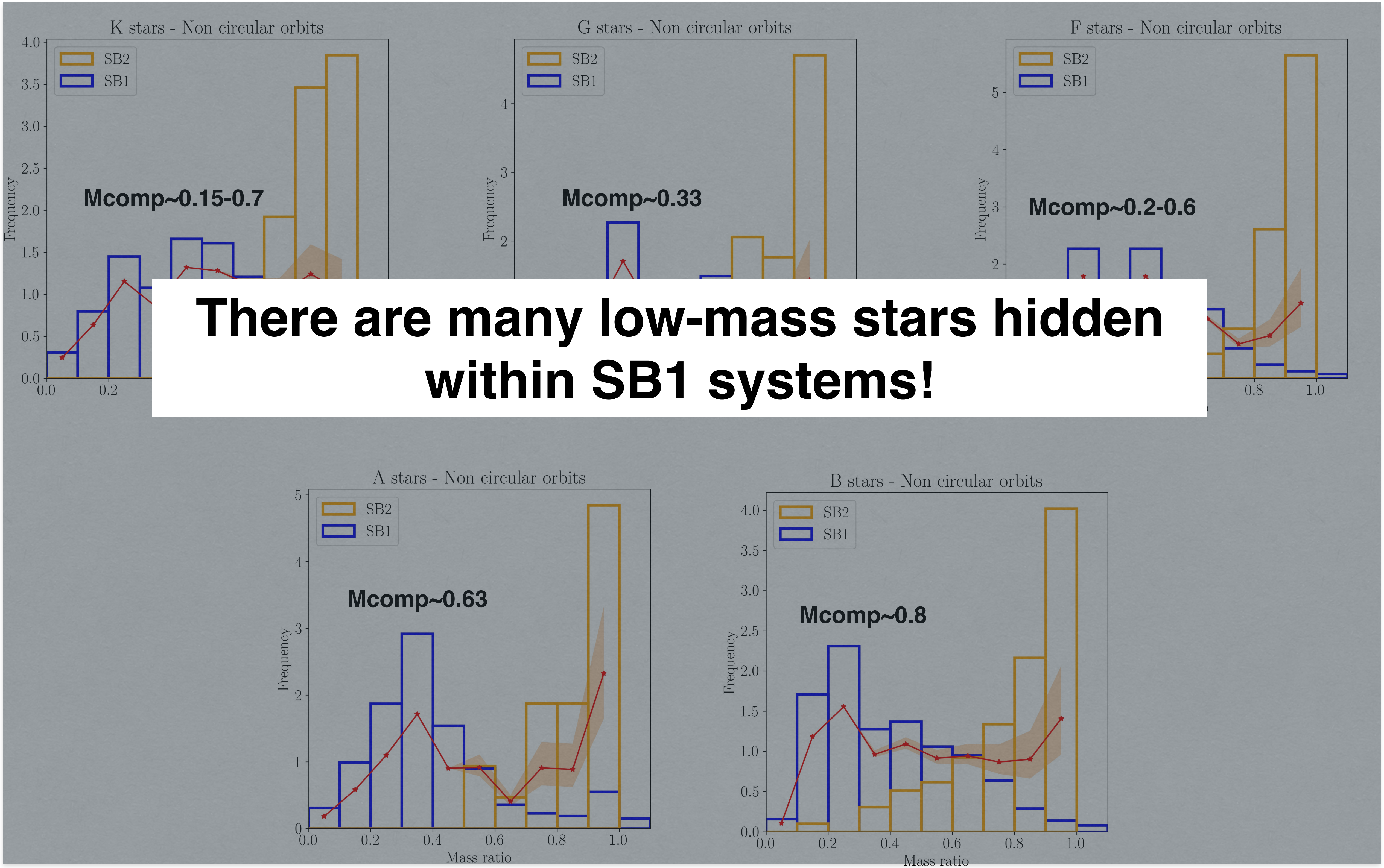






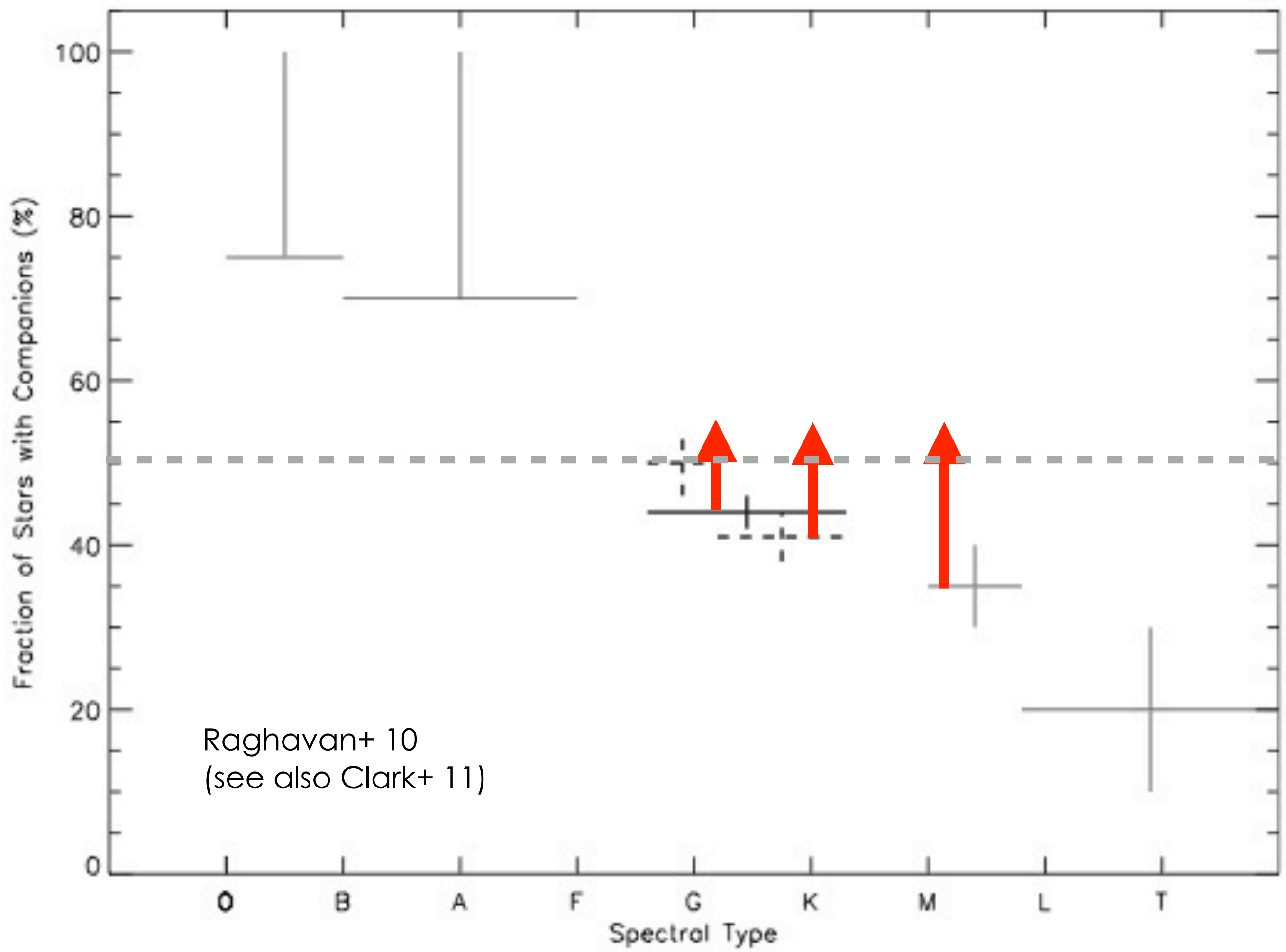


Gaia DR2 - MRD as fn of primary mass



There are many low-mass stars hidden within SB1 systems!

Multiplicity is function of Primary Mass, M_A



Mass of primary, M_A

Majority of solar-like stars are in binaries!

Binarity of G, K, M stars may be similar and above 50%

Boffin & Pourbaix 17

See also Whitworth & Lomax 15

Summary

- By cross-correlating SB9 catalogue with Gaia DR2, we determined the mass ratio distribution as a function of the primary mass: mostly uniform, with some trend from most massive stars to less massive ones

- The excess of twins seems related to A stars only and to short period systems

- There are many low-mass stars as secondaries and their binary fraction is therefore higher than generally thought

- This will provide hints on star formation.

Thank you