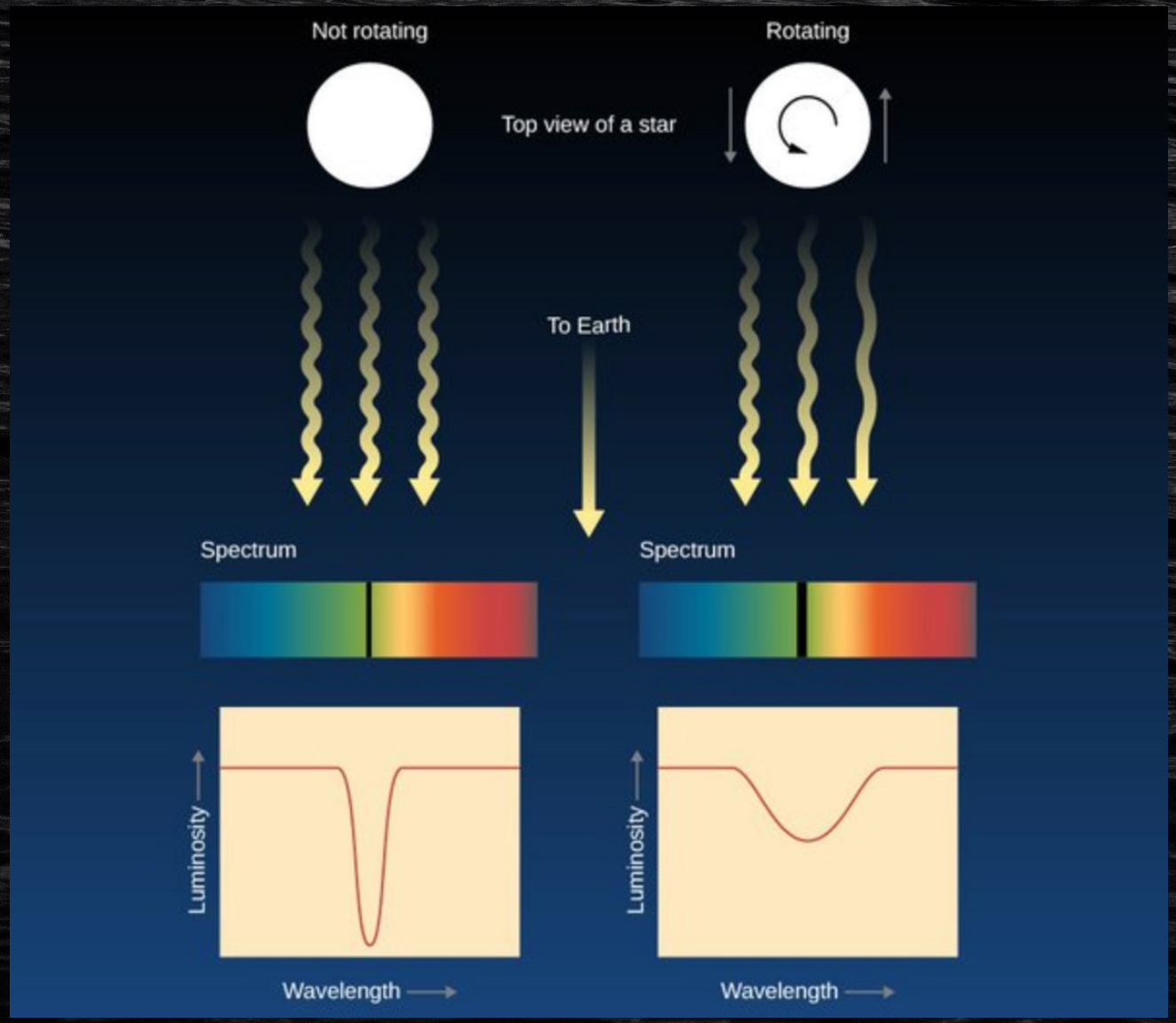
tracing the evolution of short-period binaries with super-synchronous fast rotators

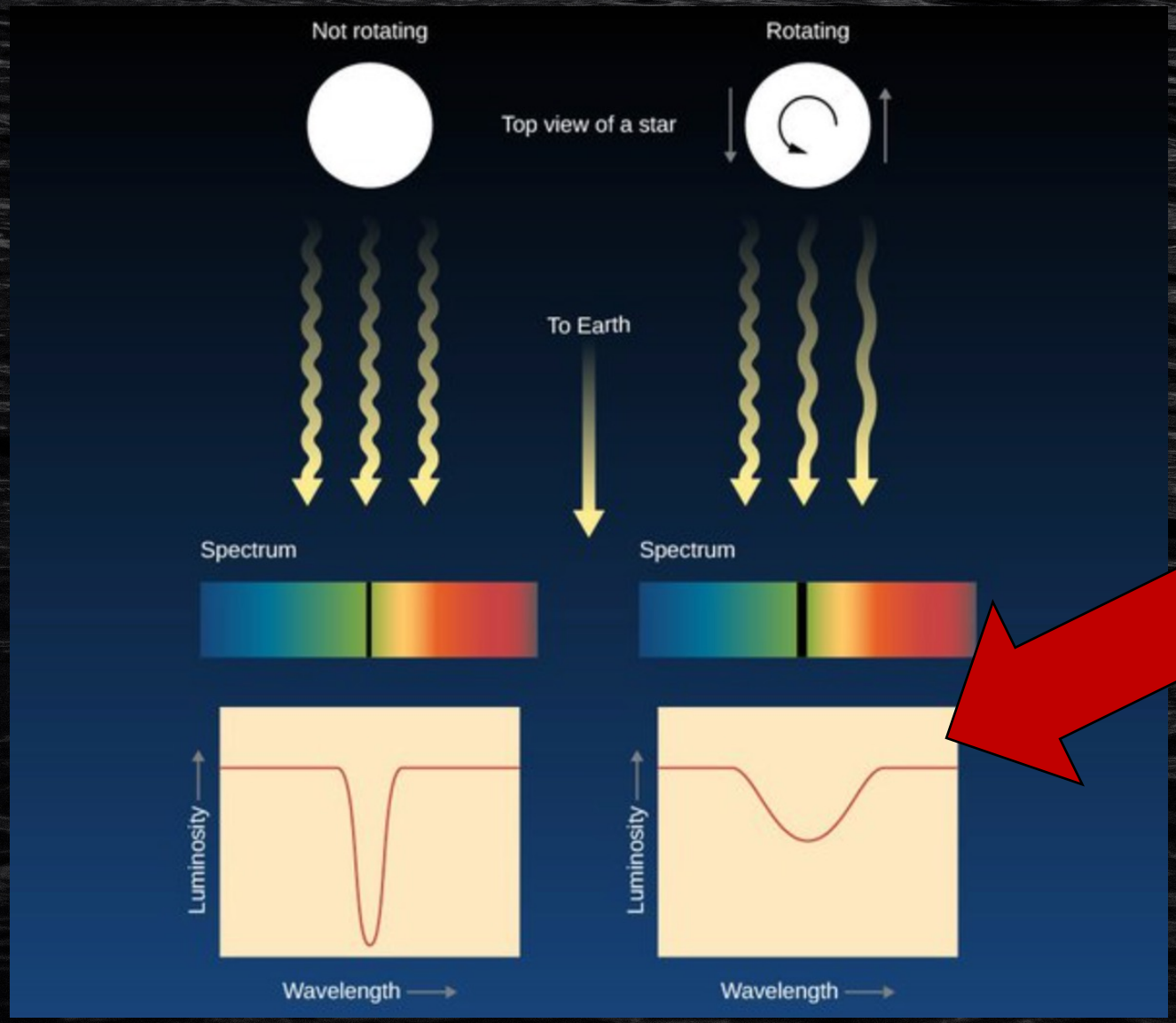
NIKOLAY BRITAVSKIY
MATHIEU RENZO
LAURENT MAHY
YAËL NAZÉ
GREGOR RAUW

tracing the evolution of short-period binaries with super-synchronous fast rotators

tracing the evolution of short-period binaries with super-synchronous fast rotators



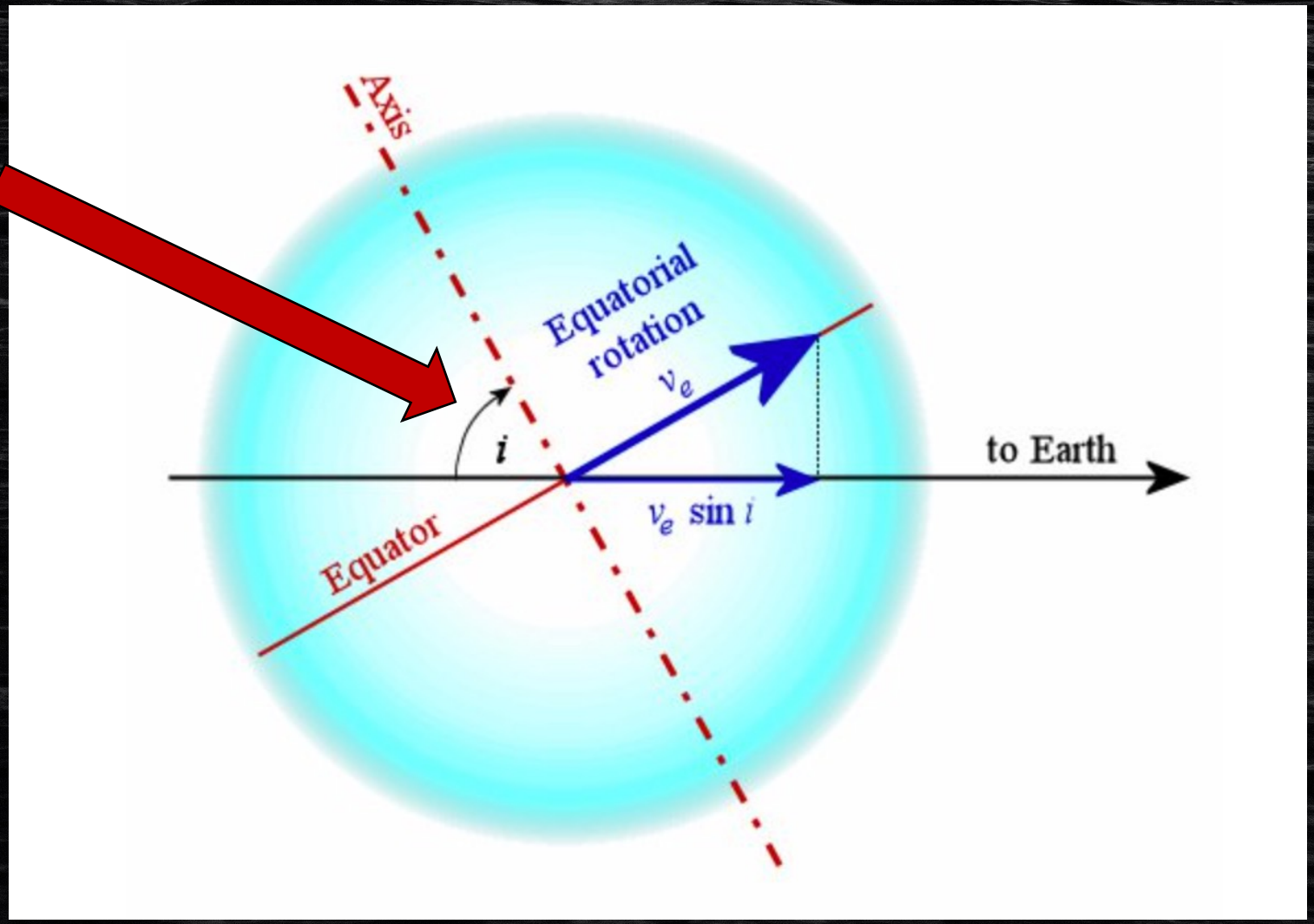
tracing the evolution of short-period binaries with super-synchronous fast rotators



line broadening can be measured through the vsini parameter

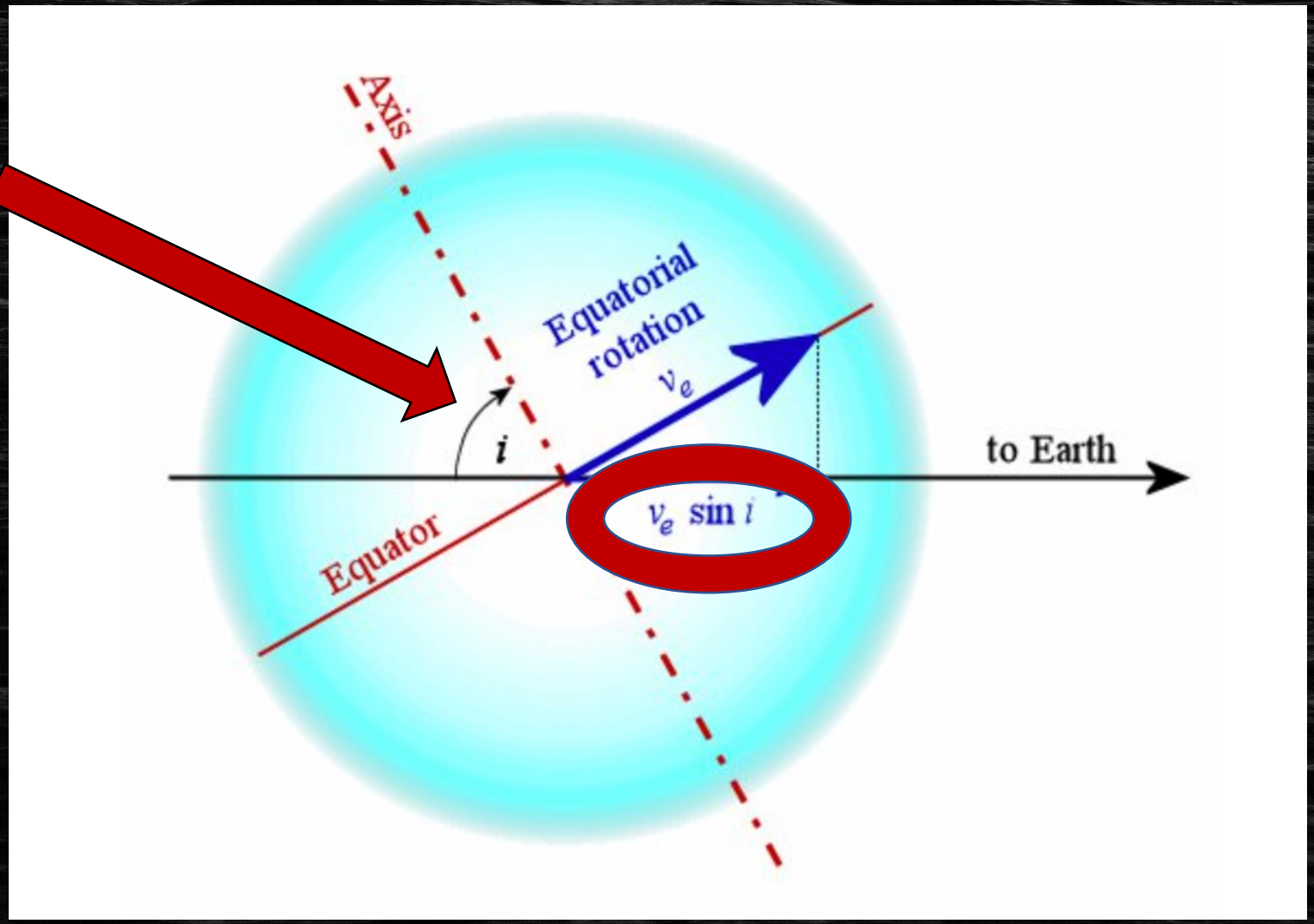
tracing the evolution of short-period binaries with super-synchronous fast rotators

we almost never don't know the inclination



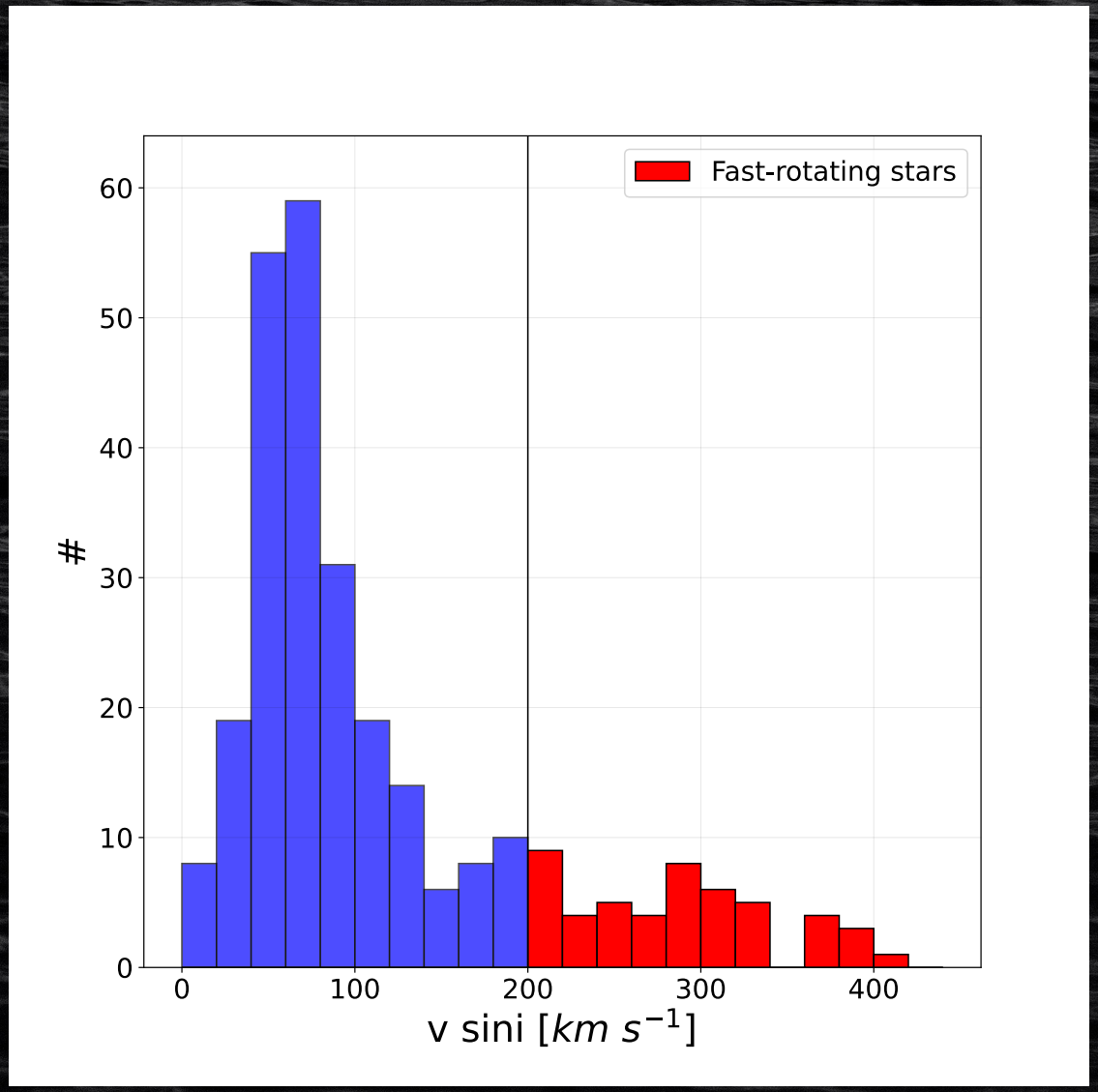
tracing the evolution of short-period binaries with super-synchronous fast rotators

we almost never don't know the inclination



tracing the evolution of short-period binaries with super-synchronous fast rotators

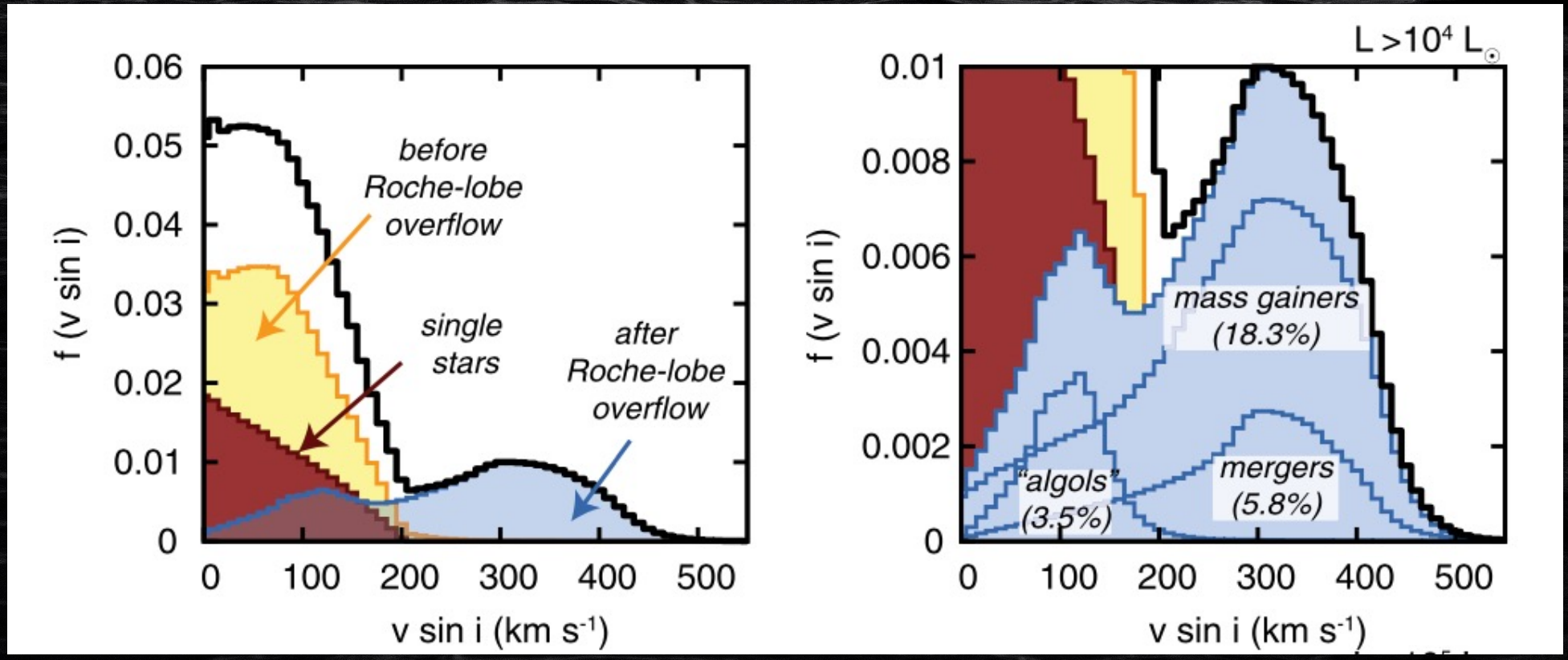
Holgado et al. (2022)
Britavskiy et al. (2023)



tracing the evolution of short-period binaries with super-synchronous fast rotators

the theoretical predictions say there are a bunch of post-interacting objects that spun up at some point …

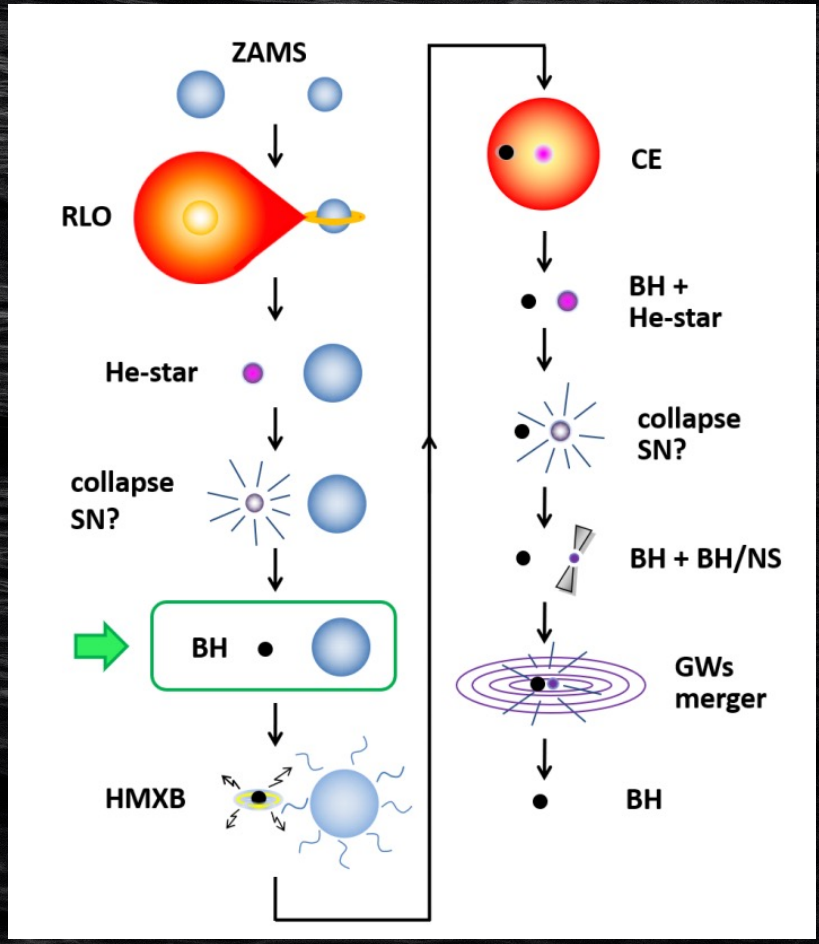
de Mink et al. (2011, 2013)



tracing the evolution of short-period binaries with super-synchronous fast rotators

… and such interactions could give us interesting binary configurations …

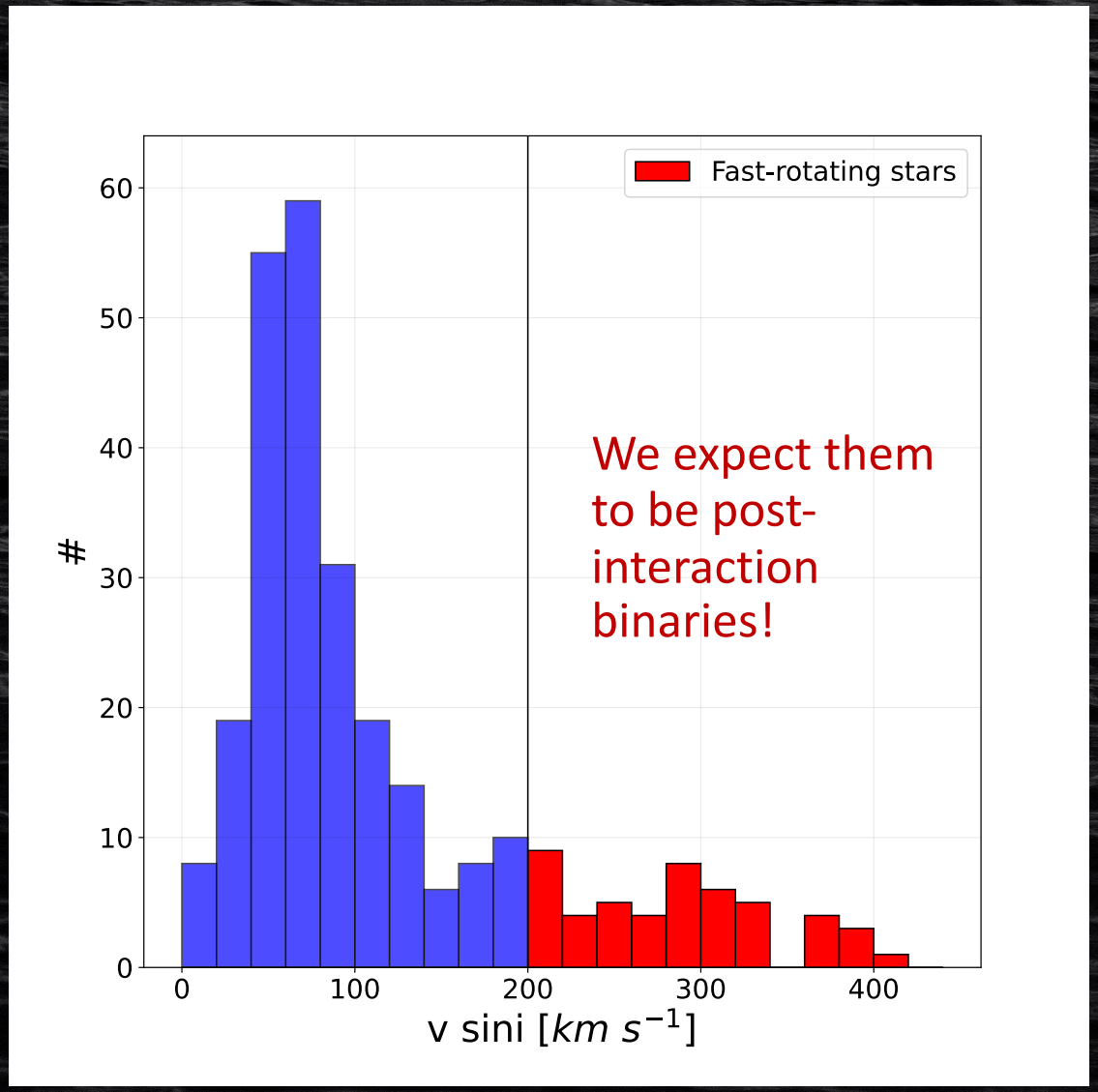
- OB + BH
- OB + NS
- OB + sdO/stripped stars
- …
- …
- …
- OB + everything you want



Langer et al. (2020)

tracing the evolution of short-period binaries with super-synchronous fast rotators

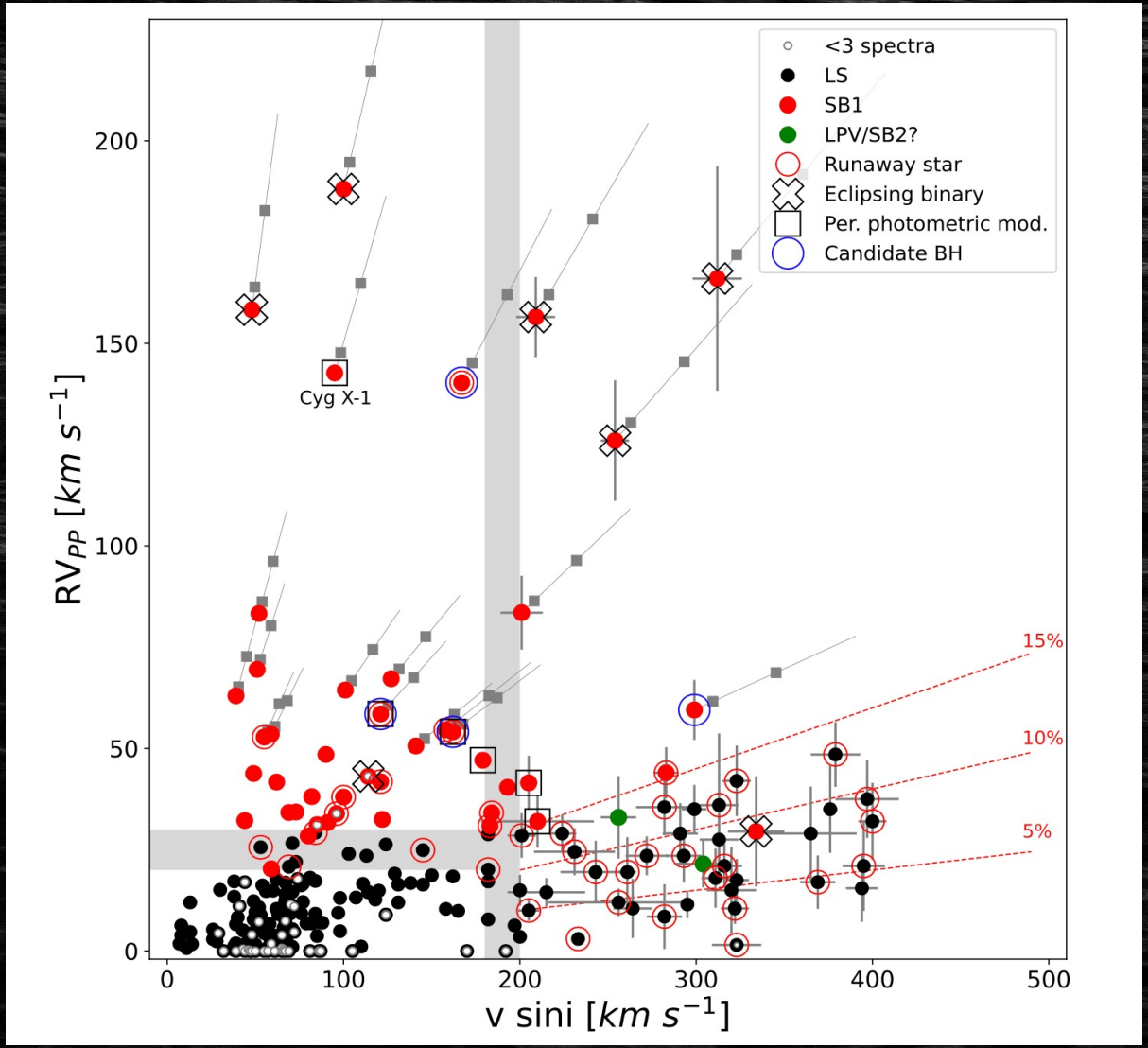
Holgado et al. (2022)
Britavskiy et al. (2023)



tracing the evolution of short-period binaries with super-synchronous fast rotators

Britavskiy et al. (2023)

- peak-to-peak radial velocity analysis
- runaway status
- analysis of lightcurves (eclipsing binaries and other photometric variations)

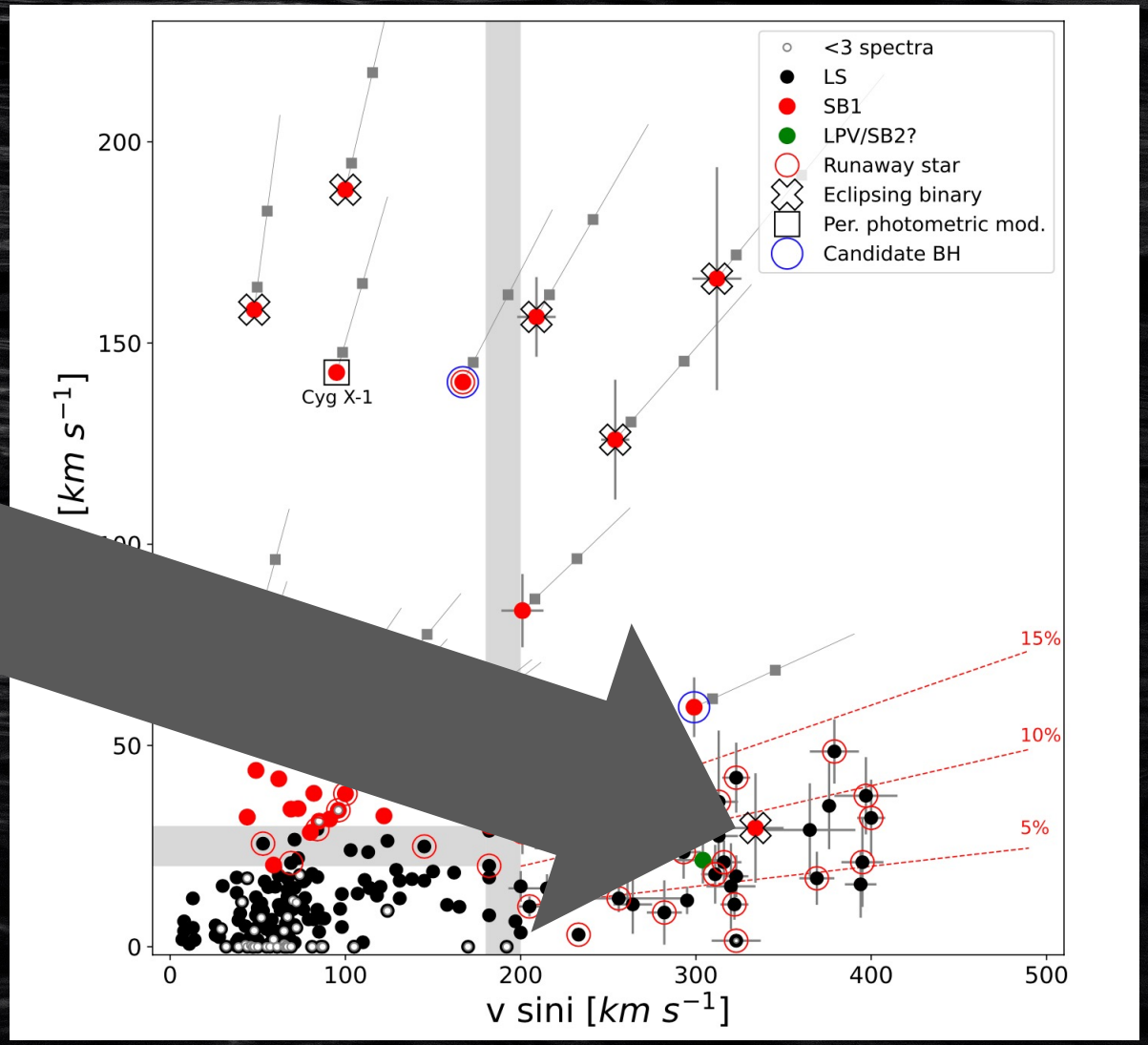


tracing the evolution of short-period binaries with super-synchronous fast rotators

Britavskiy et al. (2023)

HD 46485

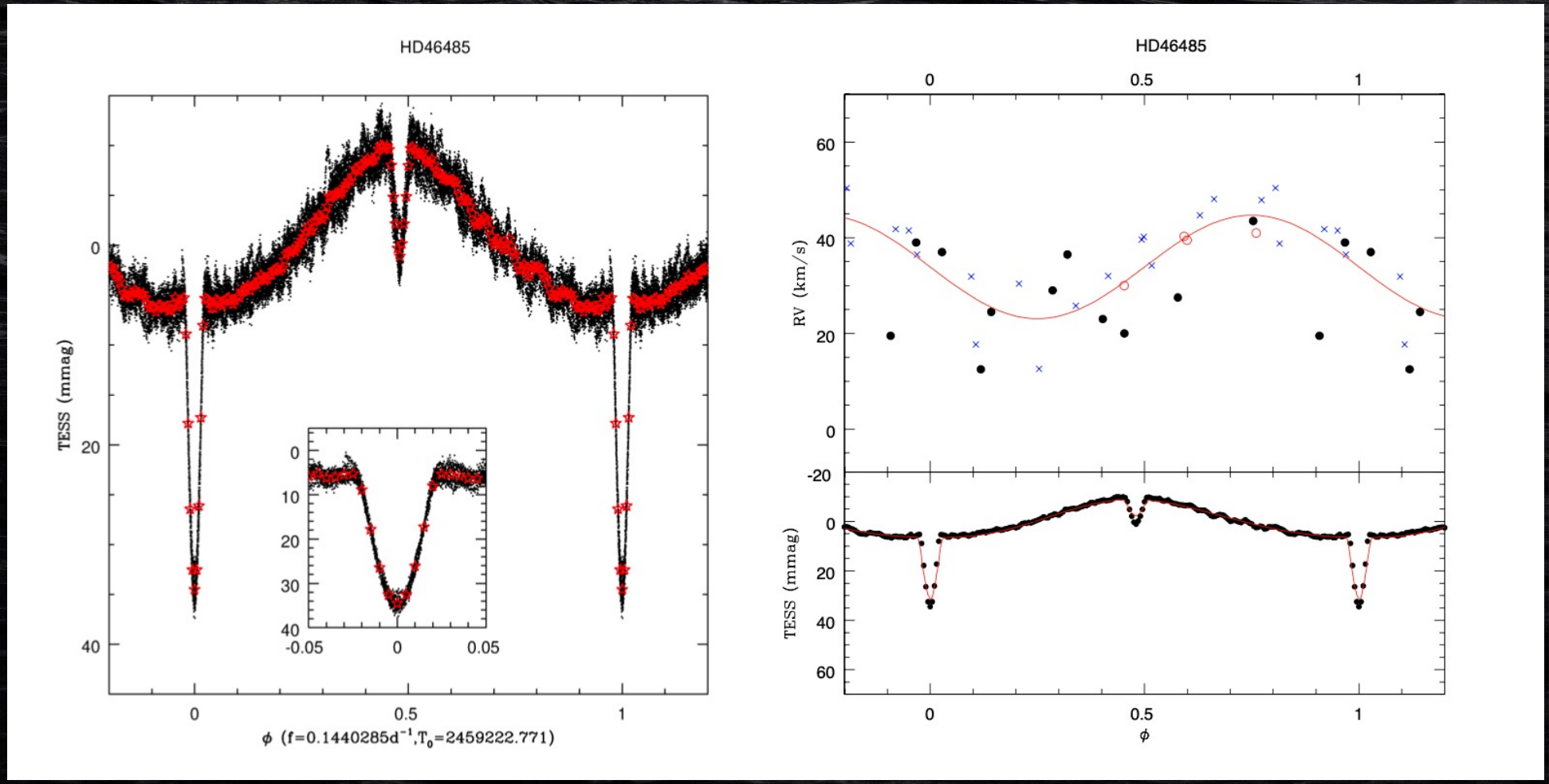
- vsini ~ 334 km/s
- p ~ 6.9 days
- M1 = 24 Msun, M2 = 1 Msun



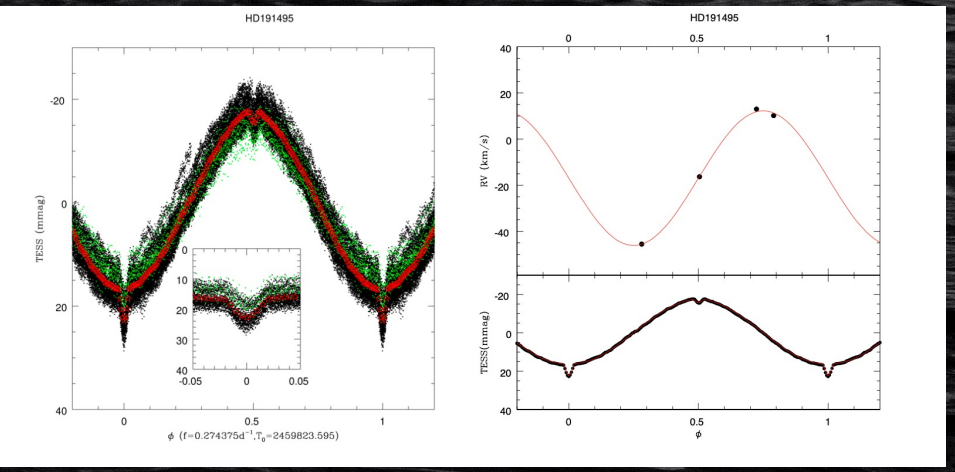
tracing the evolution of short-period binaries with super-synchronous fast rotators

HD 46485

Naze et al. (2023)

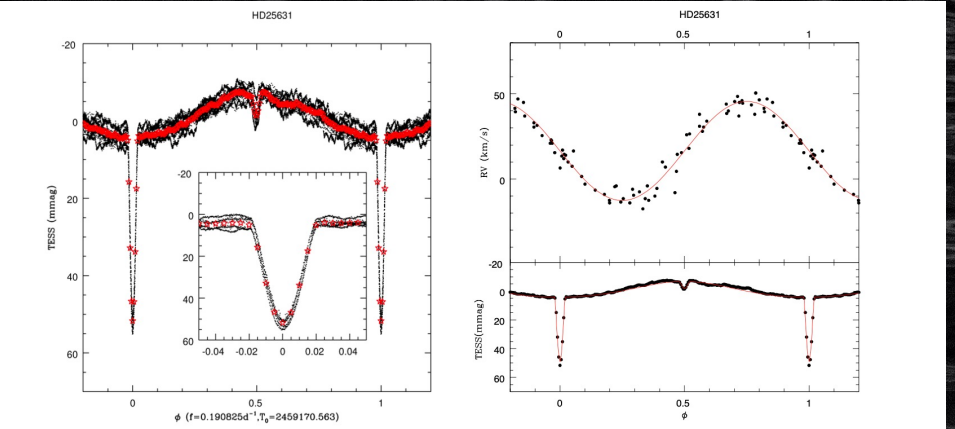


Naze et al. (2023)



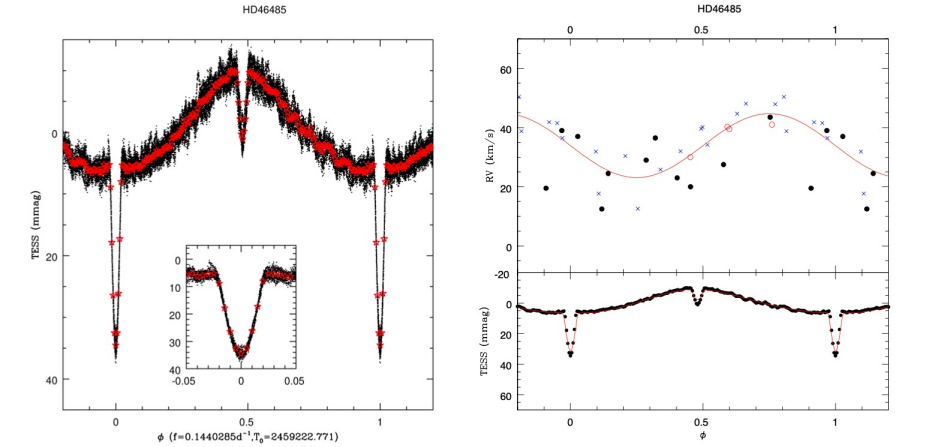
HD 191495

- vsini ~ 201 km/s
- p ~ 3.6 days
- M1 = 15 Msun, M2 = 1.5 Msun



HD 25631

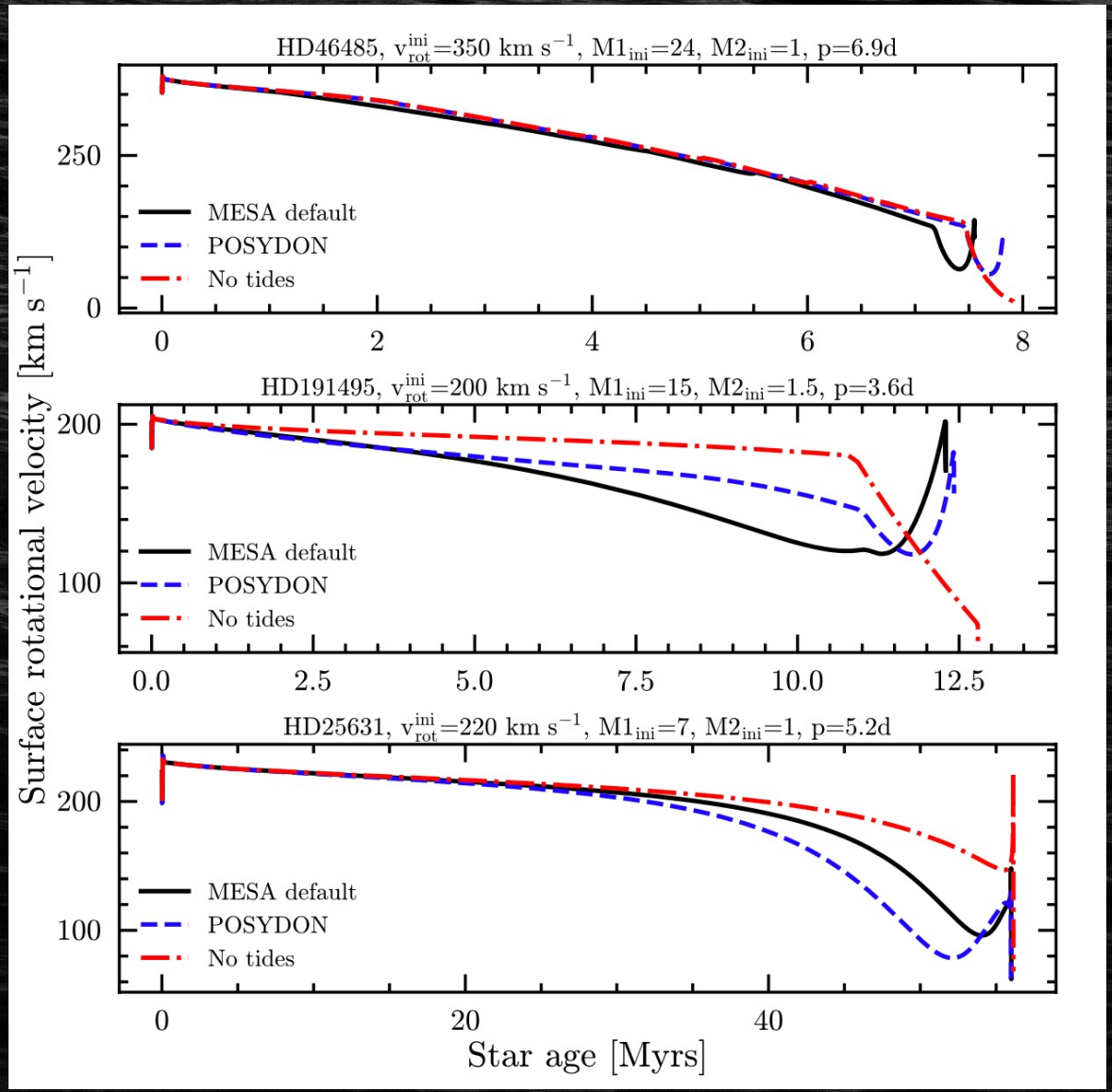
- vsini ~ 221 km/s
- p ~ 5.2 days
- M1 = 7 Msun, M2 = 1 Msun



HD 46485

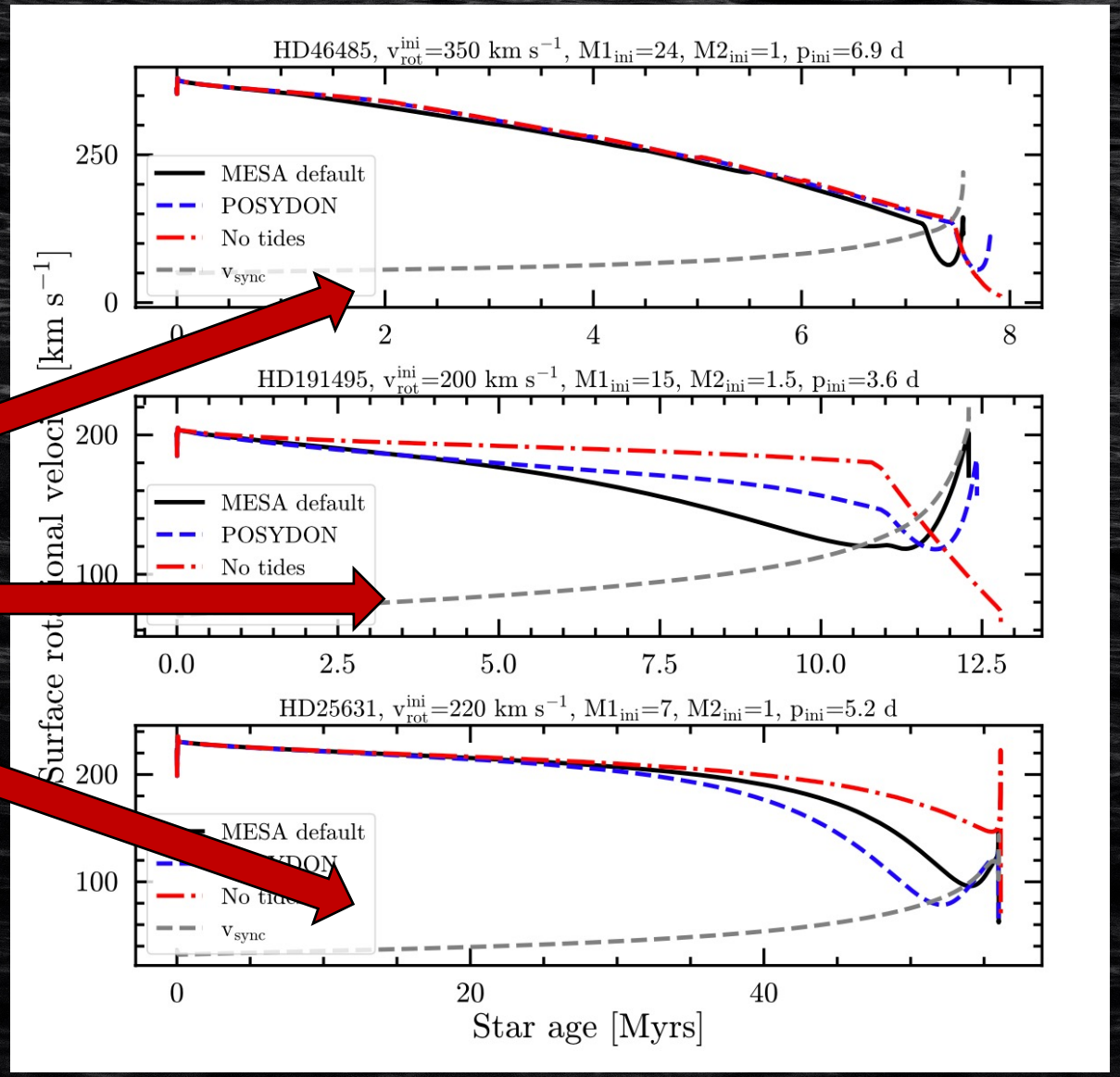
- vsini ~ 334 km/s
- p ~ 6.9 days
- M1 = 24 Msun, M2 = 1 Msun

tracing the evolution of short-period binaries with super-synchronous fast rotators



Britavskiy et al. (2024)

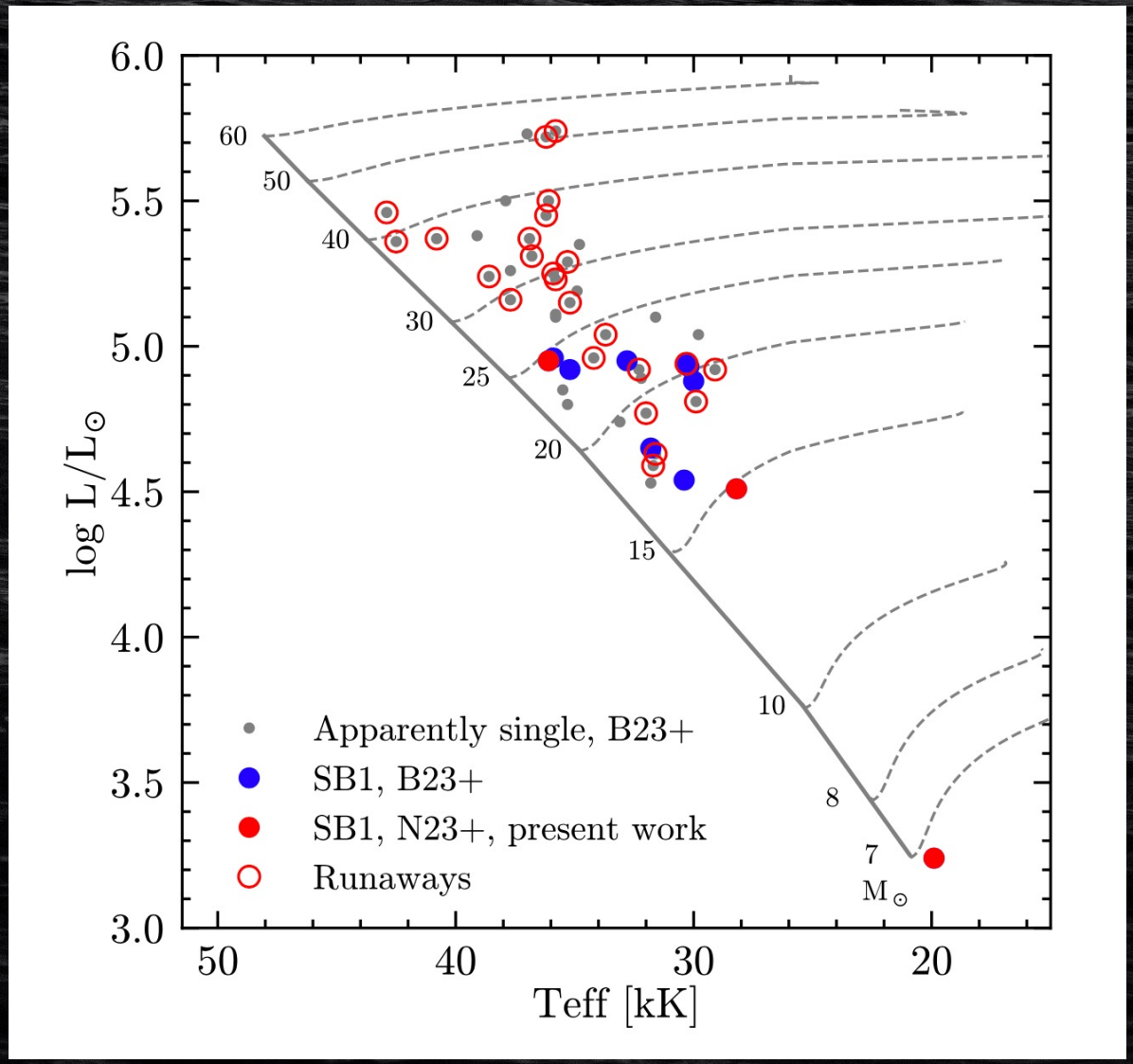
tracing the evolution of short-period binaries with super-synchronous fast rotators



current rotational velocities are much higher than synchronization velocity

Britavskiy et al. (2024)

tracing the evolution of short-period binaries with super-synchronous fast rotators



Holgado et al. (2022)
Britavskiy et al. (2023)
Naze et al. (2023)
Britavskiy et al. (2024)

tracing the evolution of short-period binaries with super-synchronous fast rotators

Britavskiy et al. (2024)

- why fast-rotating?
  - primordial rotation
  - tides
  - mass accretion
  - merging scenario
- why short-period configuration?
  - protostellar disk fragmentation (Tokovinin & Moe 2020)
  - post-interaction scenarios (e.g., post - CE)

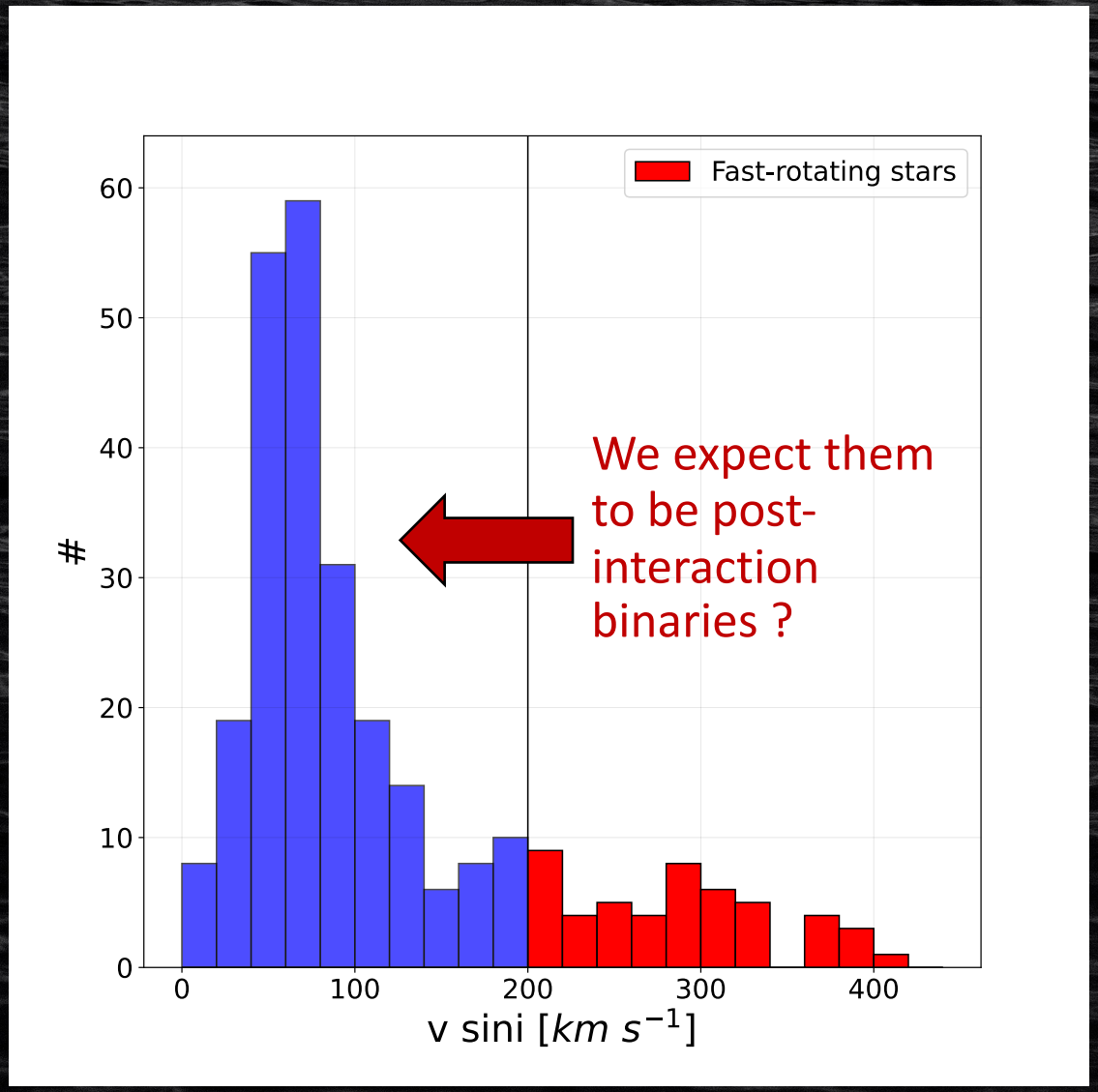
tracing the evolution of short-period binaries with super-synchronous fast rotators

Britavskiy et al. (2024)

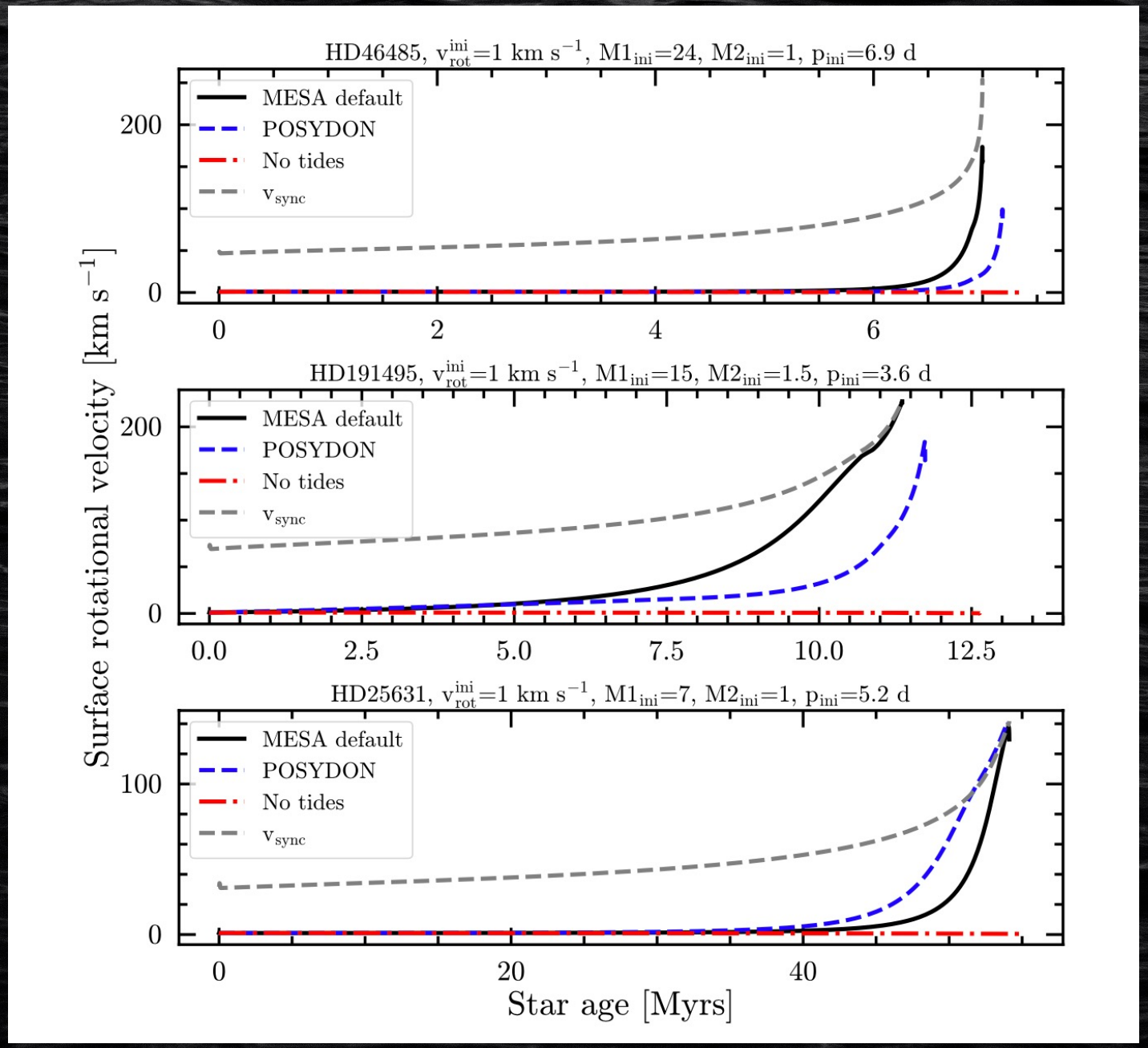
- why fast-rotating?
  - primordial rotation
  - tides ← not efficient
  - mass accretion ← can't match simultaneously P and q
  - merging scenario ← >90 % triples will be dynamically unstable
- why short-period configuration?
  - protostellar disk fragmentation (Tokovinin & Moe 2020)
  - post-interaction scenarios (e.g., post - CE)

tracing the evolution of short-period binaries with super-synchronous fast rotators

Holgado et al. (2022)
Britavskiy et al. (2023)



tides


HD46485, v_{rot}^{ini}=1 km s^{-1}, $M1_{ini}$=24, $M2_{ini}$=1, p_{ini}=6.9 d
MESA default
POSYDON
No tides
v_{sync}
200
0
0
2
4
6
HD191495, v_{rot}^{ini}=1 km s^{-1}, $M1_{ini}$=15, $M2_{ini}$=1.5, p_{ini}=3.6 d
MESA default
POSYDON
No tides
v_{sync}
200
0
0.0
2.5
5.0
7.5
10.0
12.5
HD25631, v_{rot}^{ini}=1 km s^{-1}, $M1_{ini}$=7, $M2_{ini}$=1, p_{ini}=5.2 d
MESA default
POSYDON
No tides
v_{sync}
100
0
0
20
40
Surface rotational velocity [km s^{-1}]
Star age [Myrs]

tides

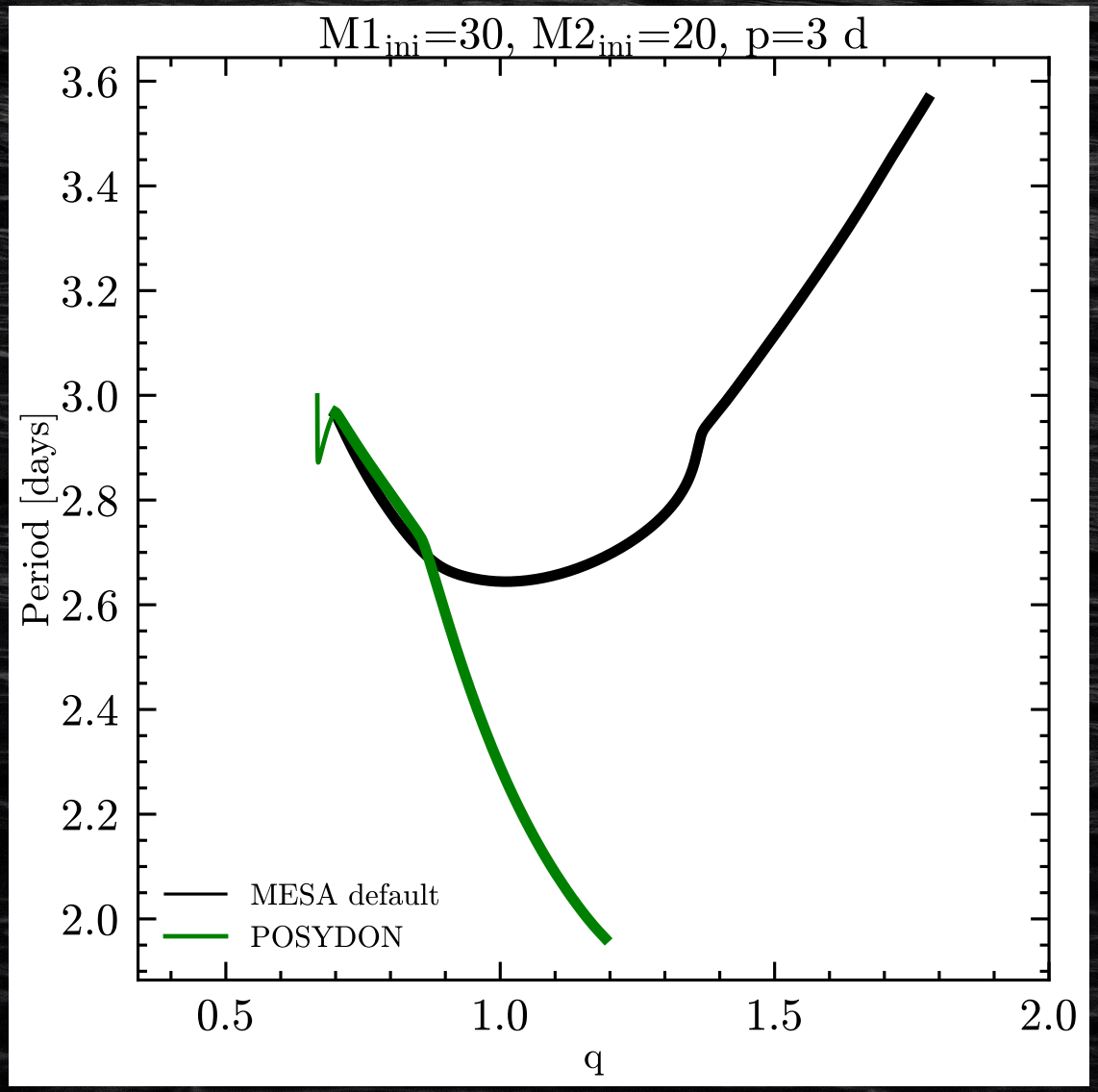
- MESA default: “HUT_RAD”, synchronization timescale following Hurley et al. (2002) for radiative envelopes;

$$E_2 = 1.592 \times 10^{-9} \left(\frac{M}{M_\odot} \right)^{2.84}$$

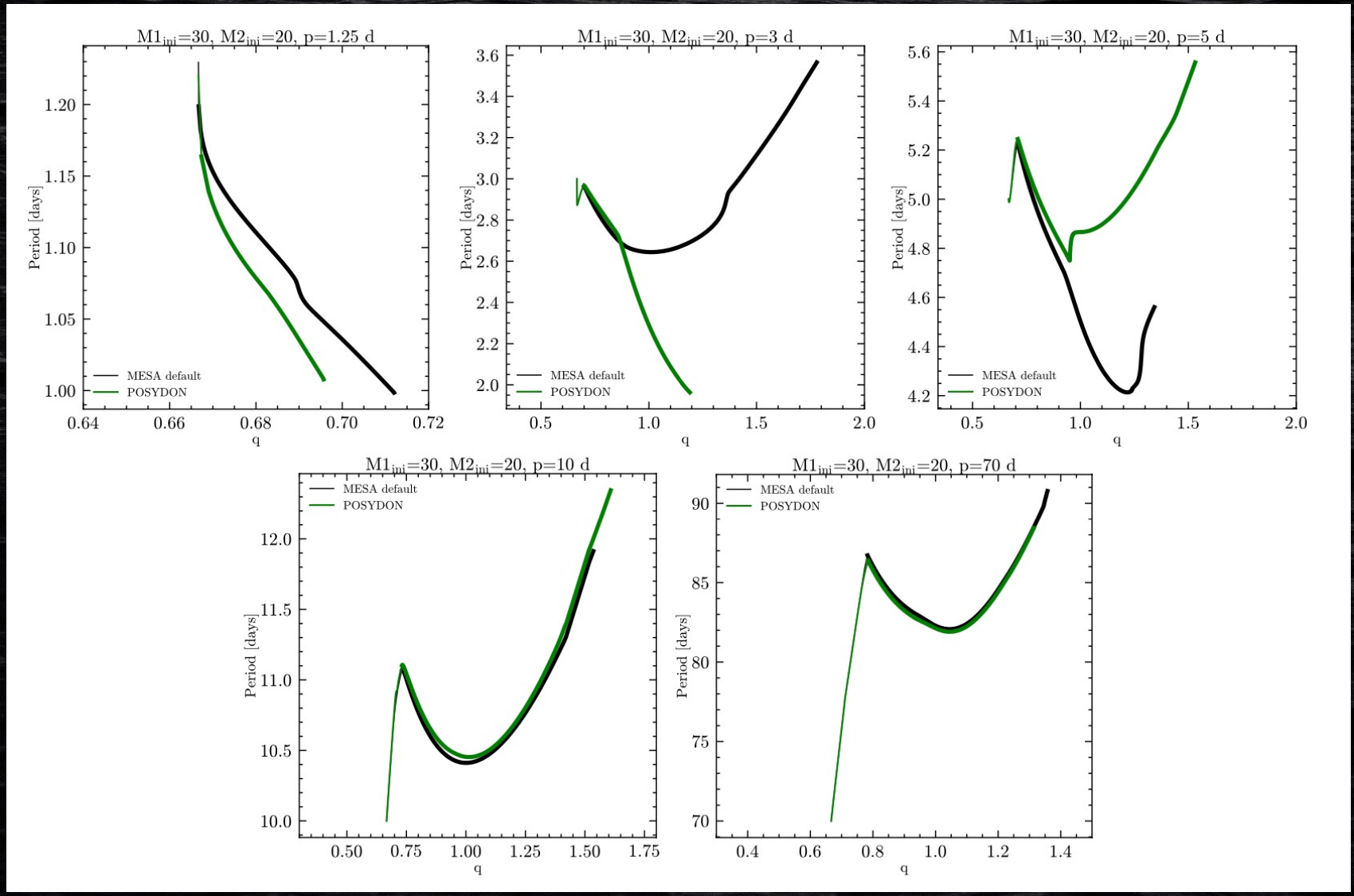
- POSYDON: “structure_dependent”, layer-by-layer dissipation timescale which is depending on whether the layer is convective or radiative (Qin et al. 2018);

$$E_2 = \begin{cases} 10^{-0.42} (R_{\rm conv}/R)^{7.5} & \text{for hydrogen-rich stars} \\ 10^{-0.93} (R_{\rm conv}/R)^{6.7} & \text{for stripped-helium stars.} \end{cases}$$

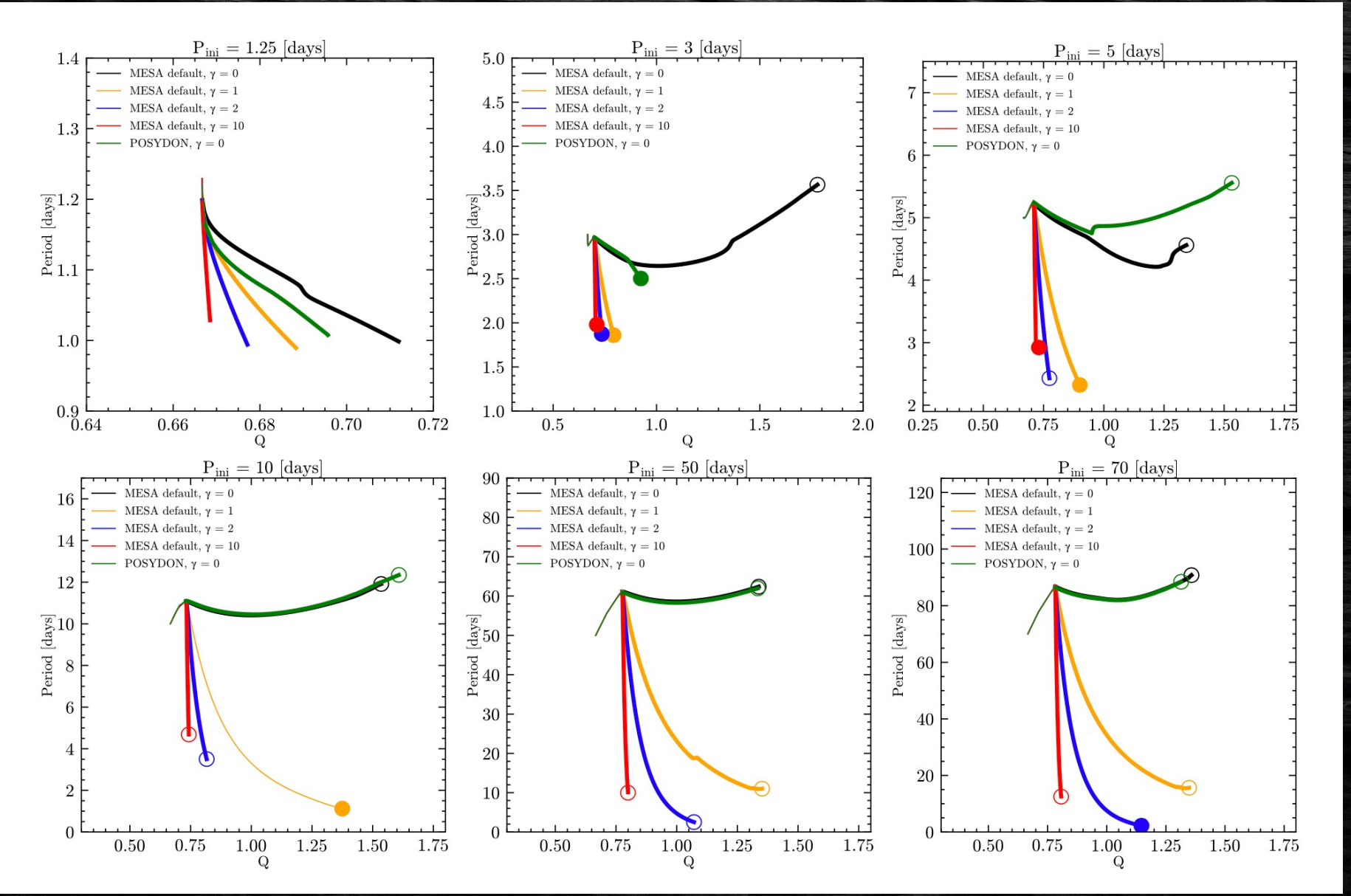
post mass transfer scenario



post mass transfer scenario (conservative mass transfer)



post mass transfer scenario (non conservative mass transfer)

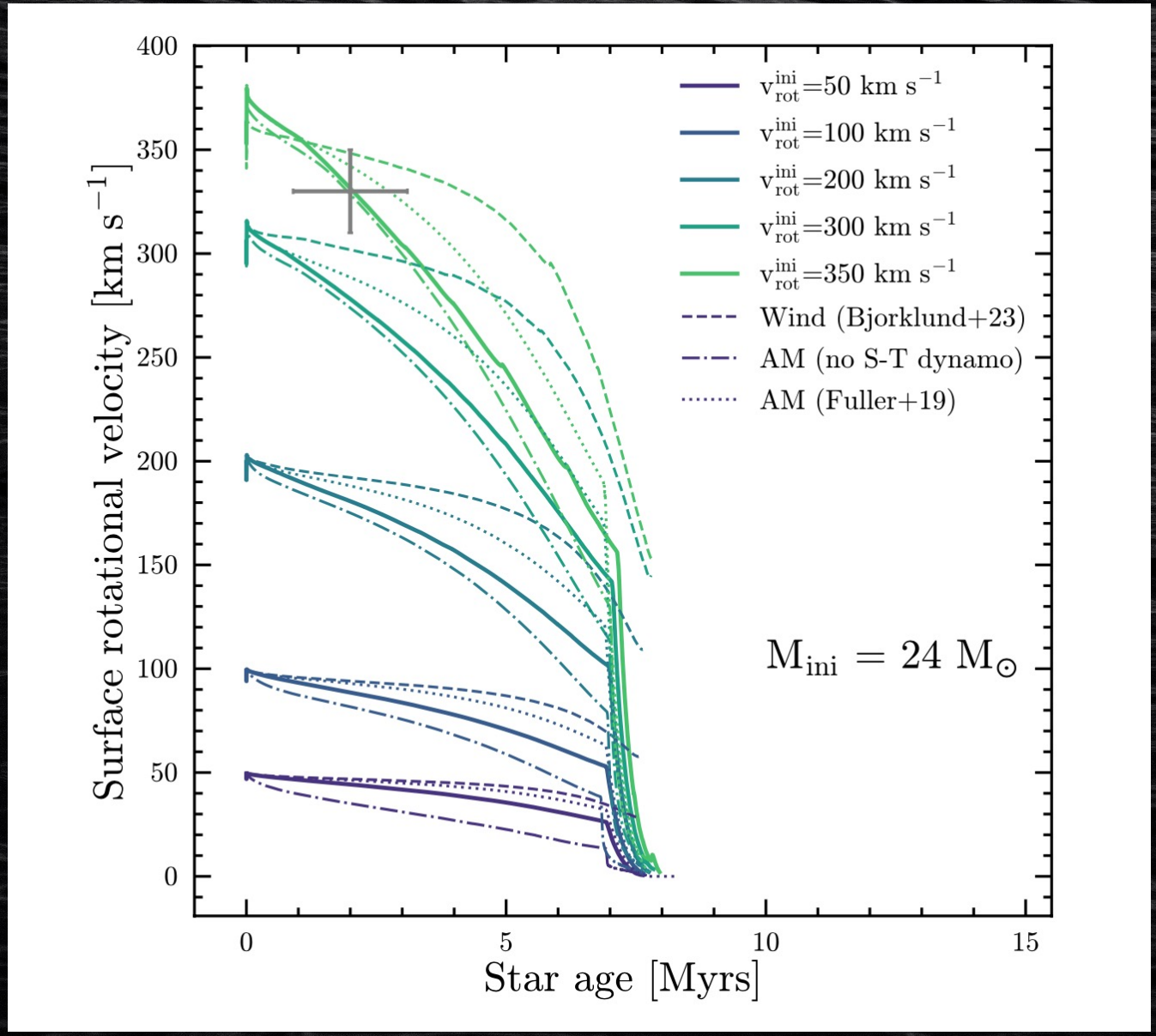


merger in a triple

- mergers need not be fast-rotating
  - dynamical mass and angular momentum loss during the merging itself
  - post-merging magnetic-braking
  - internal readjastment of the merging product

- small parameter space to form an initialy stable triple
  - we don’t care about non stable triple – they will instantly merge or destroyed

primordial rotation (Galactic metallicity)



tracing the evolution of short-period binaries with super-synchronous fast rotators

Britavskiy et al. (2024)

- why fast-rotating?
  - primordial rotation
  - tides ← not efficient
  - mass accretion ← can't match simultaneously P and q
  - merging scenario ← >90 % triples will be dynamically unstable
- why short-period configuration?
  - protostellar disk fragmentation (Tokovinin & Moe 2020)
  - post-interaction scenarios (e.g., post - CE)