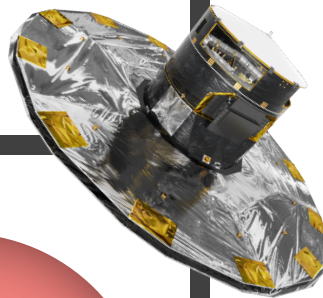
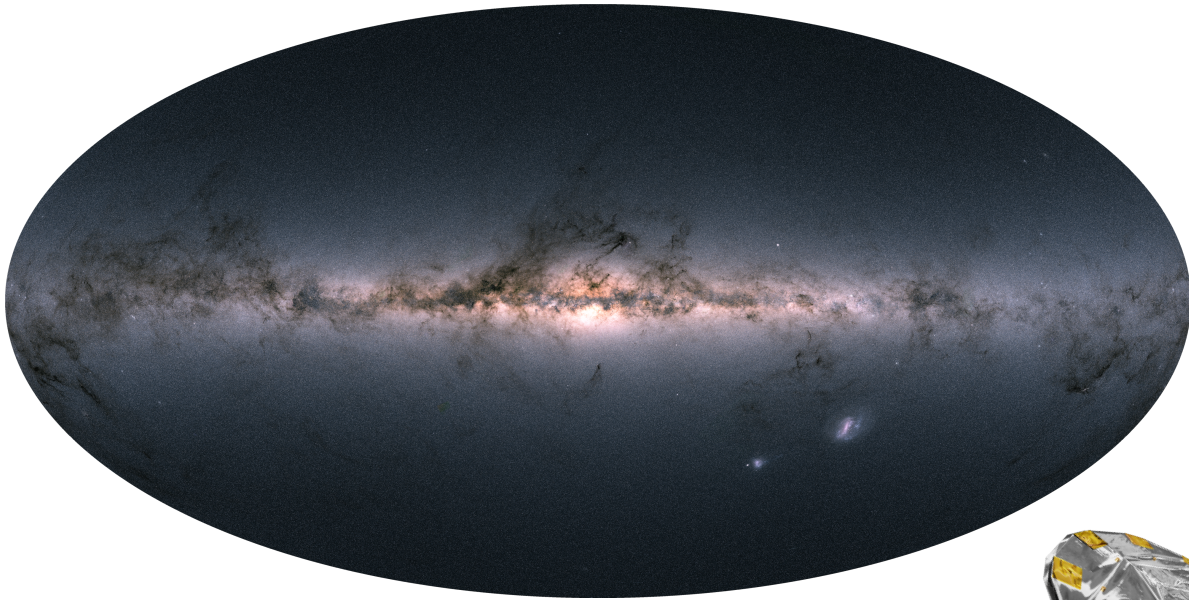




WHY WAIT FOR DR3? 300,000+ BINARIES IN GAIA DR2

Douglas Boubert
Magdalen, Oxford
EWASS, 2019

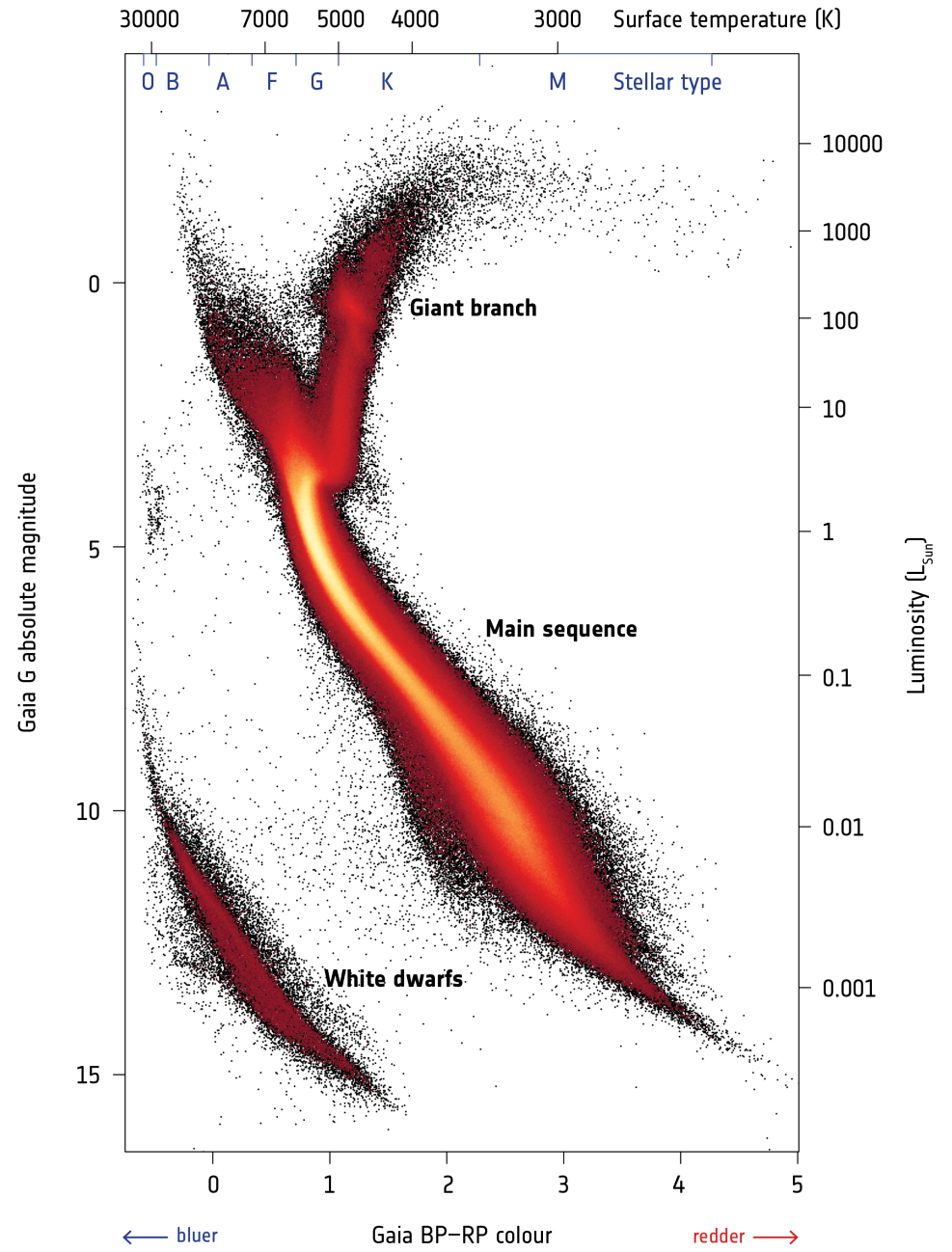


position & brightness on the sky
1 692 919 135

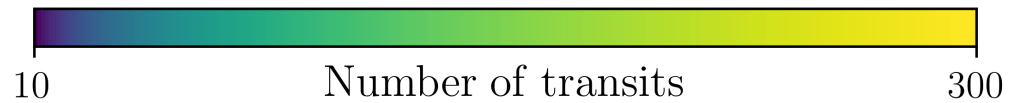
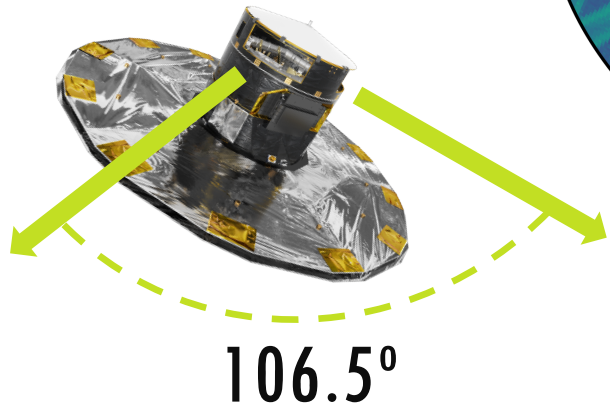
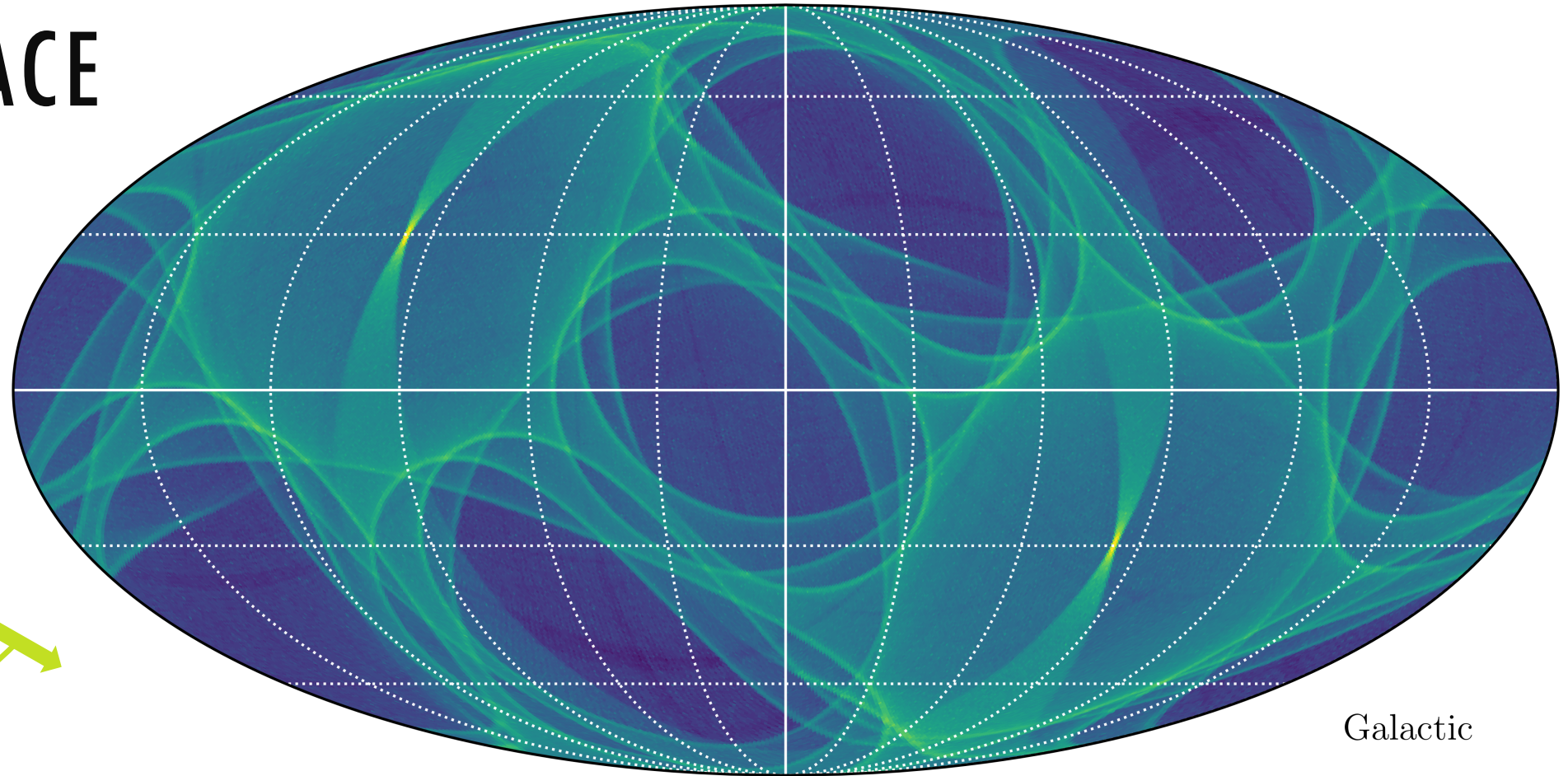
radial velocity
7 224 631

parallax and proper motion
1 331 909 727

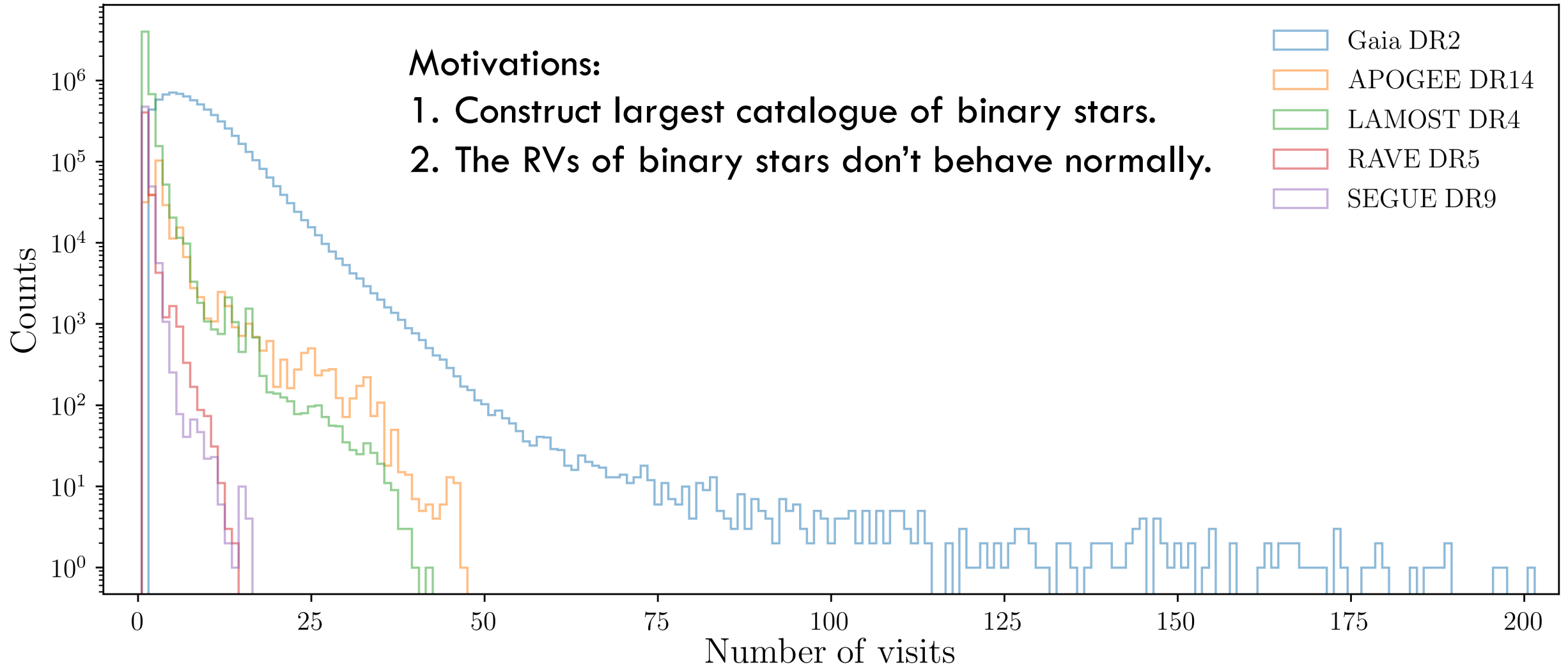
red colour
1 383 551 713
 blue colour
1 381 964 755



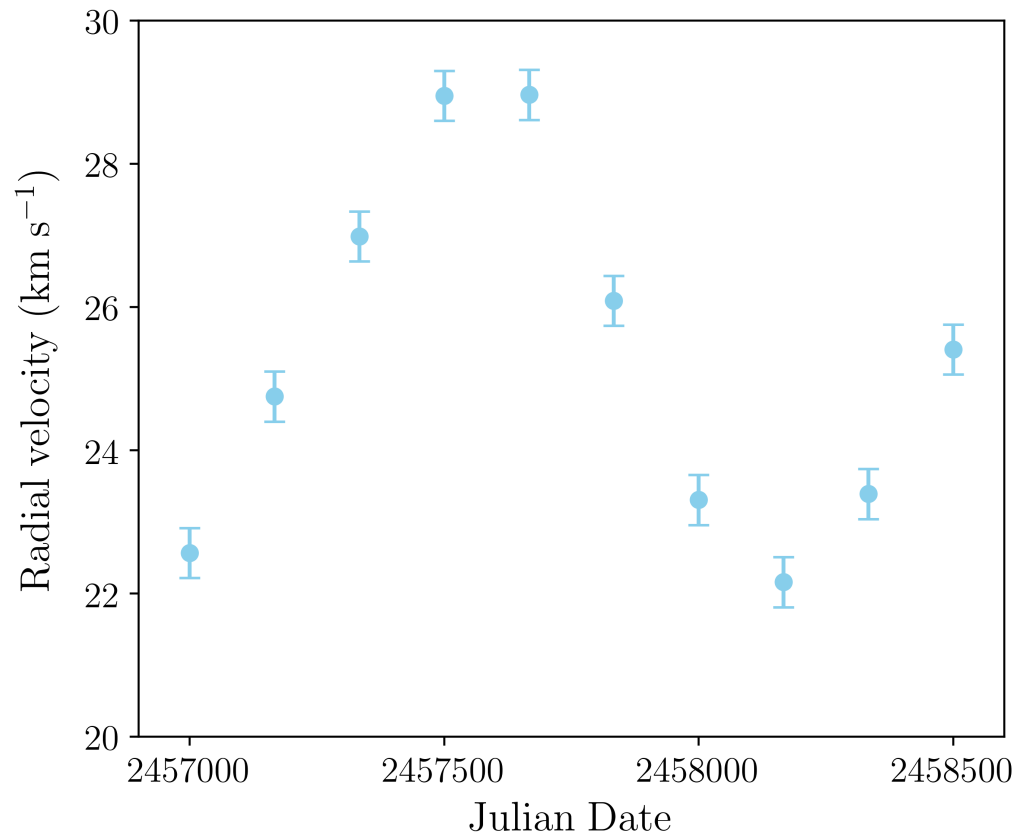
GAIA IS A SPINNING TOP IN SPACE



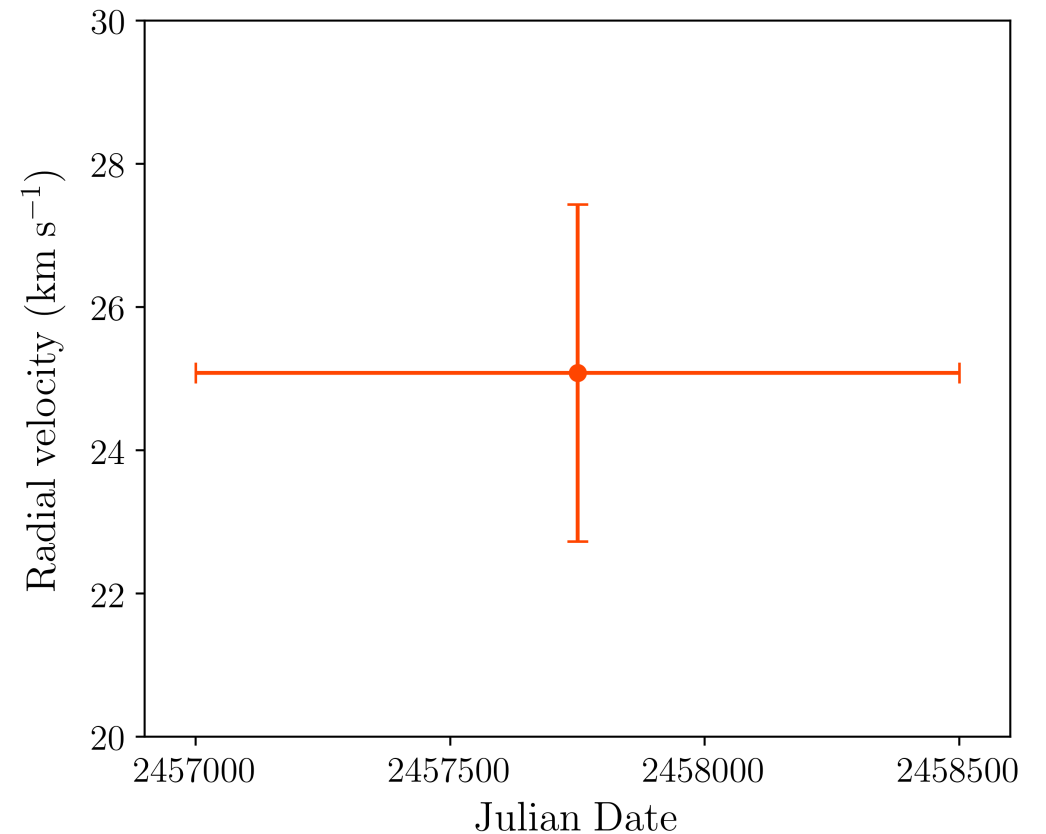
GAIA WILL FIND MILLIONS OF BINARIES



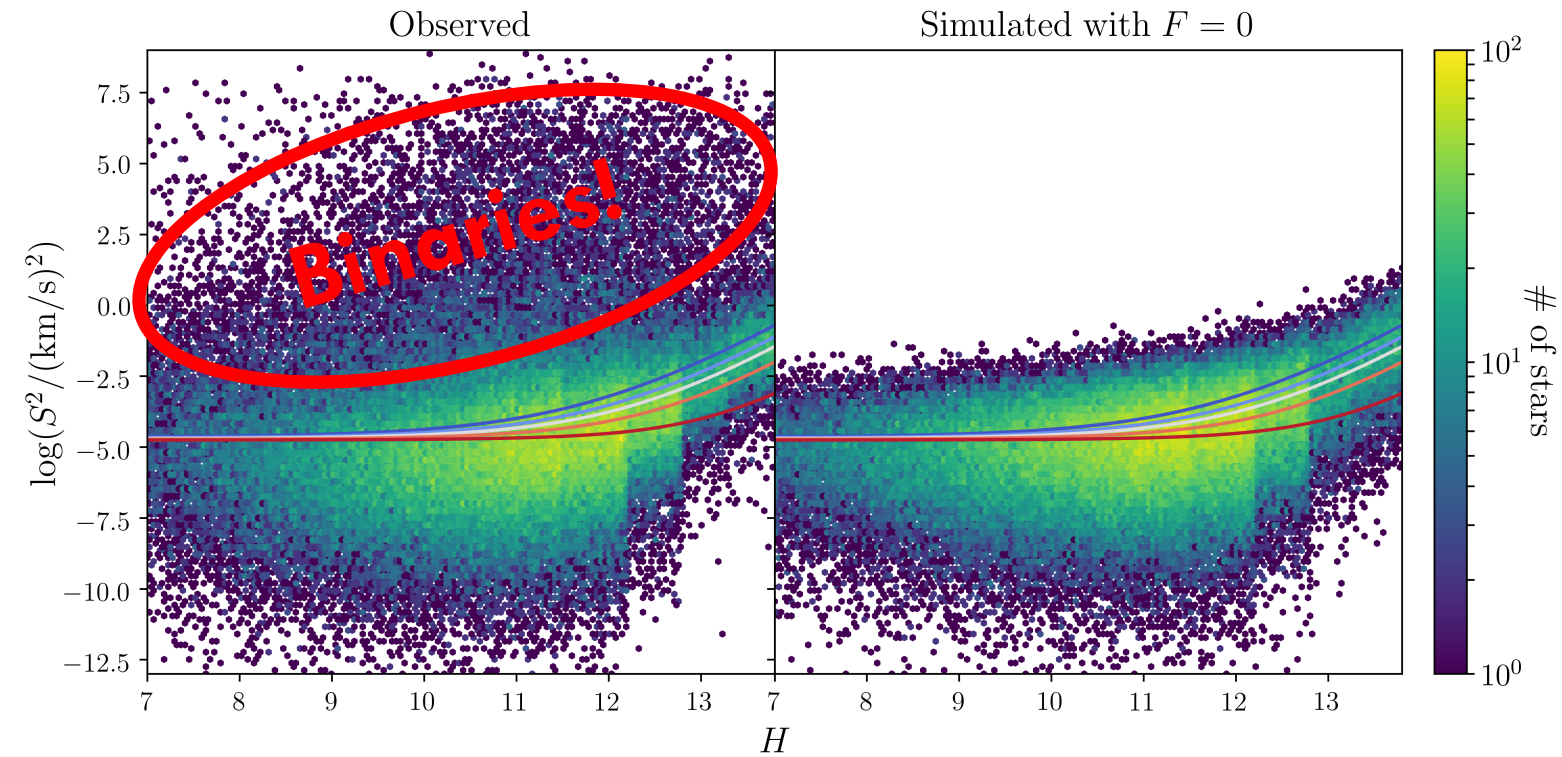
CAN WE FIND BINARY STARS IN GAIA DR2? DR3?



Expectation

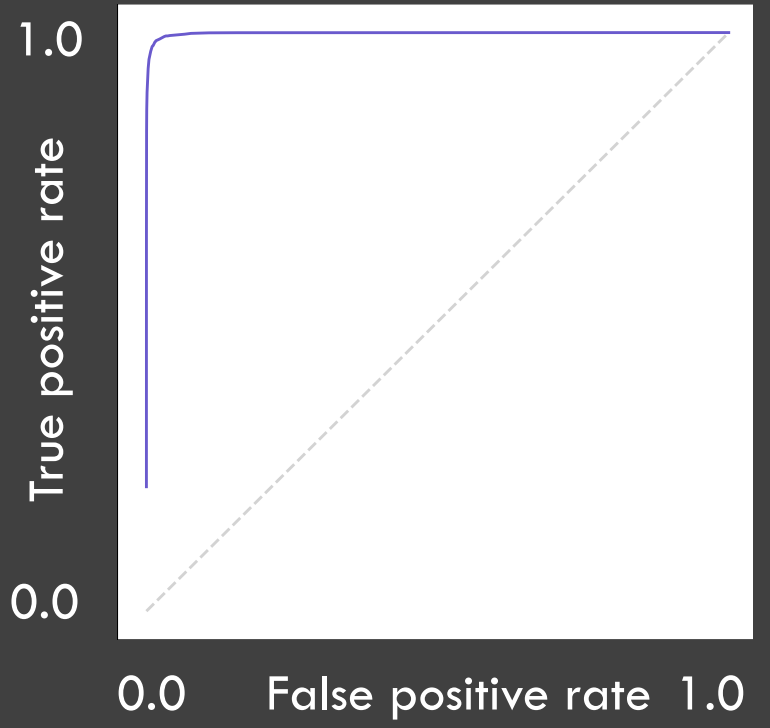


Reality



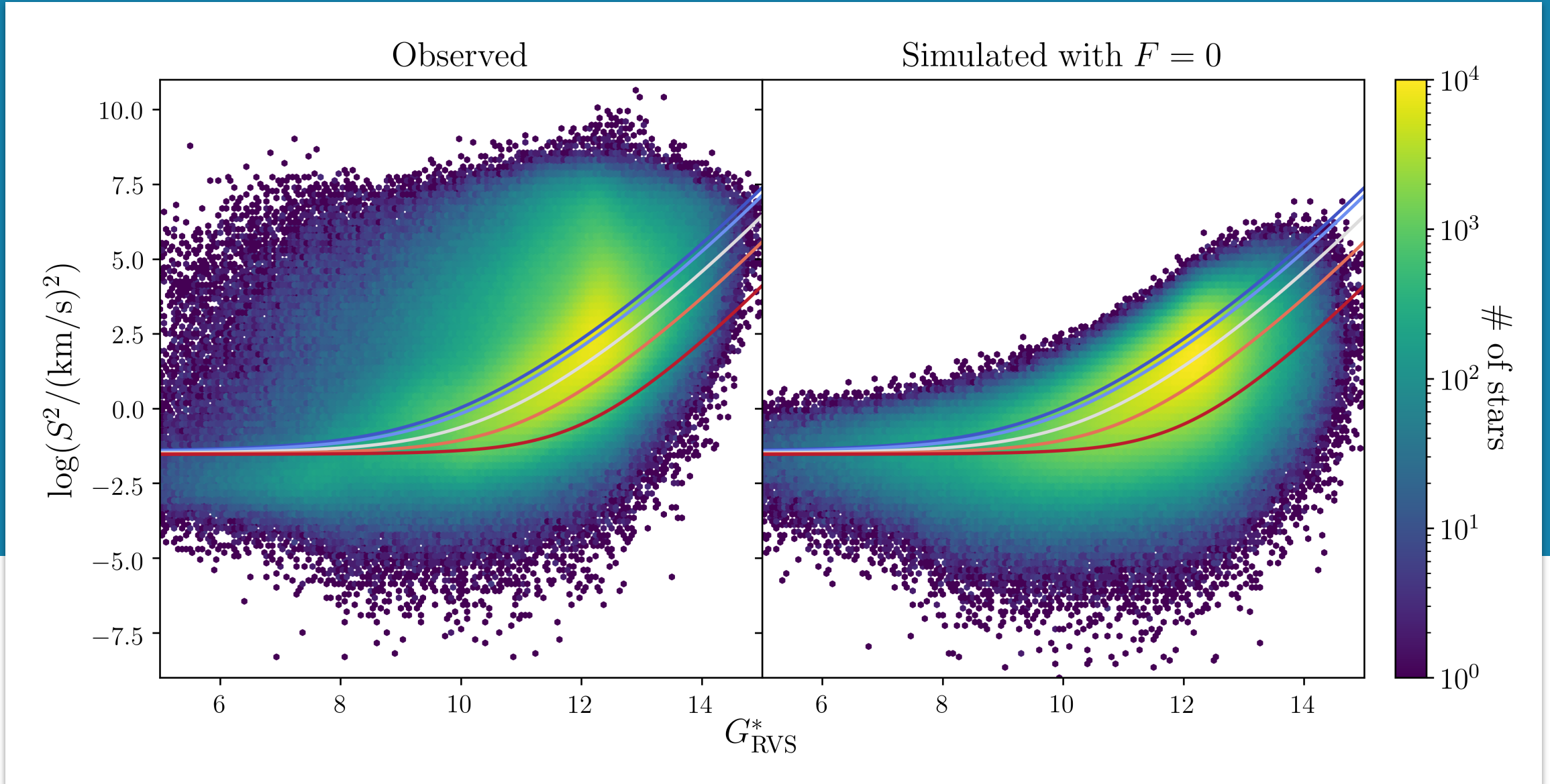
Our statistical model gives the 'evidence' that a star is a binary.

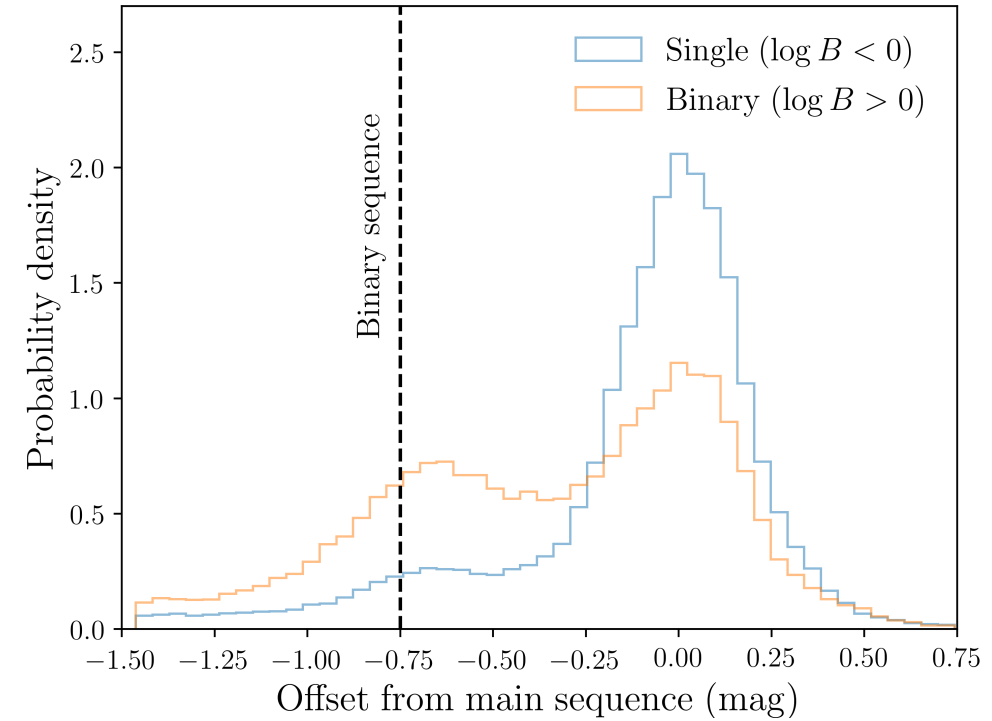
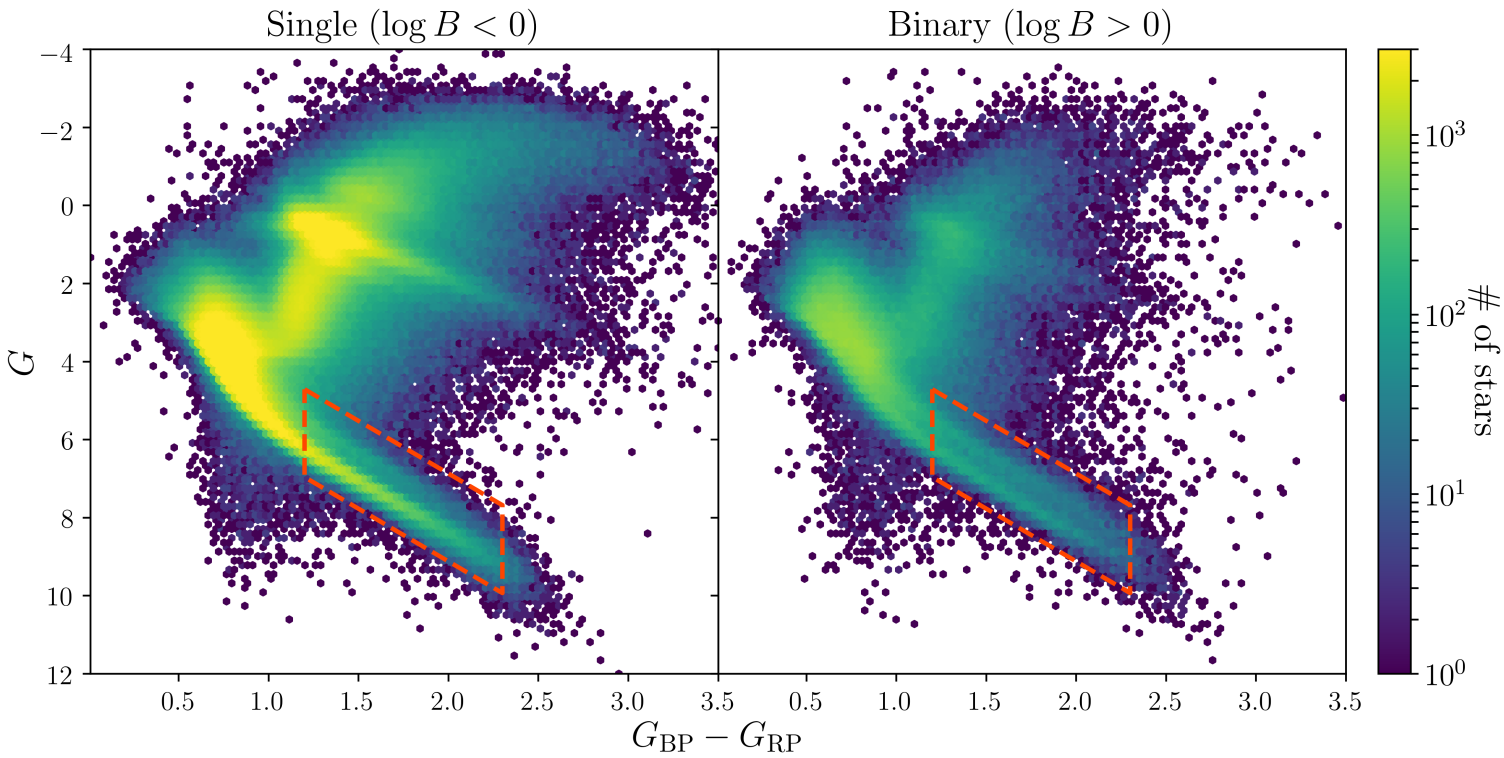
We can recover 99% of known binaries found by Price-Whelan et al. (2018) in APOGEE DR14.



DOES IT WORK WITH APOGEE?

DOES IT WORK WITH GAIA?

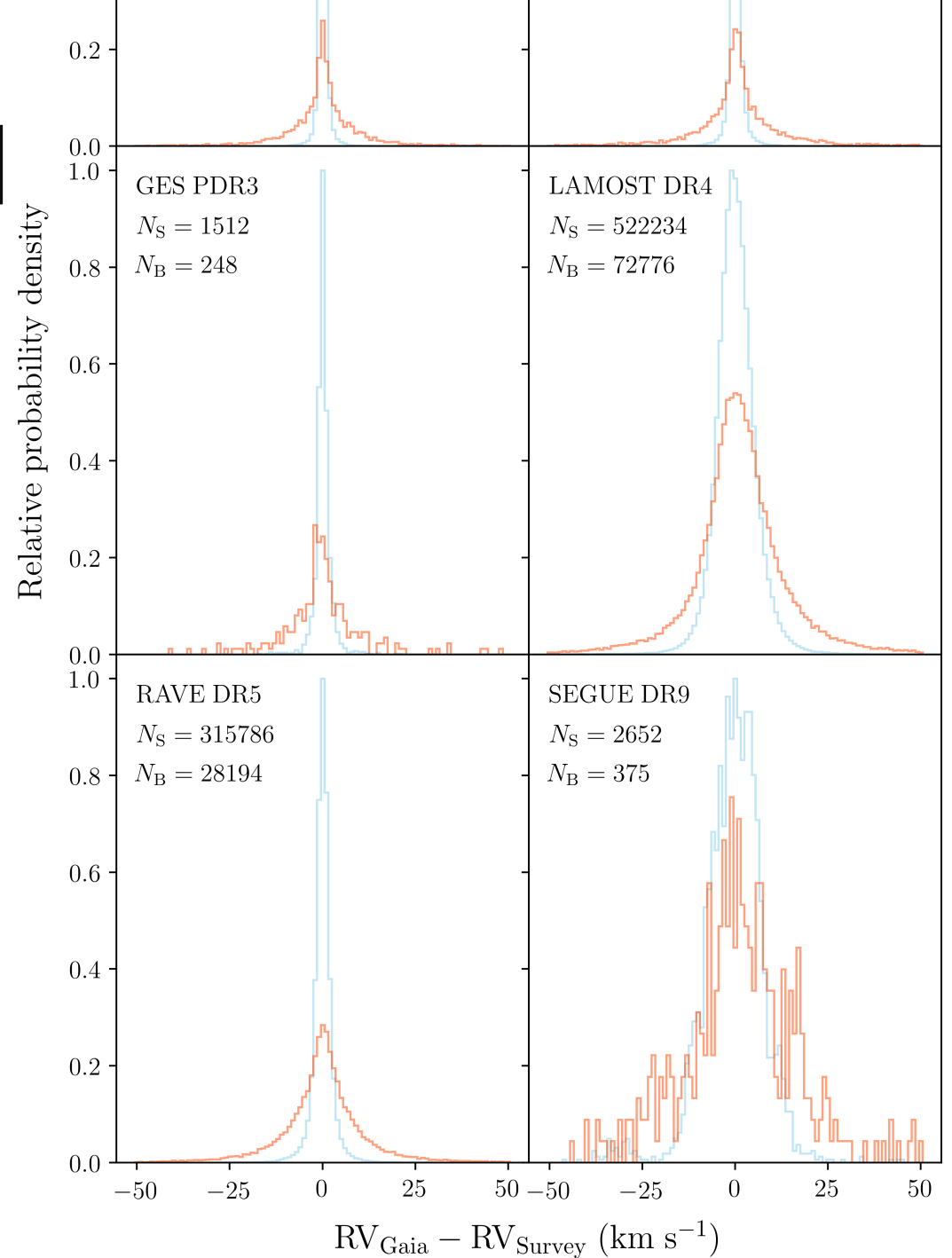
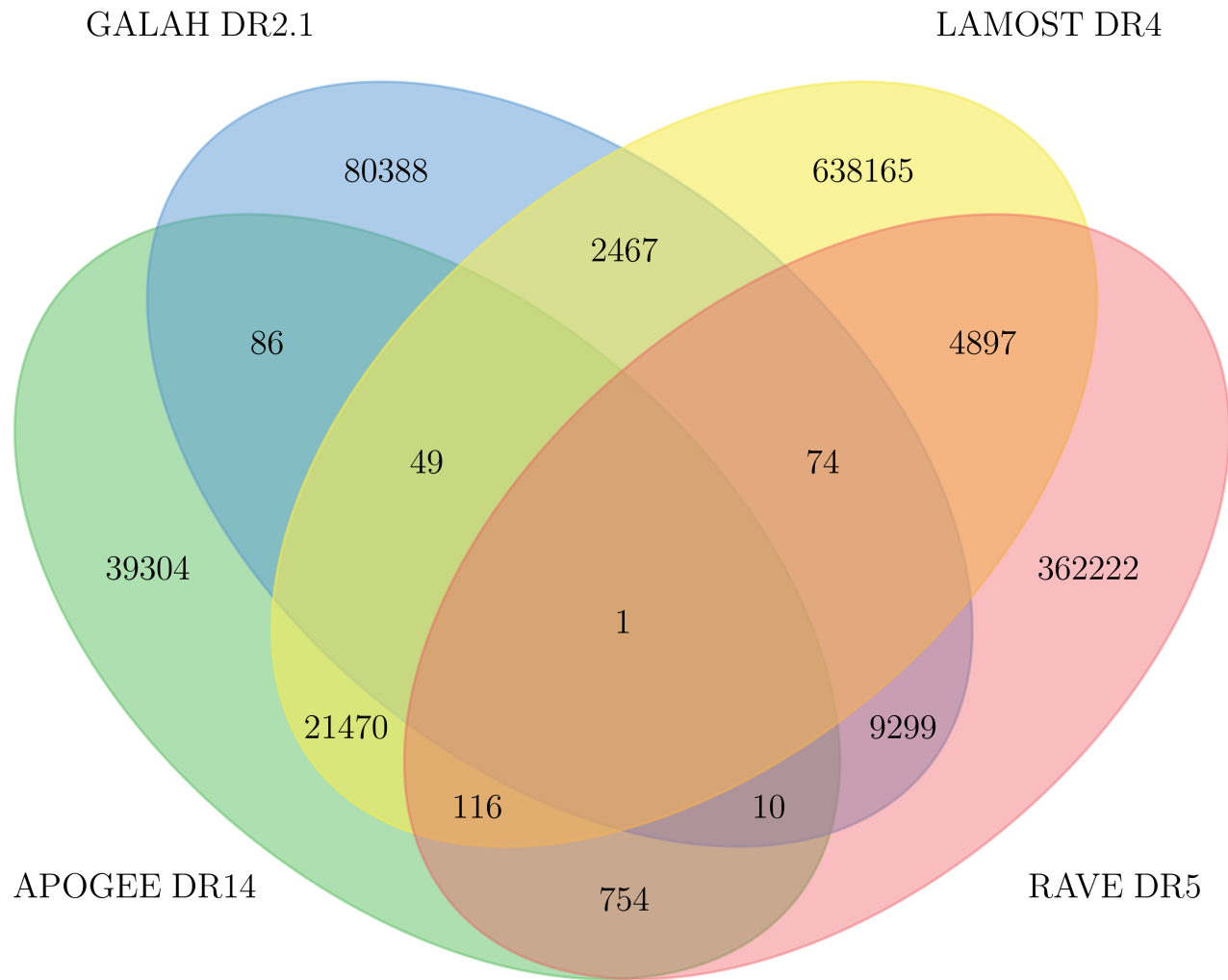


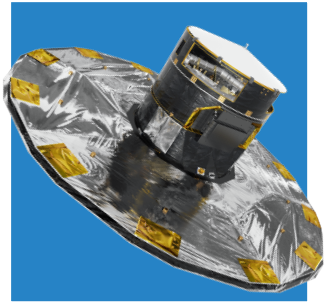


A BINARY SEQUENCE EMERGES

Binary sequence:
Unresolved equal
mass binary star

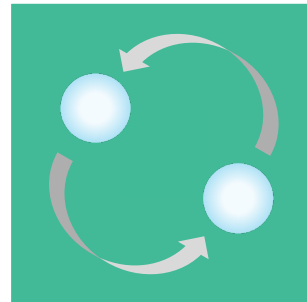
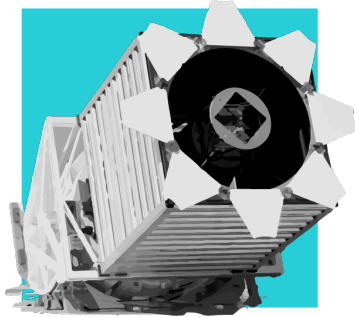
GAME, SET AND (CROSS-)MATCH



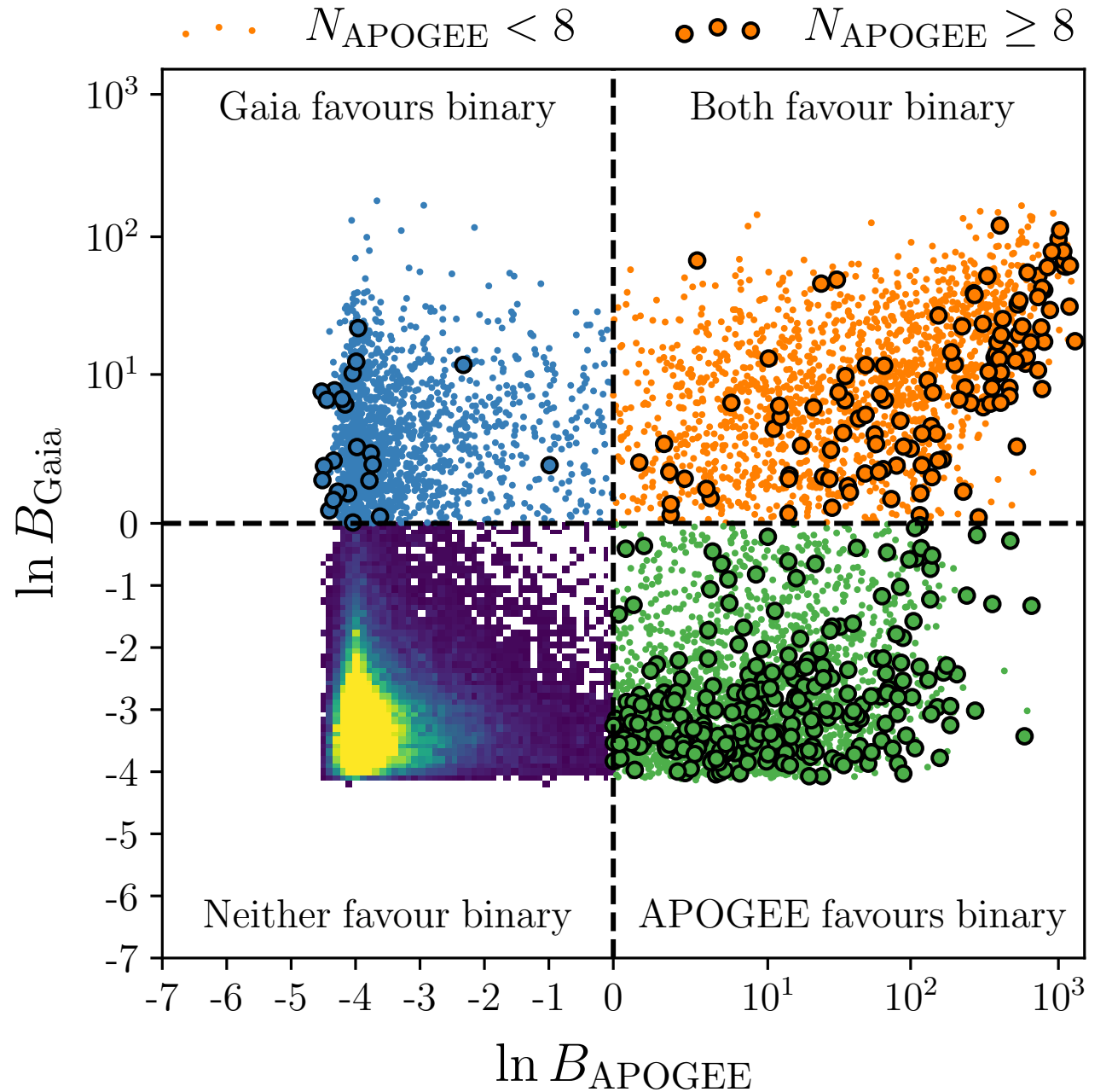


Classify stars as single or binary using Gaia data only.

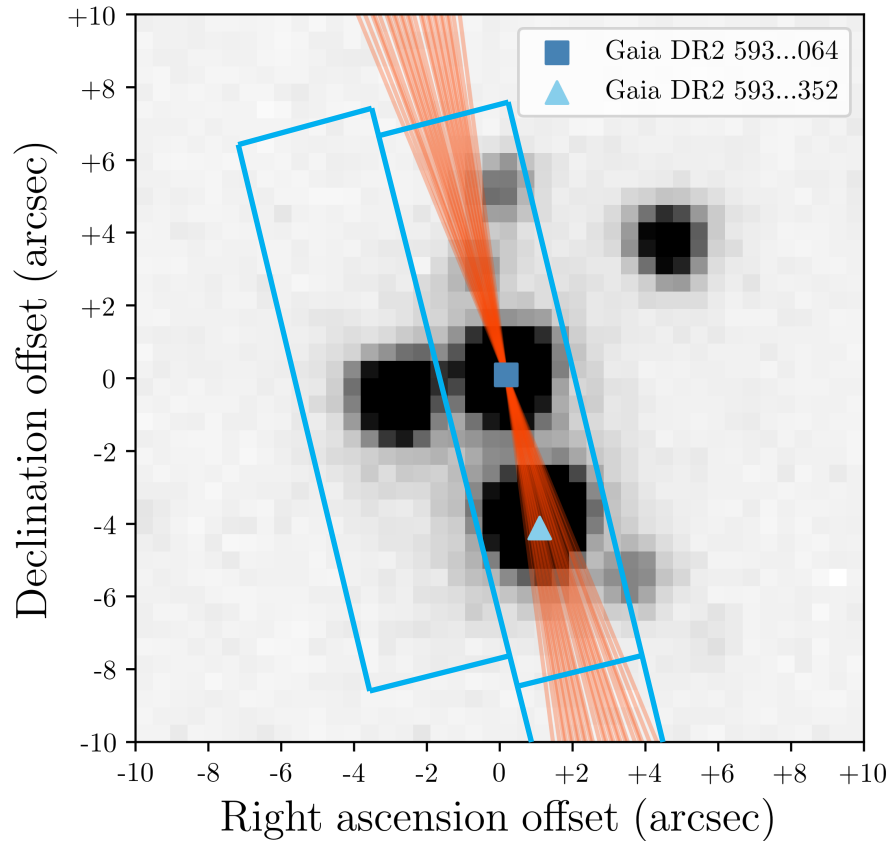
Classify stars as single or binary using APOGEE data only.



Compare!



A HYPERVELOCITY STAR OR A SPURIOUS VELOCITY?



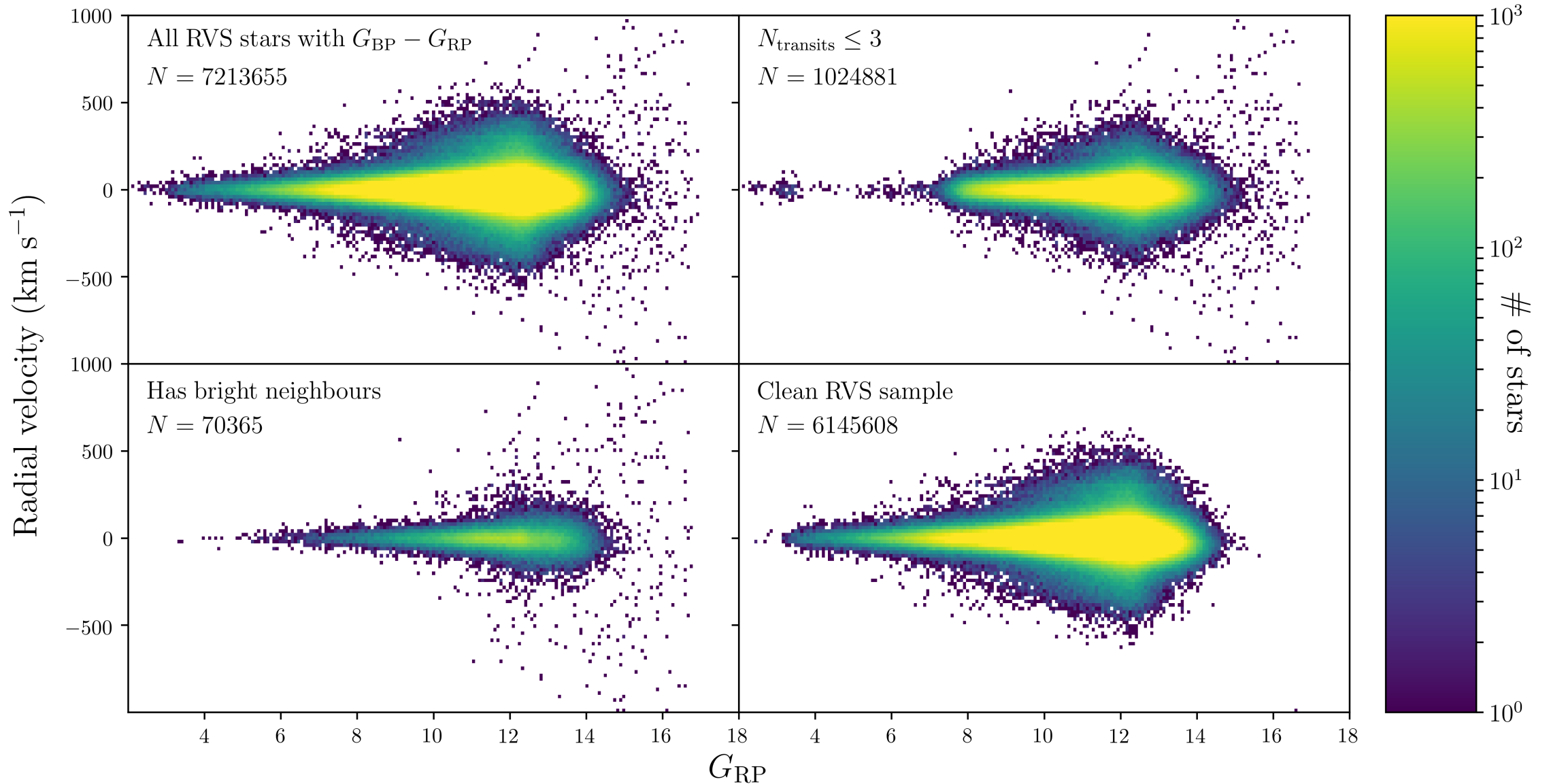
Julian Date	Radial Velocity (km s^{-1})
2458243.76	-70.0 ± 9.8
2458278.58	-43.3 ± 10.0
2458288.50	-59.0 ± 9.6
2458289.46	-54.7 ± 9.0
2458309.58	-82.5 ± 8.2
2458322.45	-46.7 ± 8.2
2458372.51	-58.2 ± 8.5
2458377.50	-52.3 ± 3.9
Our median	-56.5 ± 5.3
<i>Gaia</i> median	-614.3 ± 2.5
Difference	557.8 ± 5.9

Our eight follow-up epochs.

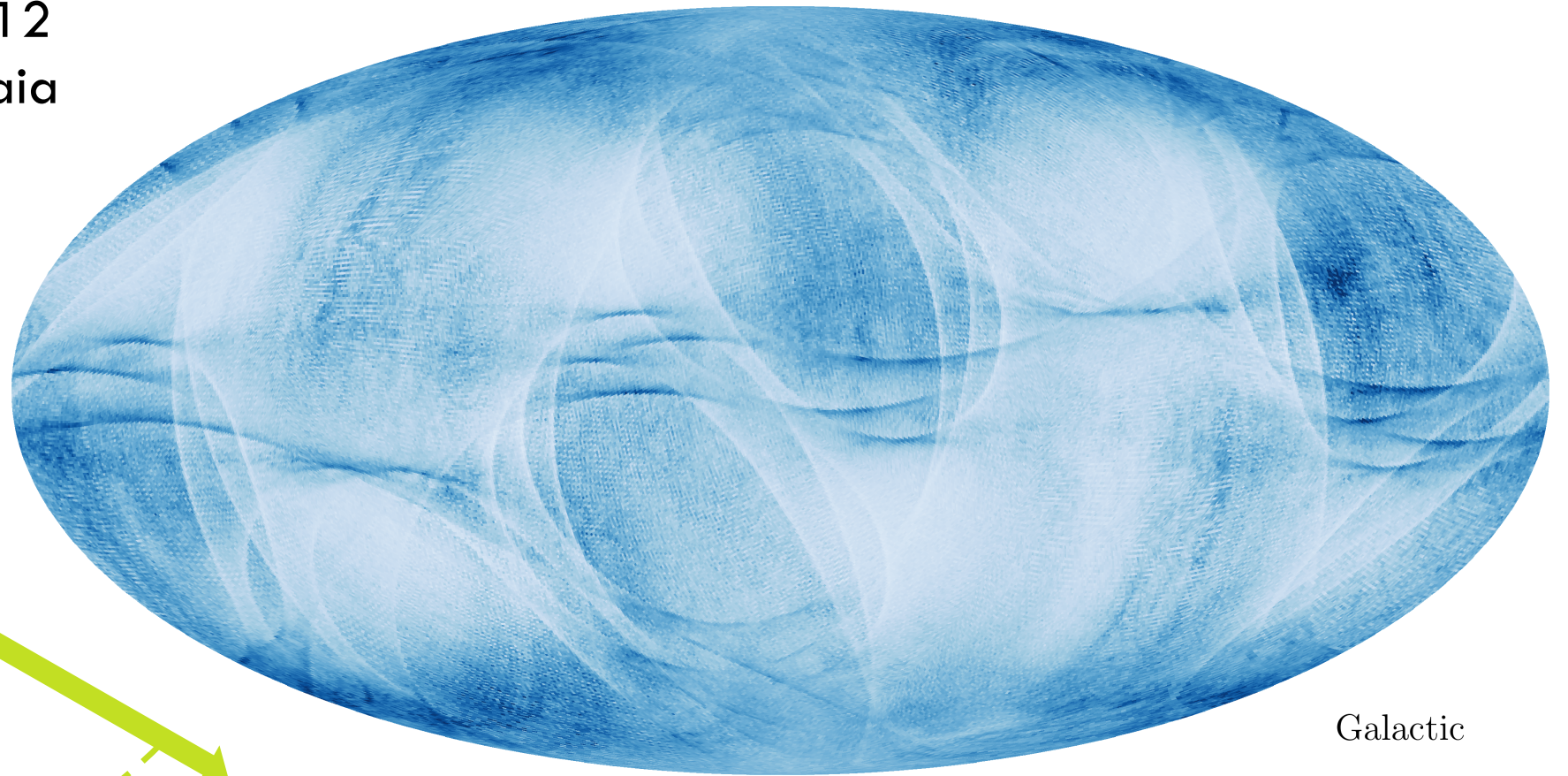
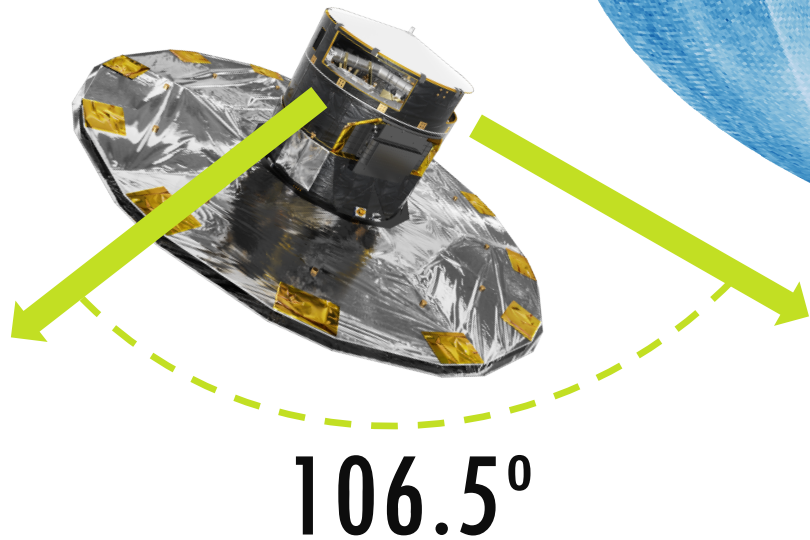
A slight tension is apparent.

KEY IDEAS:

1. All the transits can occur over a short period.
2. Gaia spectra can blend to give spurious RVs.



Assuming a $G_{RVS} = 12$
star that had ten Gaia
DR2 RVS transits ...



Galactic



CONCLUSION

Gaia will be the best survey in history at finding spectroscopic binary stars ...

- Millions of binaries are predicted to be found in DR3
- Evidence of hundreds of thousands already in DR2

... but we need to remember that Gaia is a spinning top in space that looks in two directions at once.

- Spurious RV medians from bright nearby neighbours
- Spurious RV scatter from bright not-so-nearby neighbours