How Many Exoplanets Will *Gaia* Discover?

Forecasts for *Gaia*'s Exoplanet Yield in DR4 and DR5

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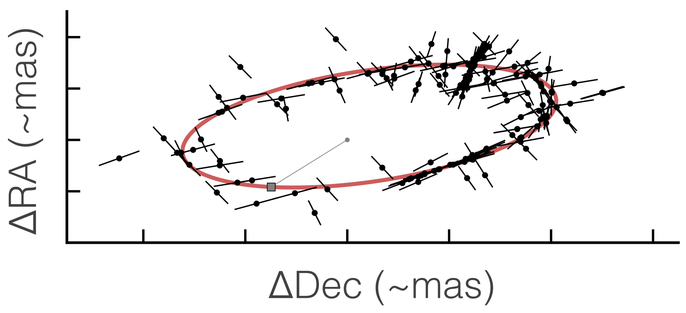
Astrometric planet detection with *Gaia*

A planet-hosting star will experience reflex motion with a max amplitude of

$$95\,\mu\text{as}\left(\frac{m_p}{M_\text{J}}\right)\left(\frac{a}{\text{AU}}\right)\left(\frac{M_\star}{M_\odot}\right)^{-1}\left(\frac{r}{10\,\text{pc}}\right)^{-1}$$

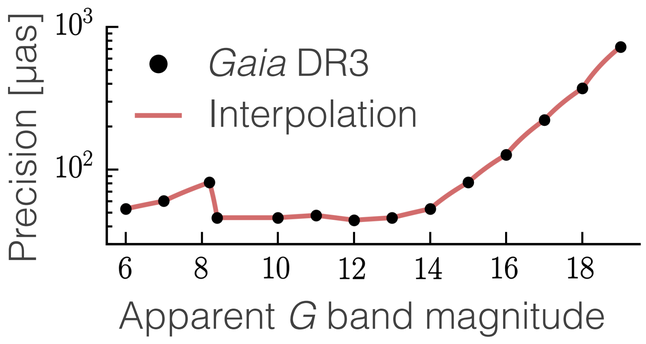
Precise astrometry from *Gaia* is expected to yield ~10^4 planets

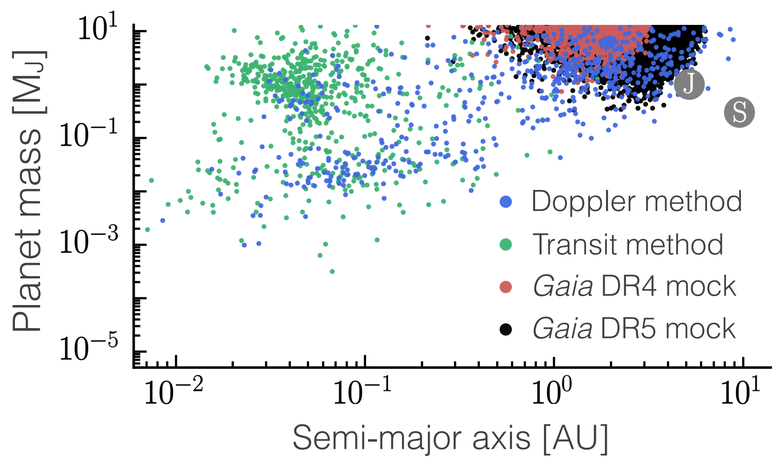
We have revisited these projections with detailed Monte Carlo simulations



Ingredients: ☀, 🪐, and 🔭

1. *Gaia*'s **local stellar population**
2. California Legacy Survey **giant-planet occurrence model**
3. *Gaia*'s demonstrated **astrometric precision** based on DR3

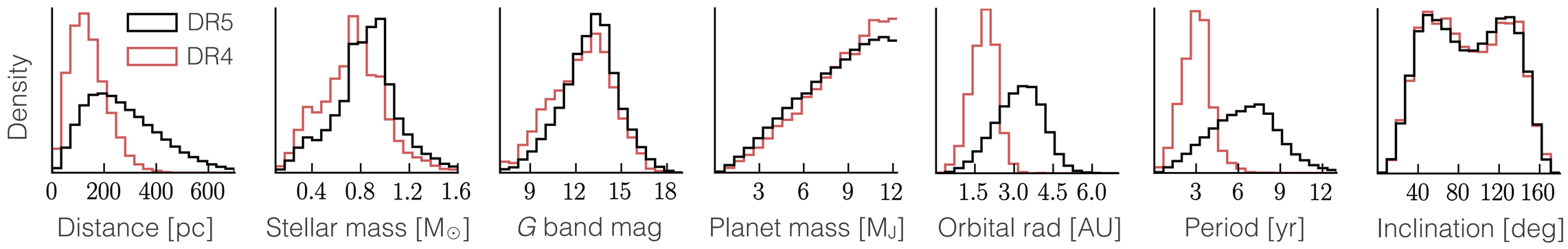




Gaia will primarily discover **super-Jupiters** on **multi-AU orbits** around nearby **GKM-type stars**

Detections of Jupiter-mass planets will be rare and are only possible for nearby stars (r ≲ 150 parsecs)

~10^4 planets in DR4 and ~10^5 in DR5



Planet yields depend on the detection criteria. We adopted the requirements:

1. $\Delta\chi^2 > 50$
2. $m_p < 13\,M_\text{J}$
3. $P_{84\text{th}}/P_{16\text{th}} < 1.5$

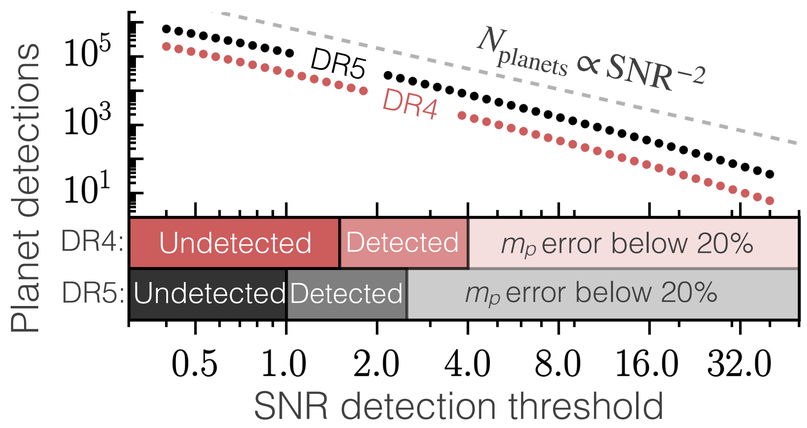
This yields **7,500 ± 2,100** planet in DR4 and **120,000 ± 22,000** in DR5

The dominant known source of uncertainty is planet occurrence

Most detections will be marginal, with weak constrains on the planet's mass and inclination

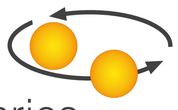
m_p should be measured to **20%** for **1,900 ± 540** planets in DR4 and **38,000 ± 7,300** in DR5

The number of detections scales sharply with SNR:



Planets should outnumber unresolved binaries

Equal-mass binaries can undergo low-amplitude astrometric motion



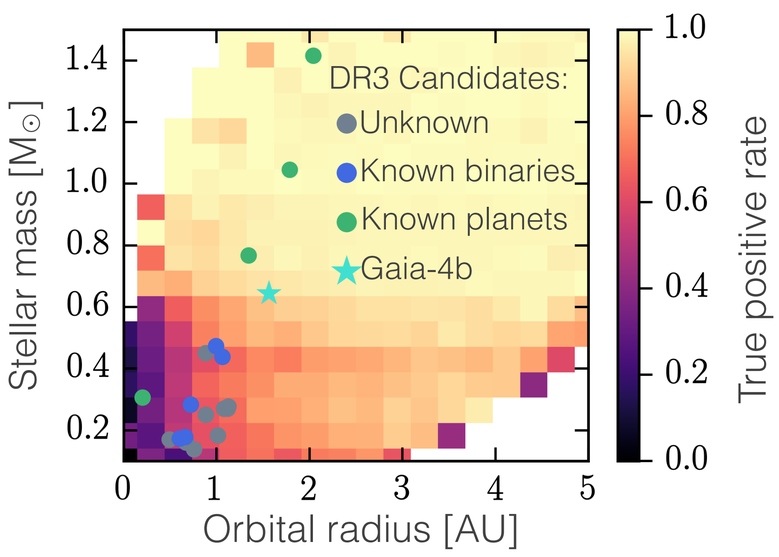
We have also simulated the detection of unresolved binaries using binary demographics

Our simulations predict that planets will outnumber binaries by a factor of **~6** in DR4 and **~15** in DR5

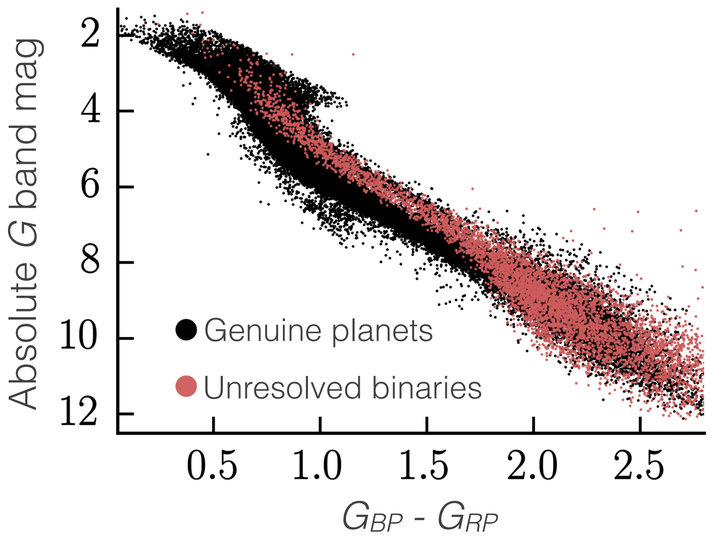
Contamination is **most severe** for **M-dwarfs** and **close-in planets**

Lammers & Winn submitted; if you would like a copy, ask!

False positive rates depend on the detection properties:



The DR3 exoplanet candidates lie in the region of most contamination



Most binaries **cannot** be excluded based on colors and luminosities

RV follow-up will be important for confirming *Gaia*-identified planets