

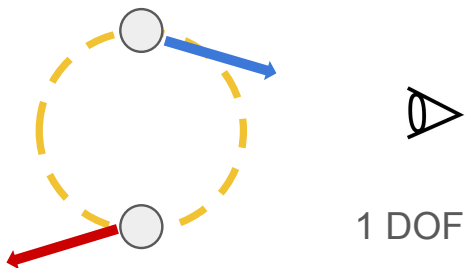
Introduction to Radial Velocities + Gaia Astrometry

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Radial Velocities (RVs)

- Line of sight reflex motion of stellar host



1 DOF

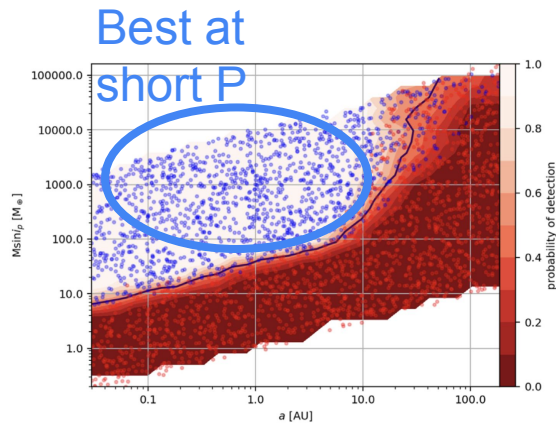
Gaia Astrometry

- Plane of sky reflex motion of stellar host

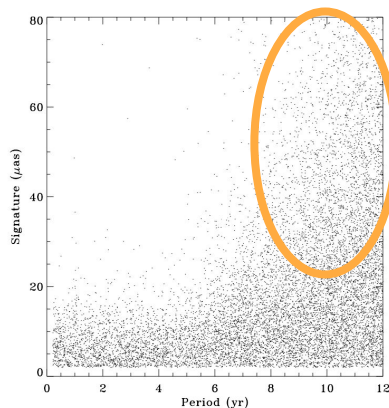


+5 DOF $\Rightarrow$ Full Orbit

Complementary Methods



+



Best at long P

$\rightarrow$

Best of both worlds
Broader accessibility
Precise orbits/true masses

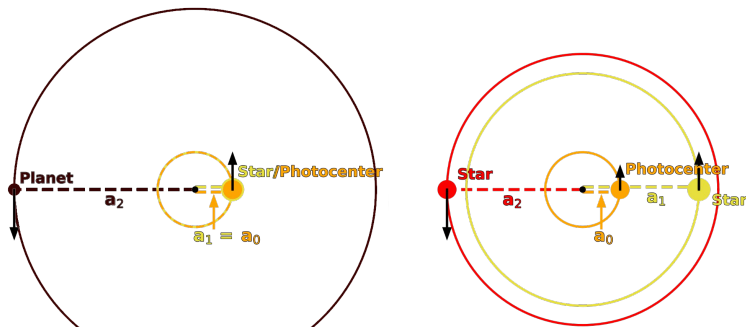
Current Data Products and Accessible Parameters

Hipparcos-Gaia	Gaia DR3	Radial Velocity Catalogues	Can Solve For:
Long-Baseline Proper Motion/Accelerations	Renormalized Unit Weight Error (RUWE)		True Masses
	Astrometric Solution	RV Time Series	Orbital Inclinations
	Proper Motion Anomaly	Activity Indicators	Angular Momentum Vectors
	Systematic RV	Spectral Properties	

Validation and Contamination

Binary Star Contamination

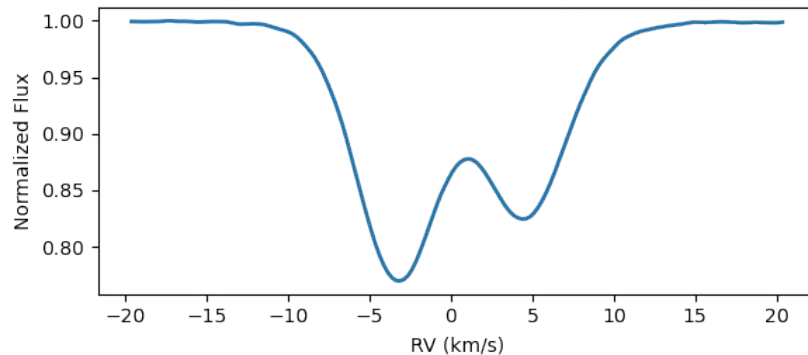
- Similar mass binaries can masquerade as planetary signals
- Binary fraction in DR3 $\approx 10\%$ (Holl+23) to 32% (Stefánsson+25)



adapted from Marcussen & Albrecht 2023

RV/Spectroscopic Validation

- Cross-Correlation Functions (CCFs) can immediately reveal binaries
- Can compare RUWE/PMa to RV masses
- Can further compare to sensitivity curves (e.g. Kervella+19)



The Power of Joint Modeling Gaia + RVs

Challenges of DR3 Alone:

Mass vs. semimajor axis
degeneracy

$$\alpha = \left(\frac{M_p}{M_\star} \right) \left(\frac{a_p}{1 \text{ AU}} \right) \left(\frac{d}{1 \text{ pc}} \right)^{-1} \text{ arcsec}$$

Noise treatment can be
unreliable

Towards a composite picture of Planetary Systems

- Model astrometry + RVs (or high contrast imaging) in MCMC framework
- Orthogonality breaks degeneracies
- Each method does the heavy lifting in it's own regime
 - RV characterizes shorter/small orbits, Gaia constrains outer companions



Vetted Candidates + System
Orbital Characterization

Key Goals and Future Prospects

Science Objectives:

- Precise mass distributions/occurrence rates
- Mutual inclinations and dynamical characterization
- Robust, vetted exoplanet catalogues

Future of Gaia + RVs:

- **Gaia DR4** - Much larger catalogues of planet candidates
- Characterization of thousands of exoplanet orbits
- Demographic studies with true mass measurements