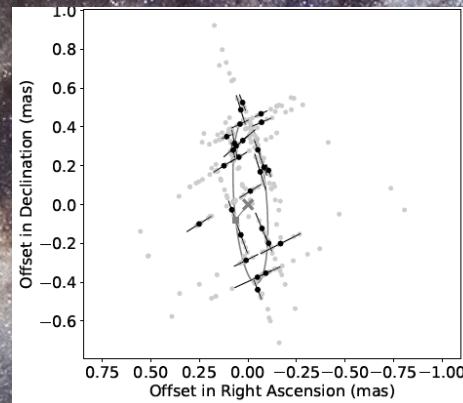
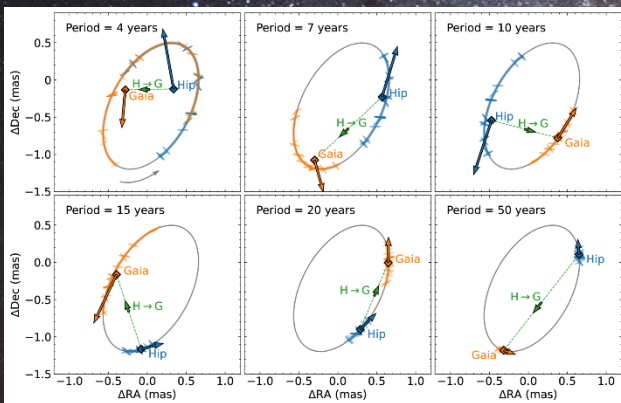


The Gaia Mission:

Toward DR4



A. Sozzetti

INAF - Osservatorio Astrofisico di Torino

On January 15th !

SKY-SCANNING COMPLETE FOR ESA'S MILKY WAY MAPPER GAIA

From 24 July 2014 to 15 January 2025, Gaia made more than three trillion observations of two billion stars and other objects, which revolutionised the view of our home galaxy and cosmic neighbourhood.



580 MILLION

Accesses of Gaia catalogue so far



13 000

Refereed scientific publications so far



2.8 MILLION

Commands sent to spacecraft



142 TB

Downlinked data (compressed)



500 TB

Volume of data release 4
(5.5 years of observations)



3 TRILLION

Observations



2 BILLION

Stars & other objects observed



938 MILLION

Camera pixels on board



15 300

Spacecraft 'pirouettes'



55 KG

Cold nitrogen gas consumed



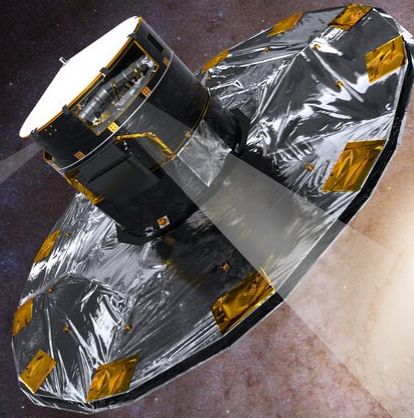
3827

Days in science operations



50 000 HOURS

Ground station time used



https://www.esa.int/Science_Exploration/Space_Science/Gaia/Last_starlight_for_ground-breaking_Gaia

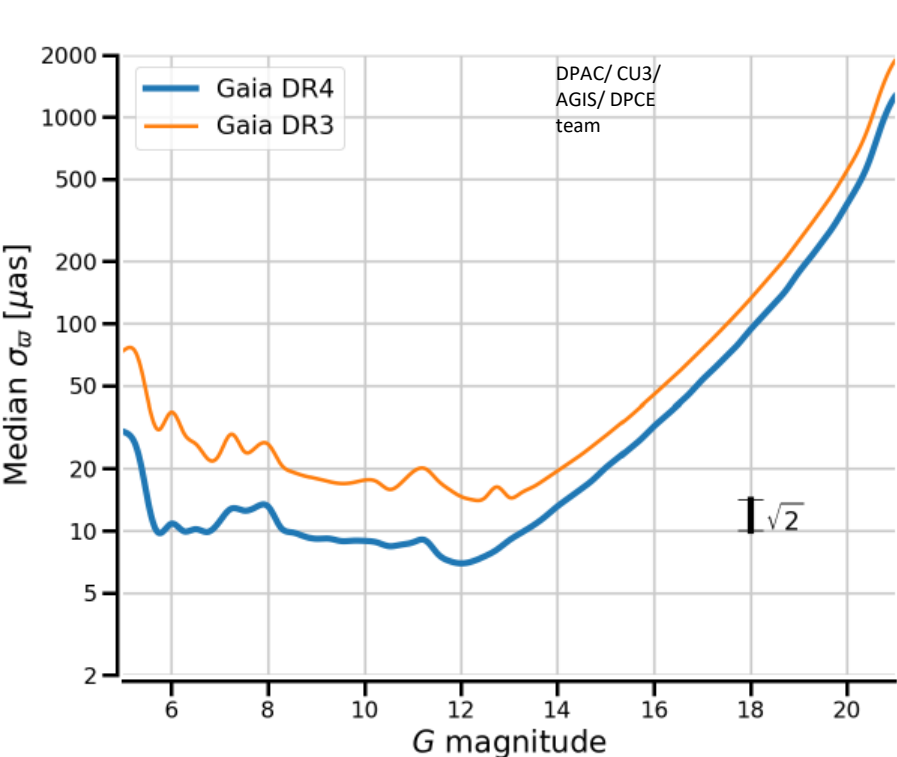
...but we are far from the end of the Gaia mission!

Gaia DR4

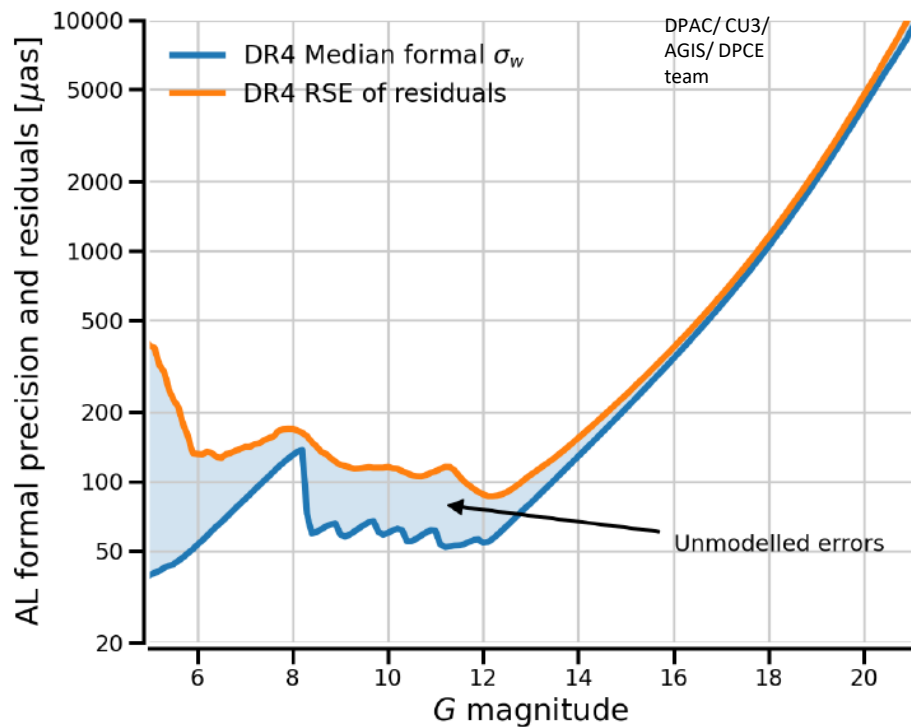
(66 months of data, not before mid-2026)

- Full astrometric, photometric, and radial-velocity catalogues.
- All available variable-star and non-single-star solutions.
- Source classifications (probabilities) plus multiple astrophysical parameters (derived from BP/RP, RVS, and astrometry) for stars, unresolved binaries, galaxies, and quasars.
- An exoplanet candidate list.
- All epoch and transit data for all sources.

DR4: Astrometry



Expected improvement surpassed for $G < 13$



- Gaia DR4 formal per CCD astrometric uncertainties $\sim 50 \mu\text{as}$ at $G \lesssim 13$ ($\sim 15 \mu\text{as}$ averaged over 9 CCDs)
- But: total uncertainties limited by calibration errors to $\sim 80\text{--}150 \mu\text{as}$ ($30\text{--}50 \mu\text{as}$ averaged over 9 CCDs)

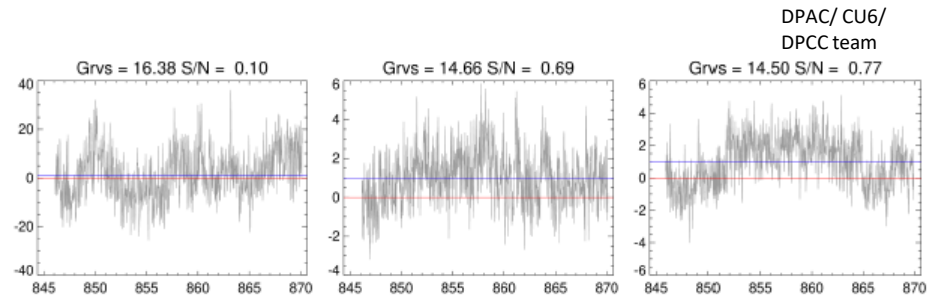
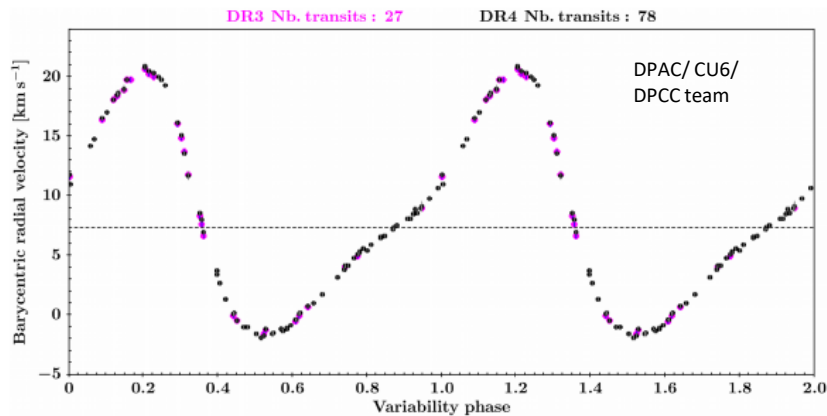
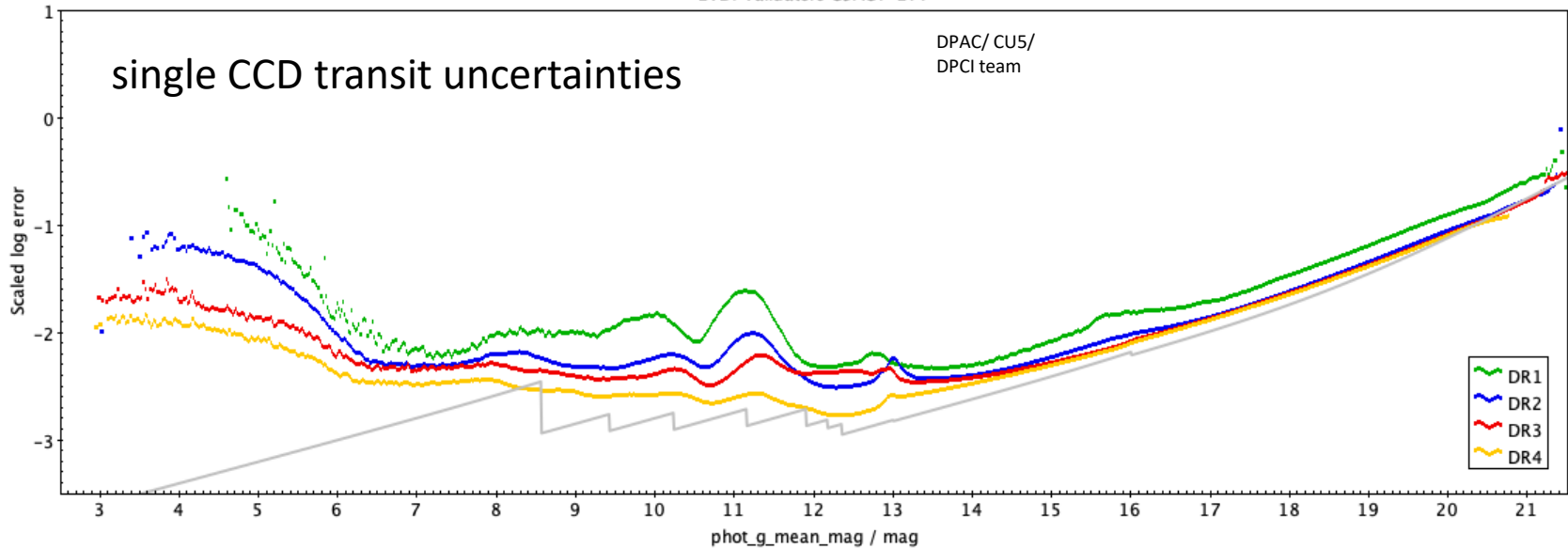


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DR4: Photometry and Spectroscopy

EVD: Validators C5ACT-277



Faint-source spectra ($G_{\text{RVS}} > 14$) will be combined

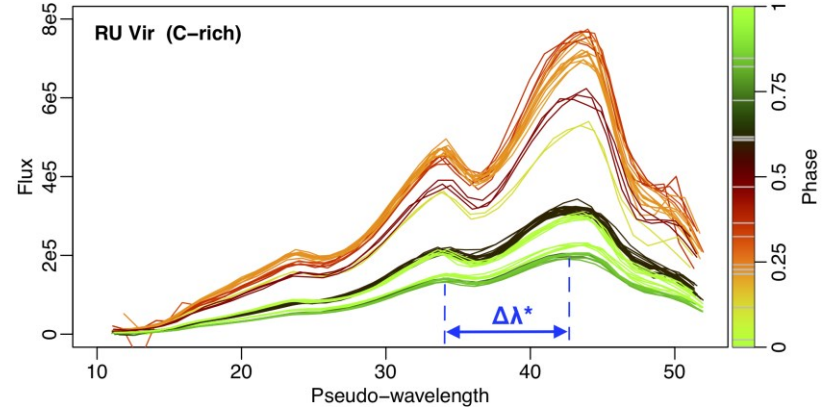
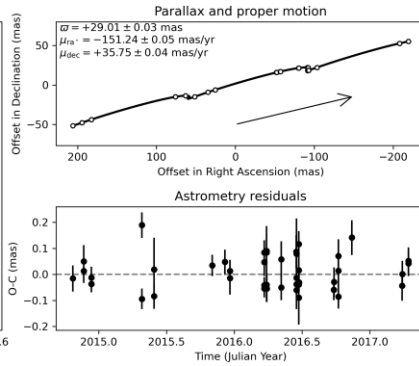
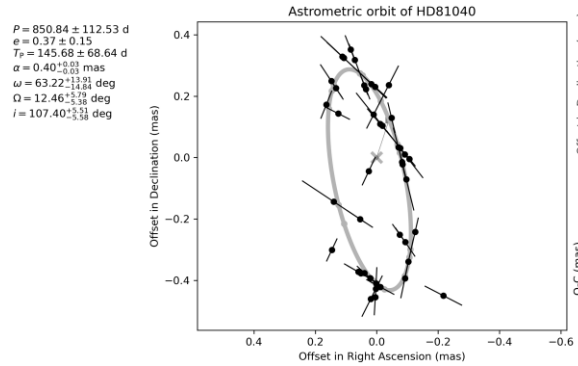
Time series for all bright sources ($G_{\text{RVS}} < 14$)



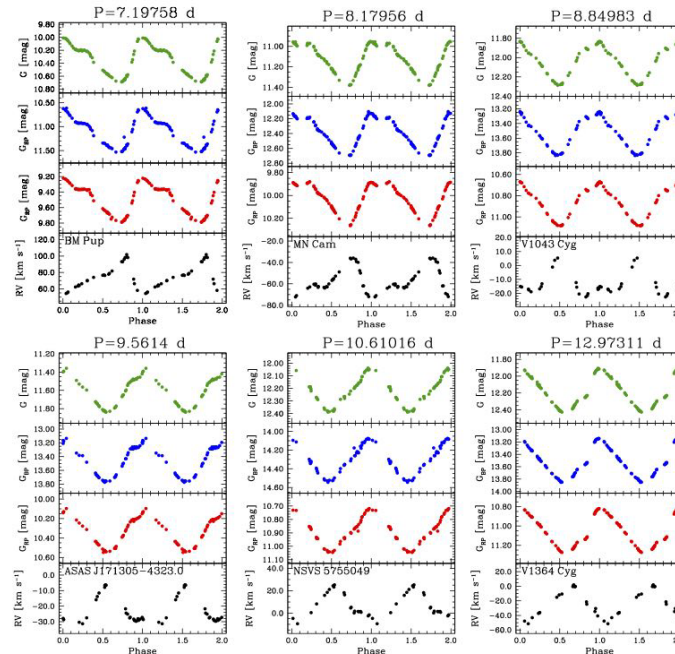
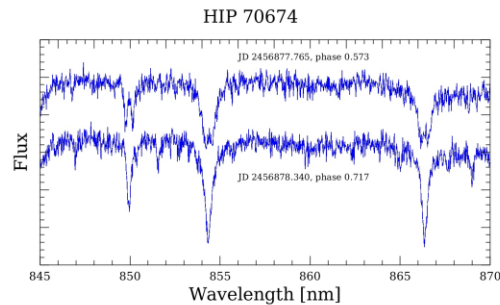
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Time-series for 2.5×10^9 sources!



Courtesy: A. Brown



- Epoch astrometry
- Light curves
- Radial velocity time series
- XP spectra time series
- RVS spectra time series

Gaia DR3 astrometry: substellar mass companions

≈ 1800 orbits



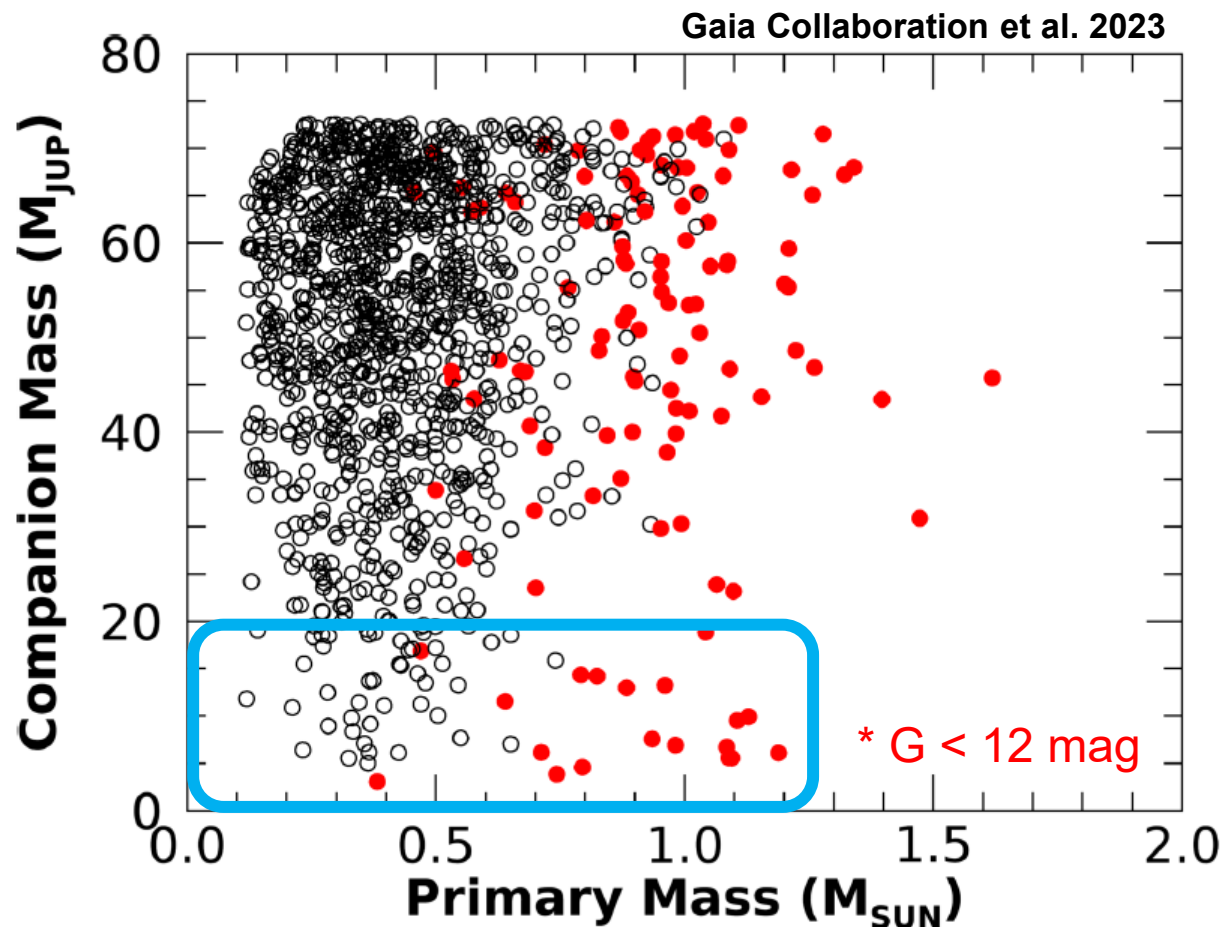
≈ 5% with $M_2 < 20 M_{\text{Jup}}$



≈ 30% with $G < 12 \text{ mag}$

Typically:

- $P < 1000$ days
- $a_0 \approx 100\text{-}400 \mu\text{s}$



Gaia DR4: What to Expect?

* From astrometry expect:

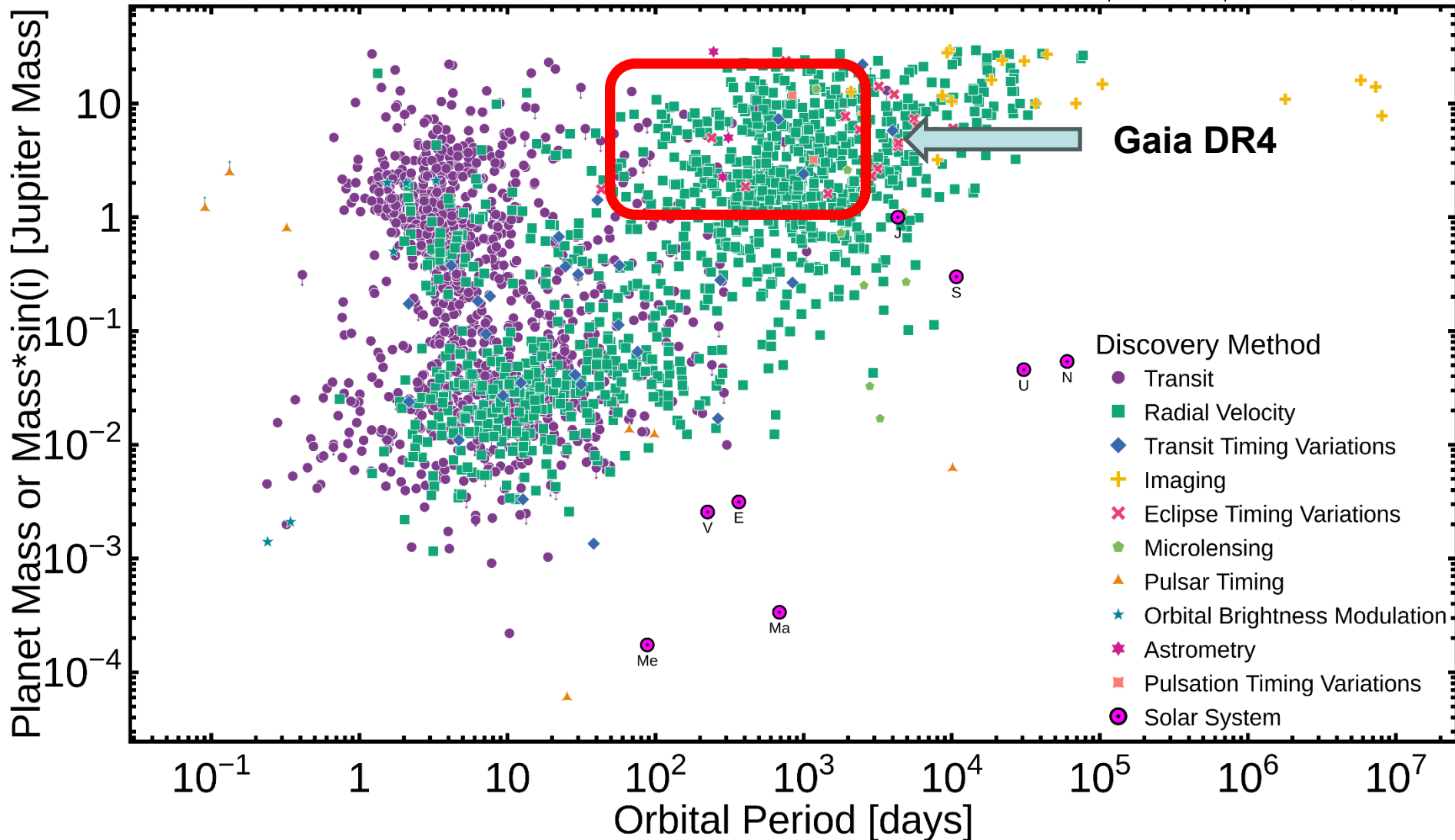
- >> 72 (DR3) solutions corresponding to a planet candidate
- >> 9 (DR3) solutions corresponding to a known planet
- Both fitted (Thiele-Innes) and derived (a , i , Ω , ω) parameters, full covariances
- A metric capturing the likelihood of false positive / true planet
- SOME multiple solutions (two planets, one planet + accelerations)
- MANY acceleration solutions (both first and second derivative of proper motion), SOME of which might be due to long-period planets
- The full astrometric time-series: on average, > 600 CCD obs!
- You'll be able to change: source model, transit selection, error model (weights), source selection

* Also:

- >> 40 (DR3) and 10 (DR3) candidate Hot Jupiters from transit photometry and RVS, respectively

Planet Mass or Mass* $\sin(i)$ vs Orbital Period

exoplanetarchive.ipac.caltech.edu, 2025-01-31



The challenge: detecting robustly signals in the 50-100 μ s regime

How to Access?

- There will be a comprehensive list of confirmed and candidate planets
- Complete information still likely spread among multiple DR4 tables.
- Preliminary contacts with NASA exoplanet archive and Extrasolar Planet Encyclopaedia for eventual ingestion

Given the catalog, what to do?

- Spectroscopy, spectroscopy, spectroscopy!
- But some high-contrast imaging too, I bet.
- Some of the follow-up efforts eased by DPAC work this time, but it will still be a very significant task
- With a large catalog of candidates, coordination of follow-up efforts desirable (Kepler and TESS FOPs instructive and successful examples)