



Gaia



Status and Data Release contents



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IPAG / OBSPM

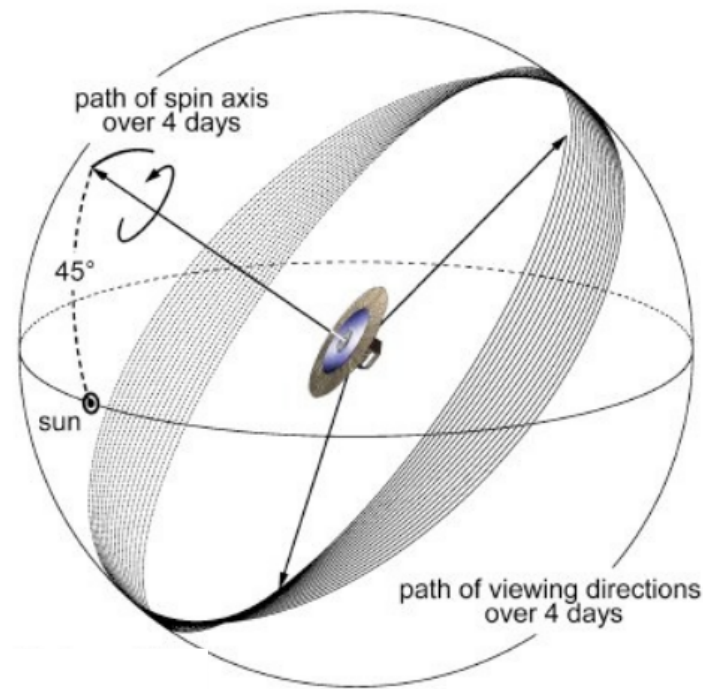
The Gaia mission

ESA cornerstone mission
5 years (+) of mission

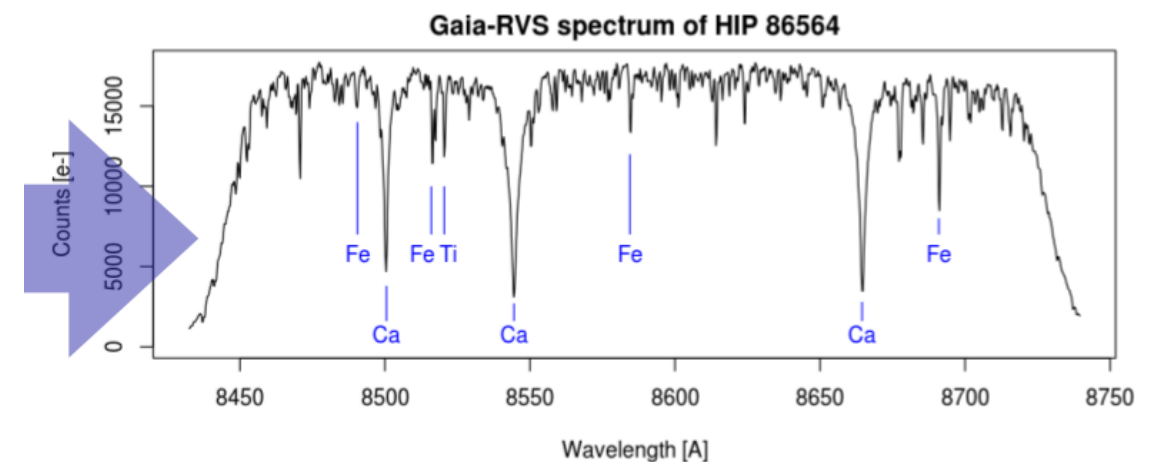
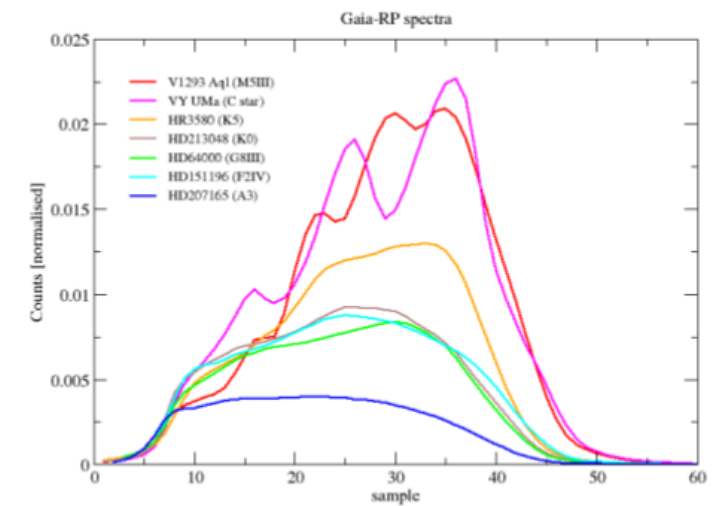
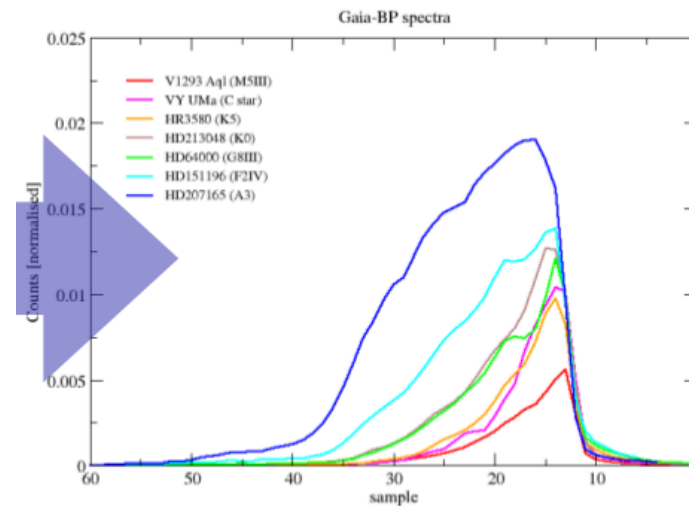
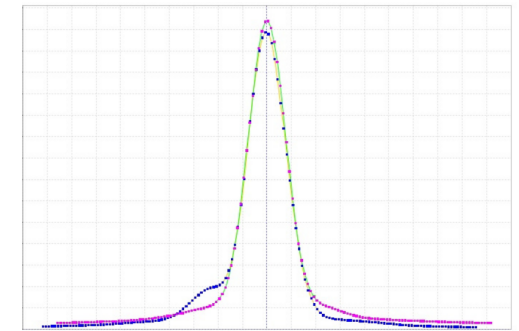
3 instruments

- Astrometry
- Spectrophotometry
- Spectroscopy (RVS)

> 1 billion stars $3 < G < 20.7$
~ 70 observations per source



along scan LSF

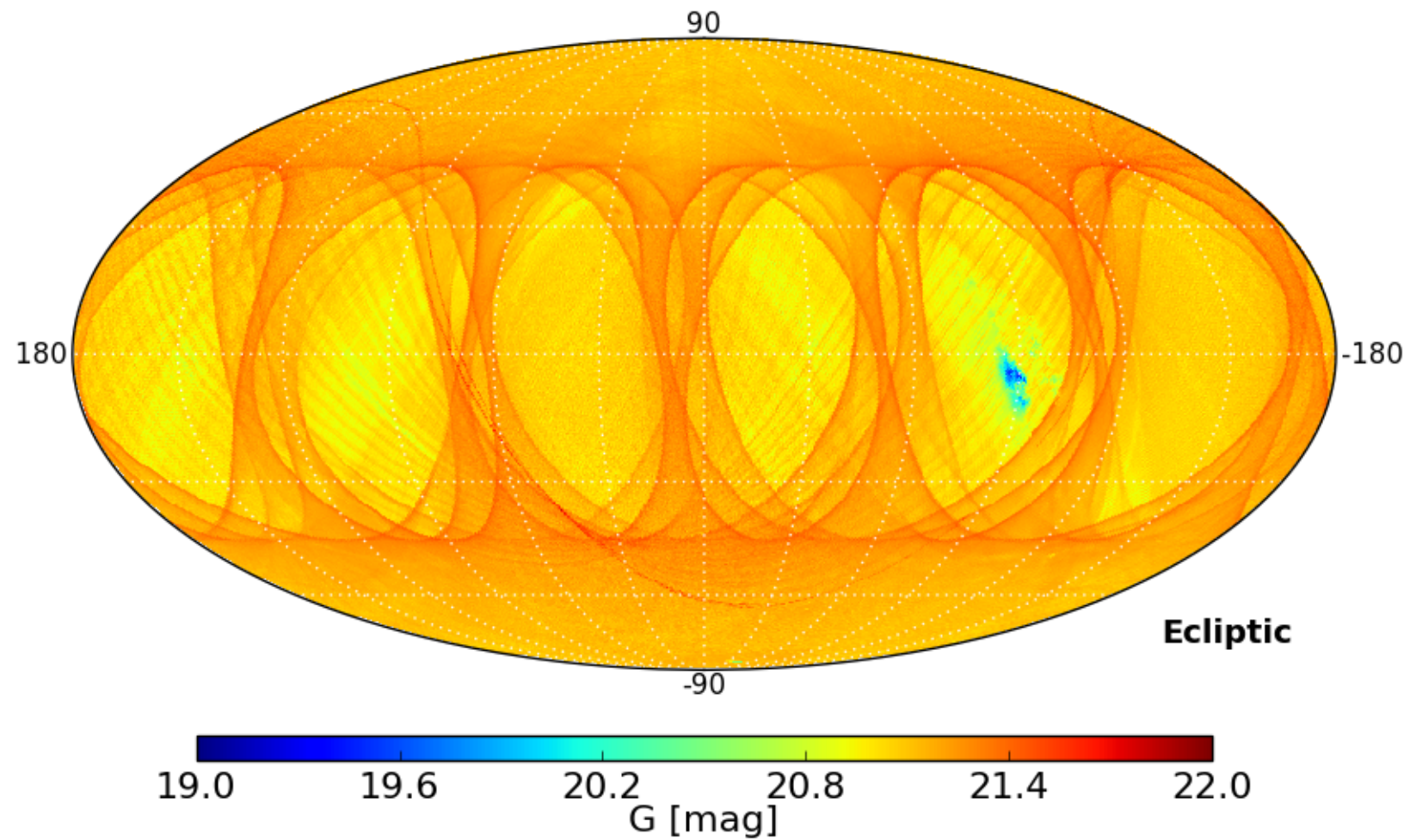


Gaia Data Releases

	DR1 (Sept 2016)	DR2 (25 April 2018)	DR3 (2021)	DR4 (TBD)
Parallaxes and proper motions	Hip/Tyc priors	Full Sample	EDR3 (2020)	++
Photometry	G	G, G _{BP} , G _{RP}		++
Radial velocities	-	RVs at G _{RVS} <12	++	++
Variables	3 000	550 000	++	++
SSOs	-	pre-selected asteroids	New SSOs	++
Astrophysical parameters	-	for G < 17 : T _{eff} , A _G Radii and luminosities <i>from integrated phot</i>	Classification + parameters from BP/RP + RVS spectra	++
Non-single stars	-	-	Non-single stars	Exoplanets
Extended objects			Selected Extended objects	
Spectra	-	-	Mean BP/RP spectra Mean RVS spectra	++
Epoch data	-	-	-	All epoch data

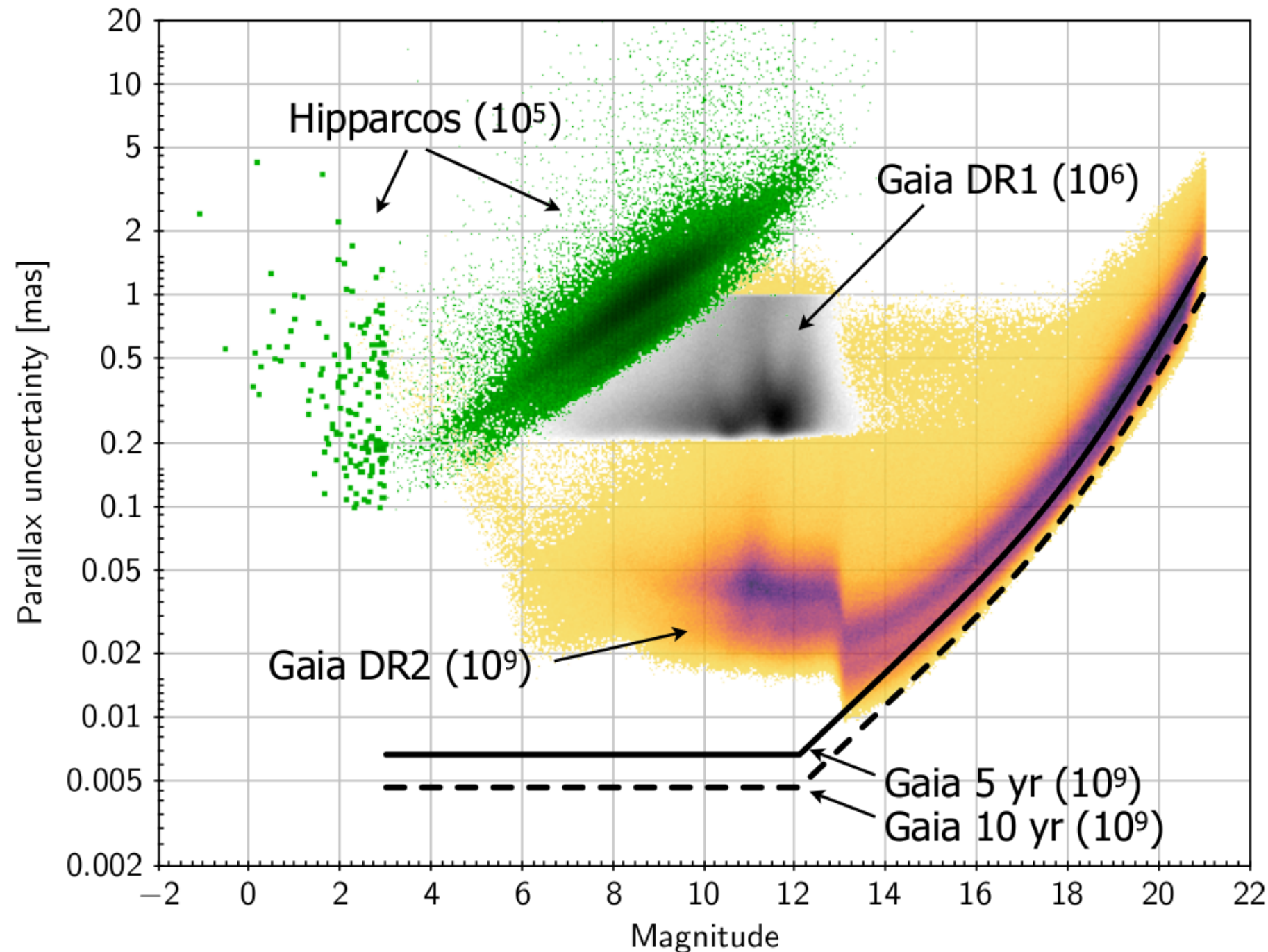
More DRs to be planned: mission extension !

DR2 completeness



Limiting magnitude: 99th percentile in G

DR2 astrometry



Typical parallax precision:

- G=15: 0.03 mas
- G=17: 0.1 mas
- G=20: 0.7 mas

Still single-star solution

Systematics below 0.1 mas

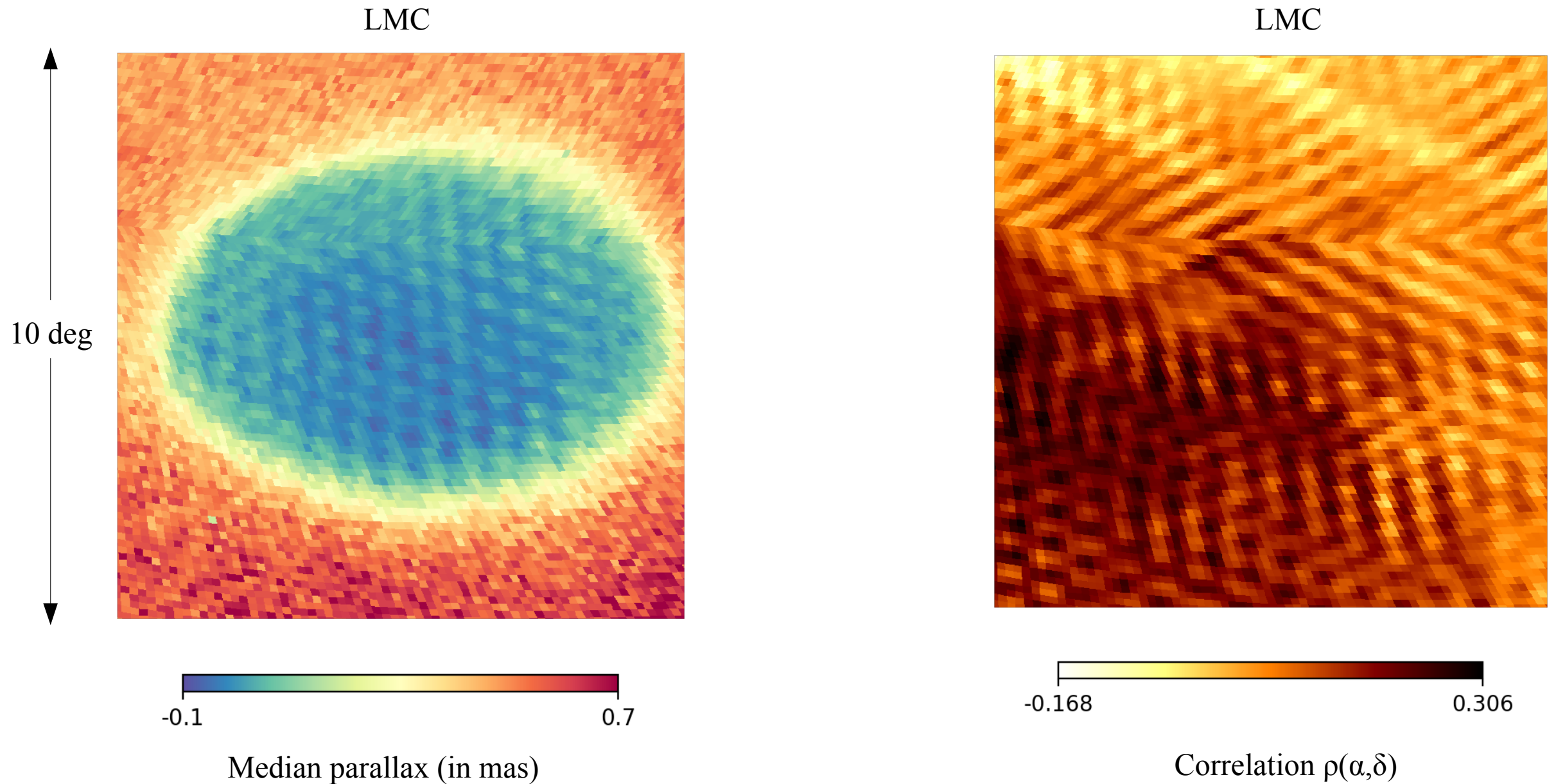
Global zero point ~ -0.03 mas

Spatial correlations at ~ 1 and ~ 20 degree scales

Provided: **formal uncertainties**
estimated from internal consistency of the measurements
do not represent the total error

DR2 astrometry : small scale systematics

Quasi-periodic patterns imprinted by the Gaia scanning law

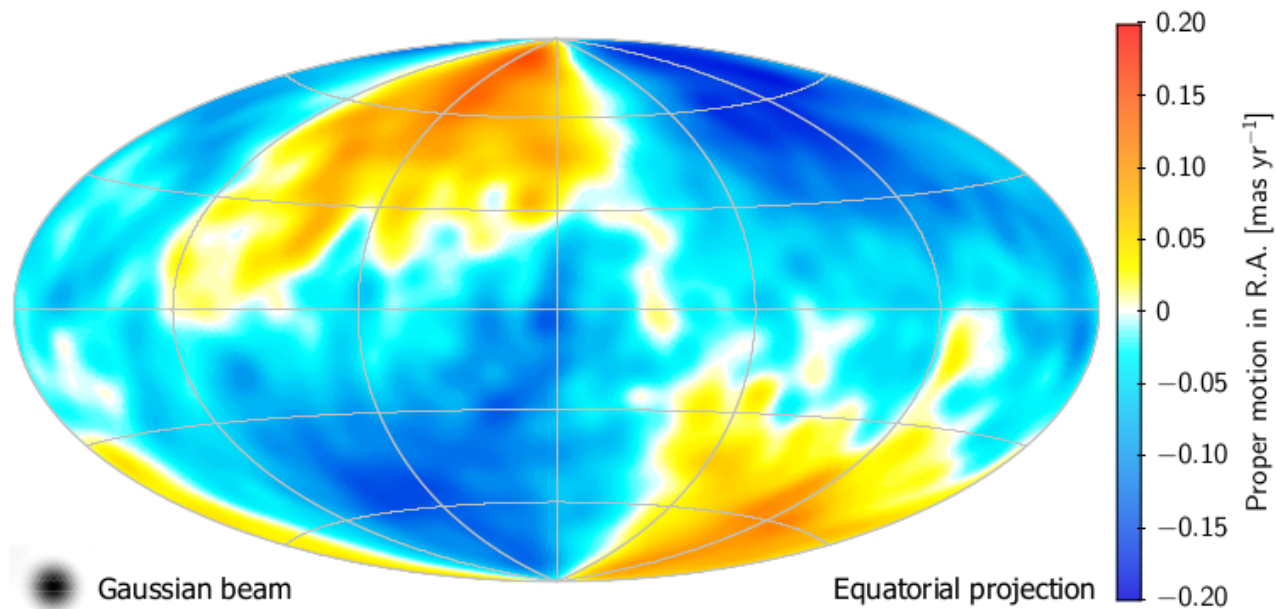


Characteristic period ~ 0.6 deg, RMS variation ~ 0.03 mas

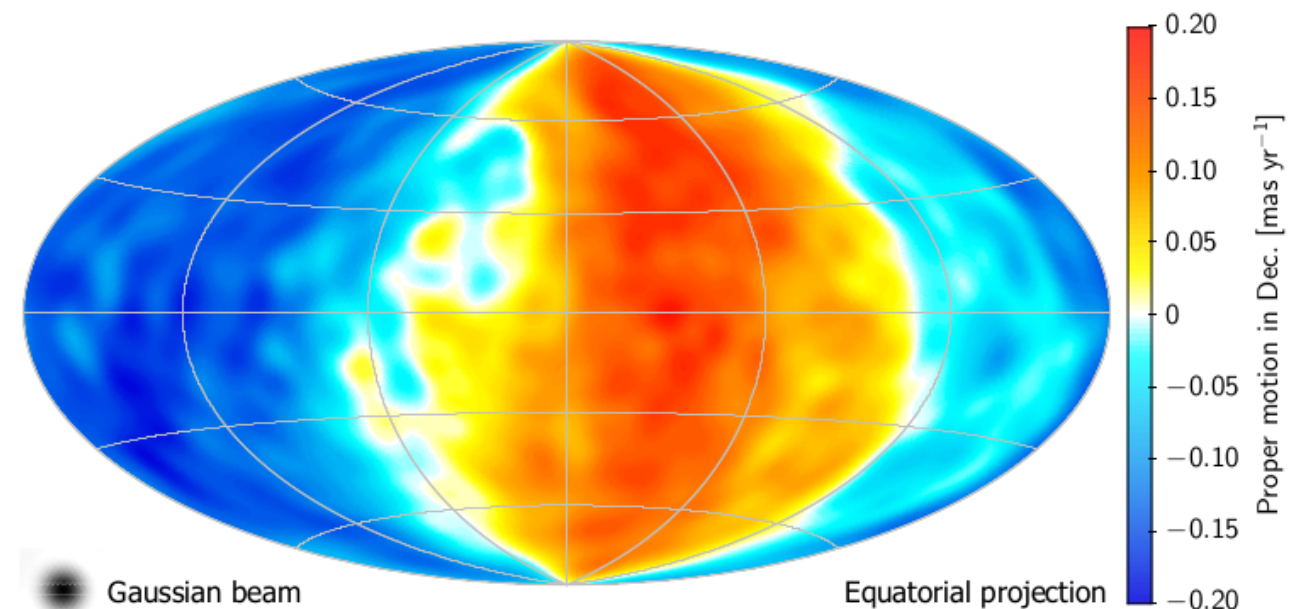
DR2 astrometry : bright stars PM systematics

Proper motion difference versus Hipparcos

R.A.

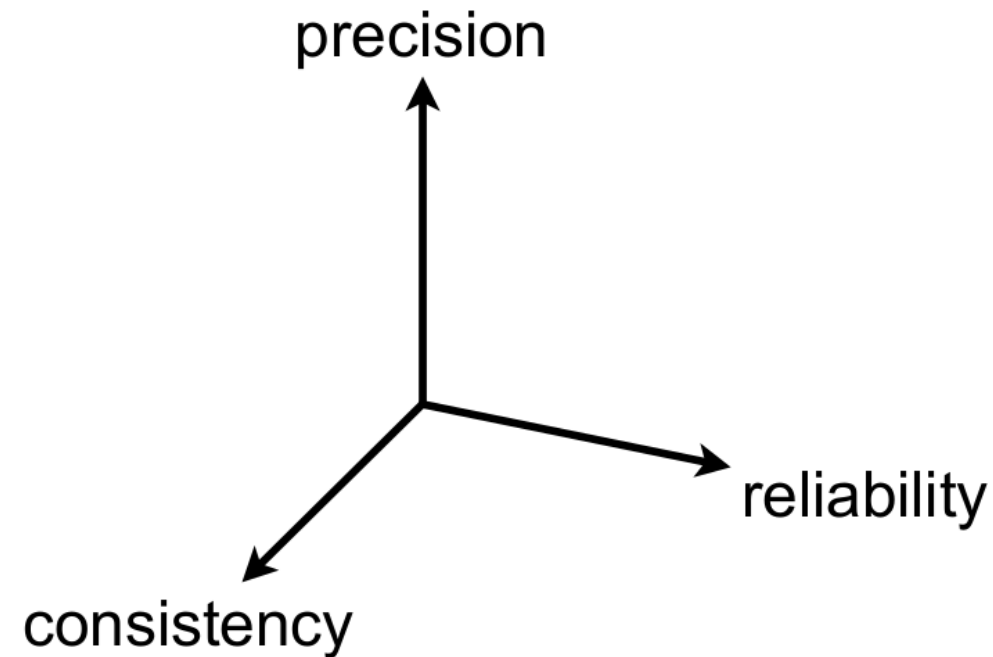


Dec.



Global rotation $\sim 0.15 \text{ mas yr}^{-1}$

DR2 astrometry : quality indicators

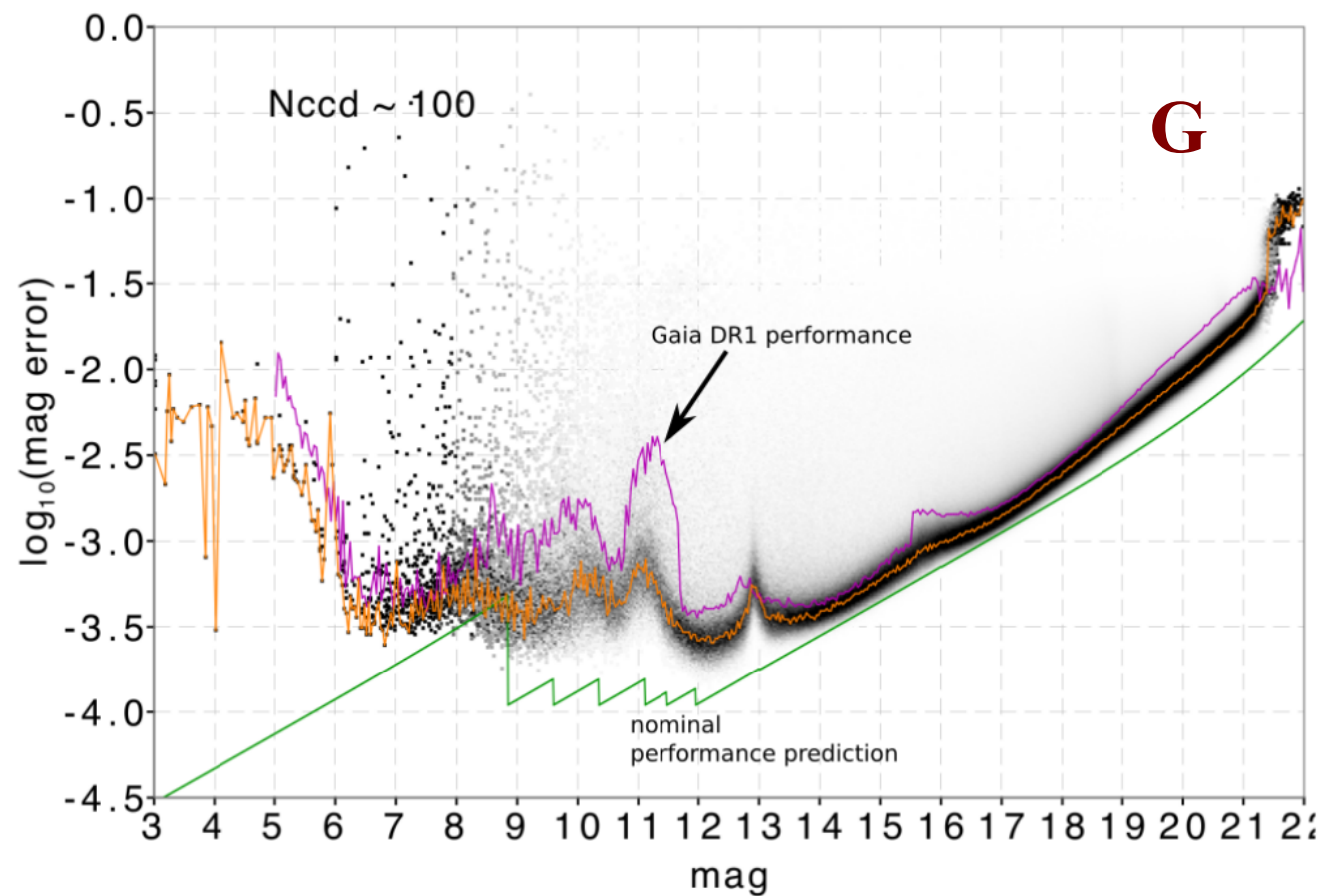


Precision: `parallax_error`, `pmra_error`, `pmdec_error` (internal!)

Reliability: `visibility_periods_used`

Consistency: **Renormalised Unit Weight Error** (see Gaia DR2 Known issue page)

DR2 photometry



~ 10 mmag level systematics

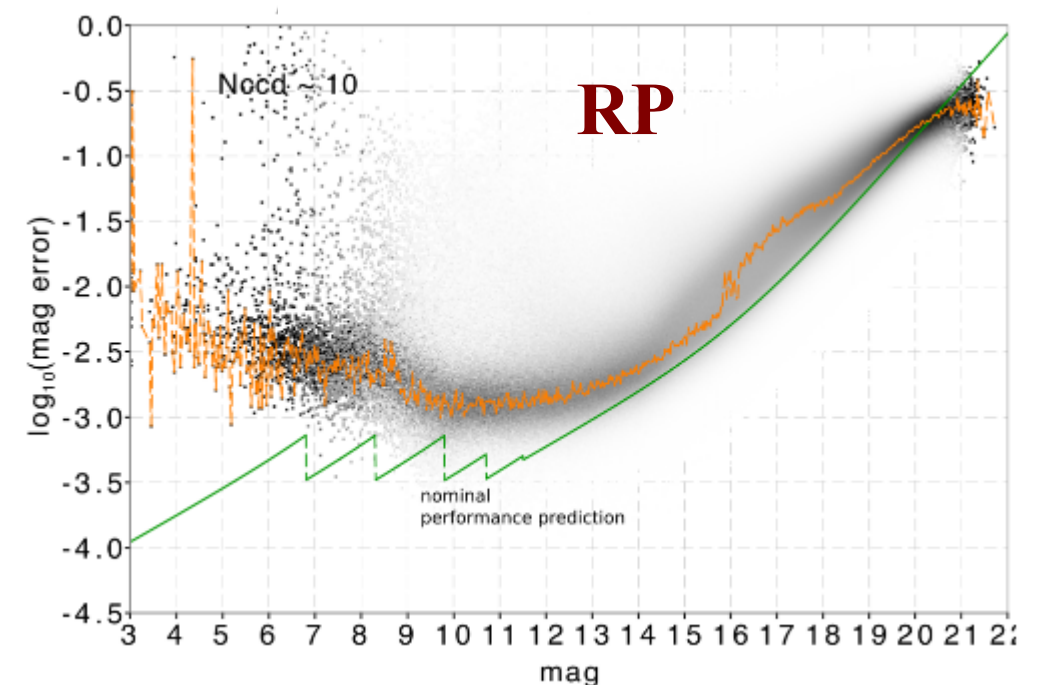
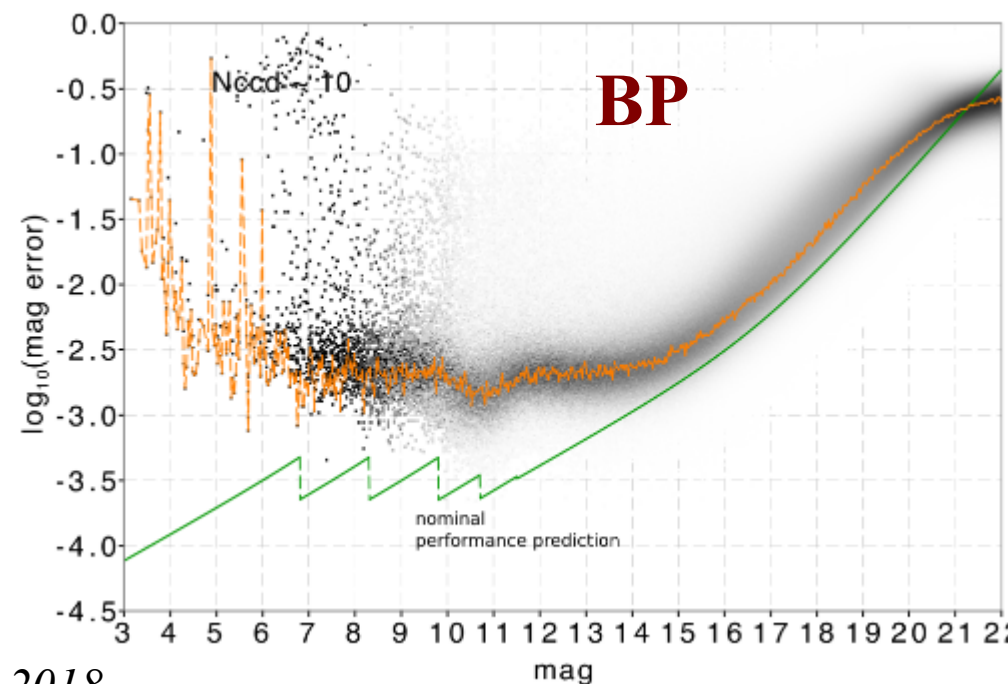
BP & RP integrated photometry

G=20: $\sigma_G \sim 0.02$ mag, $\sigma_{XP} \sim 0.2$ mag

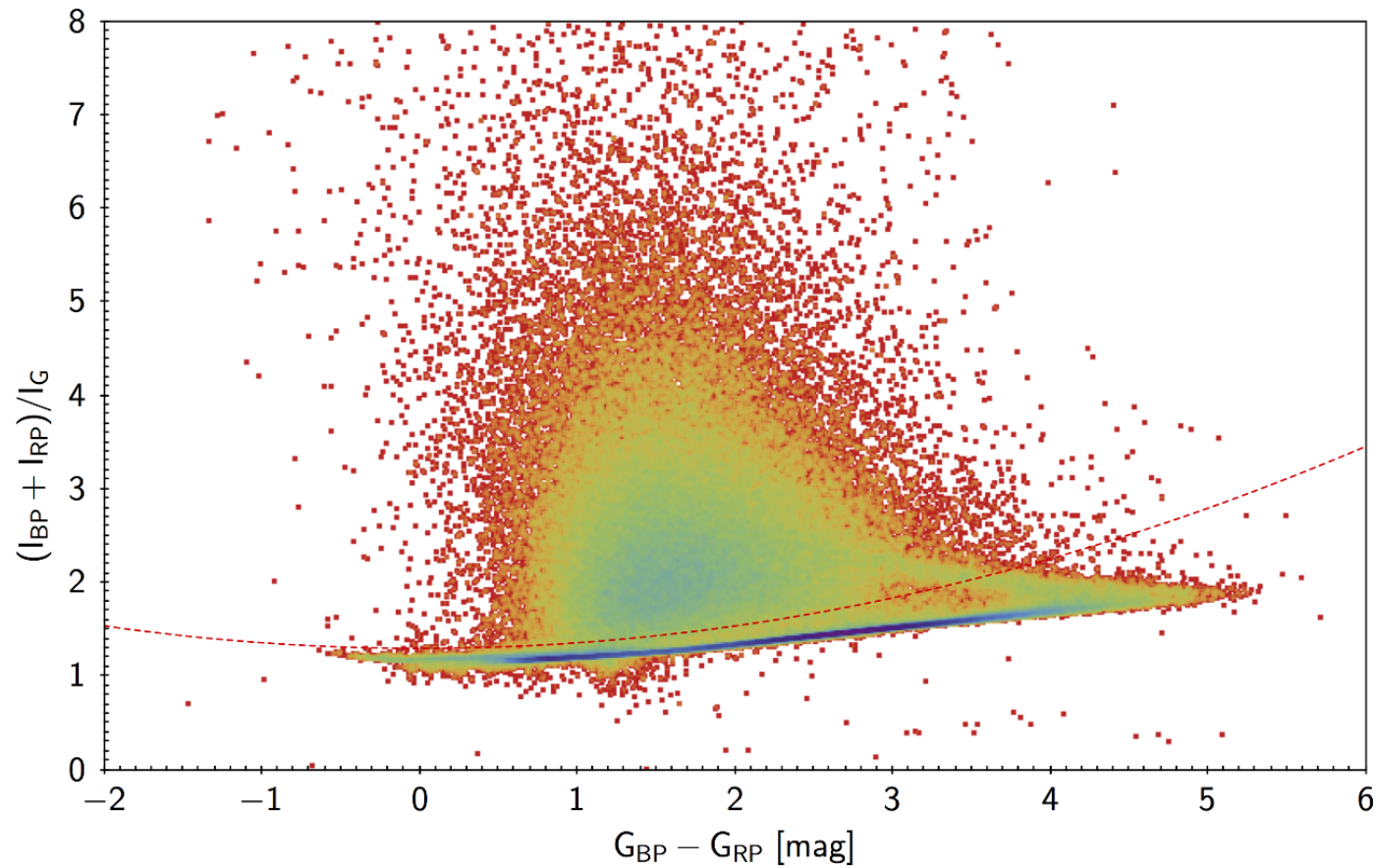
Passbands provided

! No deblending

! G band system different from DR1



DR2 photometry : main issues

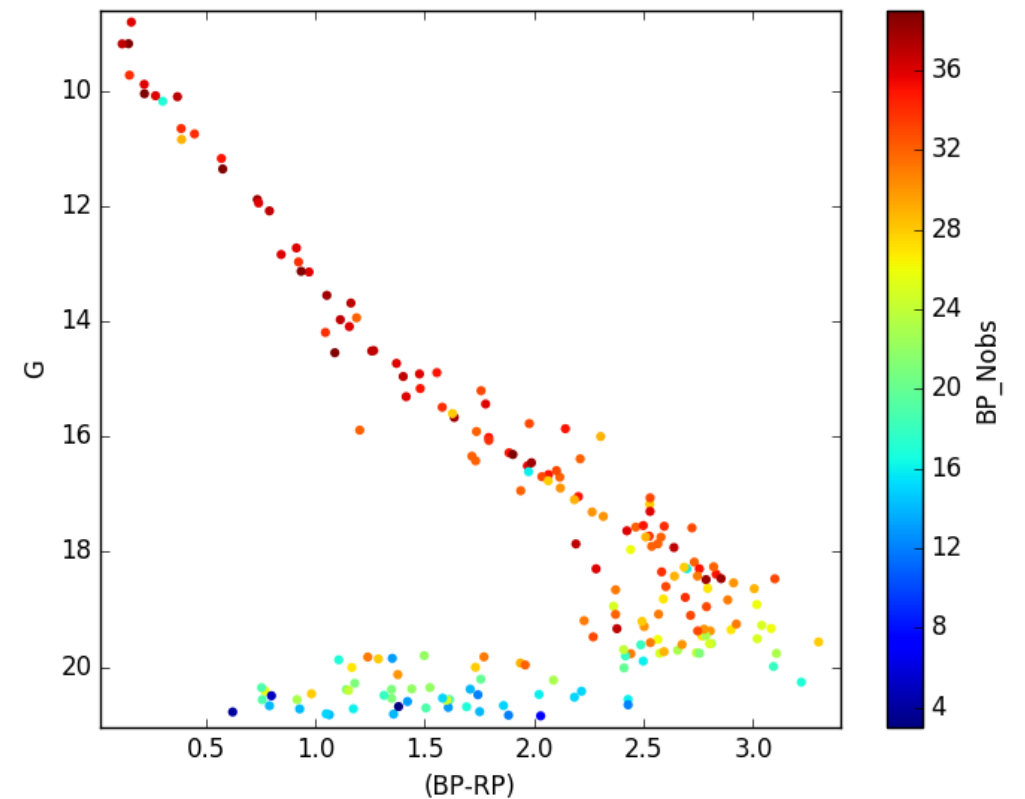


BP/RP excess flux

← crowded spectrophotometry

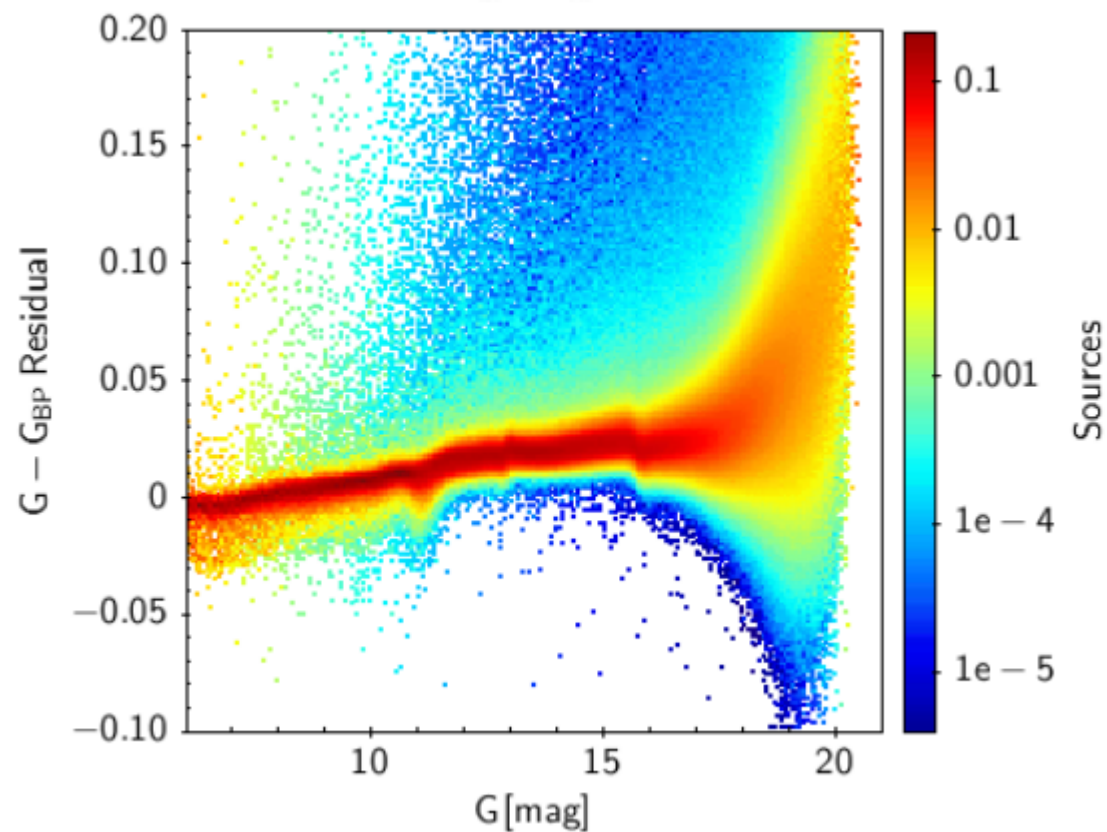
BP background under-estimation

CMD of Alessi 10



DR2 photometry : calibrations

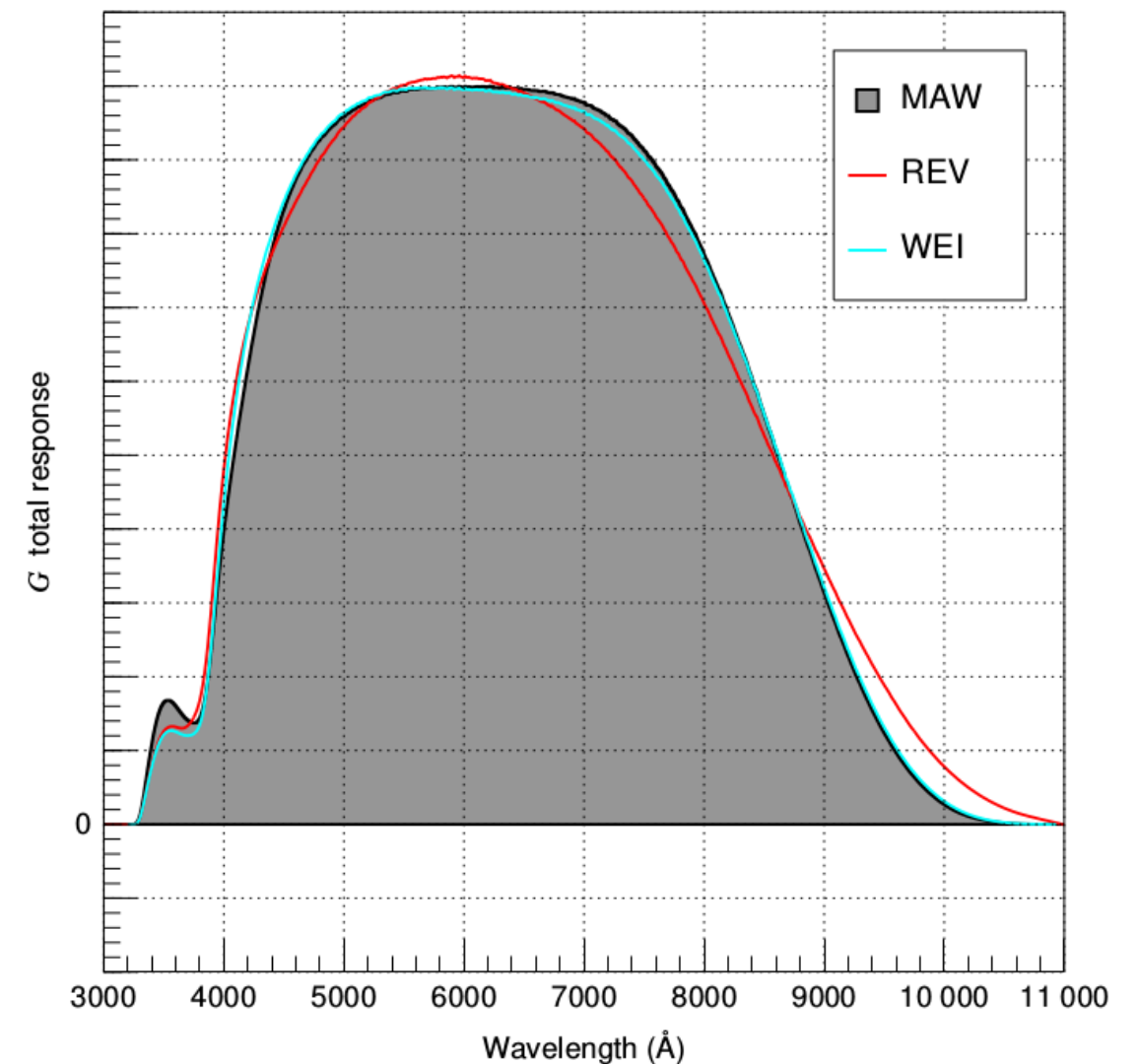
G fading of ~ 3 mmag / mag



Arenou et al. 2018

Weiler 2018

New calibrations of the Gaia photometric bands

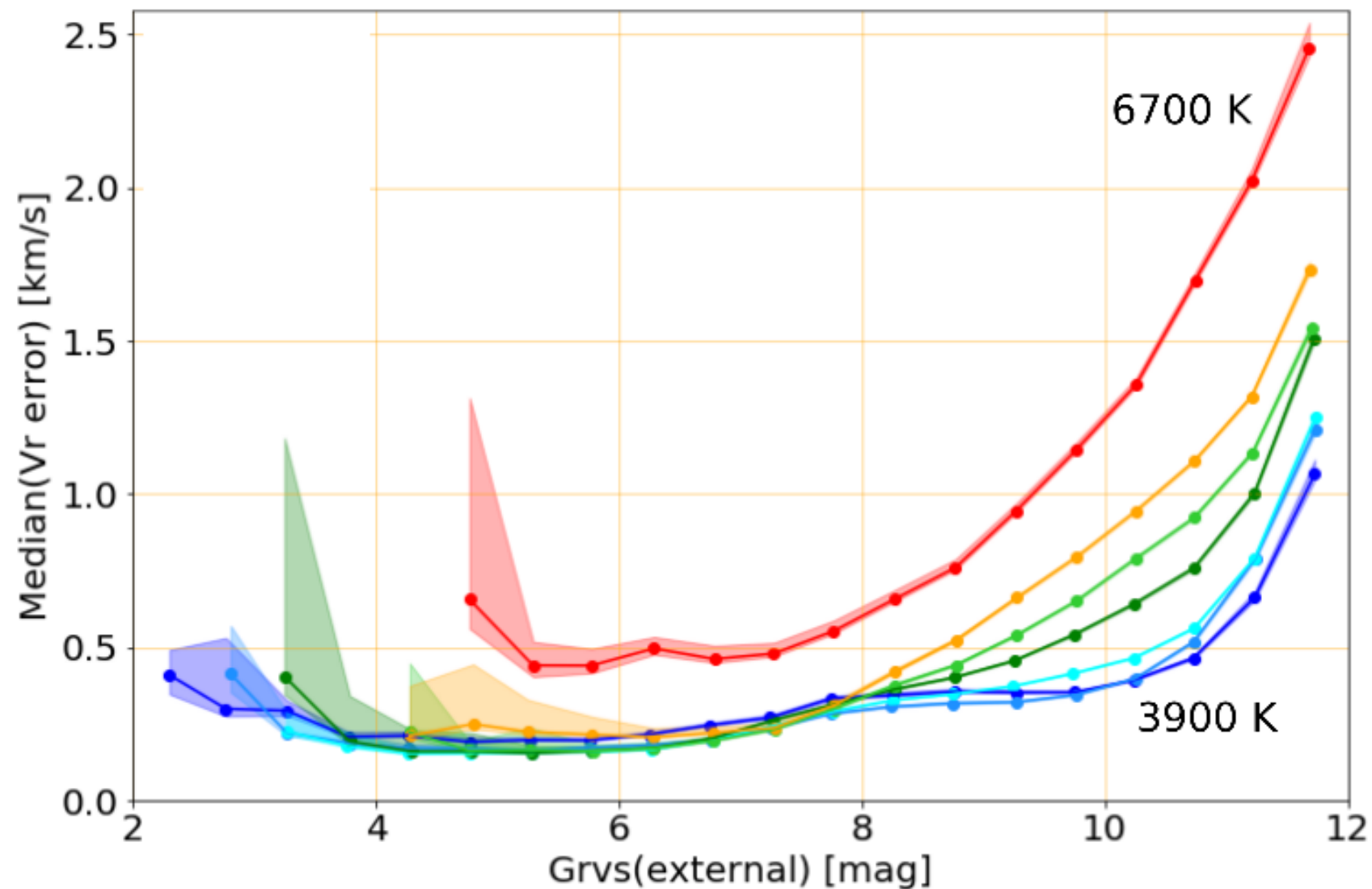


Evans et al. 2018

Weiler 2018

Maiz Apellaniz & Weiler 2018

DR2 radial velocities

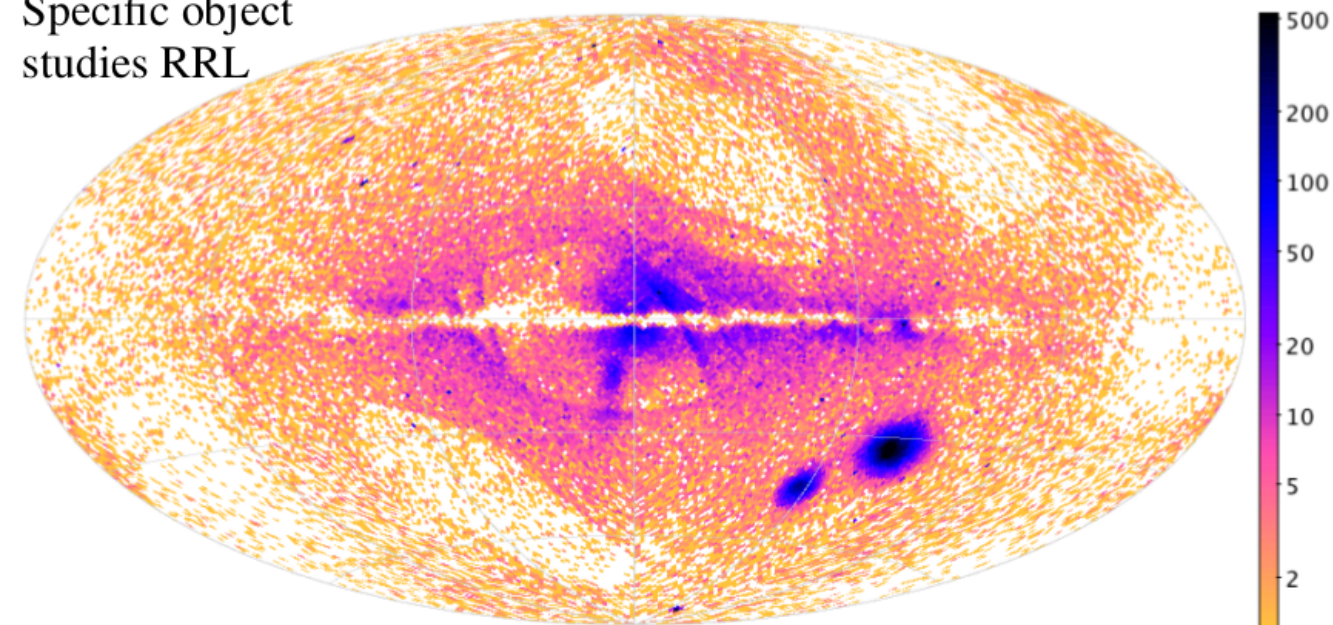


More than 7 million Vr

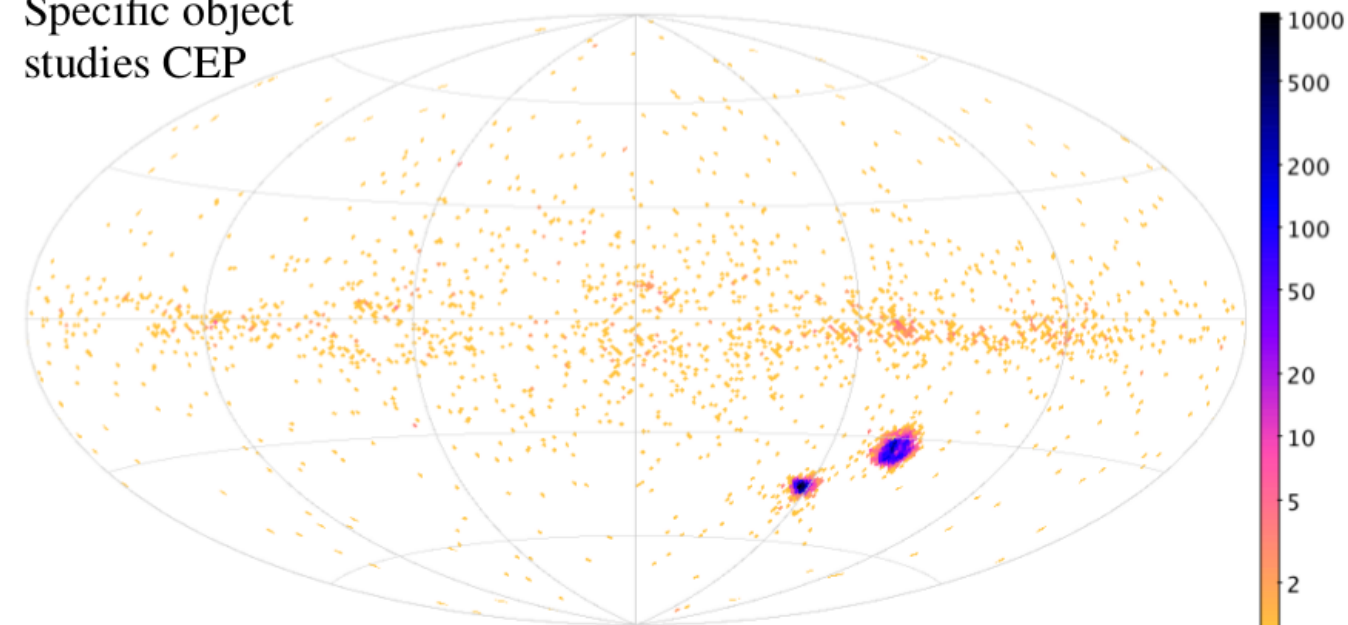
- Only for $\sim 3550 < T_{\text{eff}} < 6900$ K
- Zero point at ~ 0.1 km/s
- Systematics as a function of magnitude
- Potential contamination in crowded regions (See dr2-known-issues, *Boubert et al. 2019*)

DR2 variables

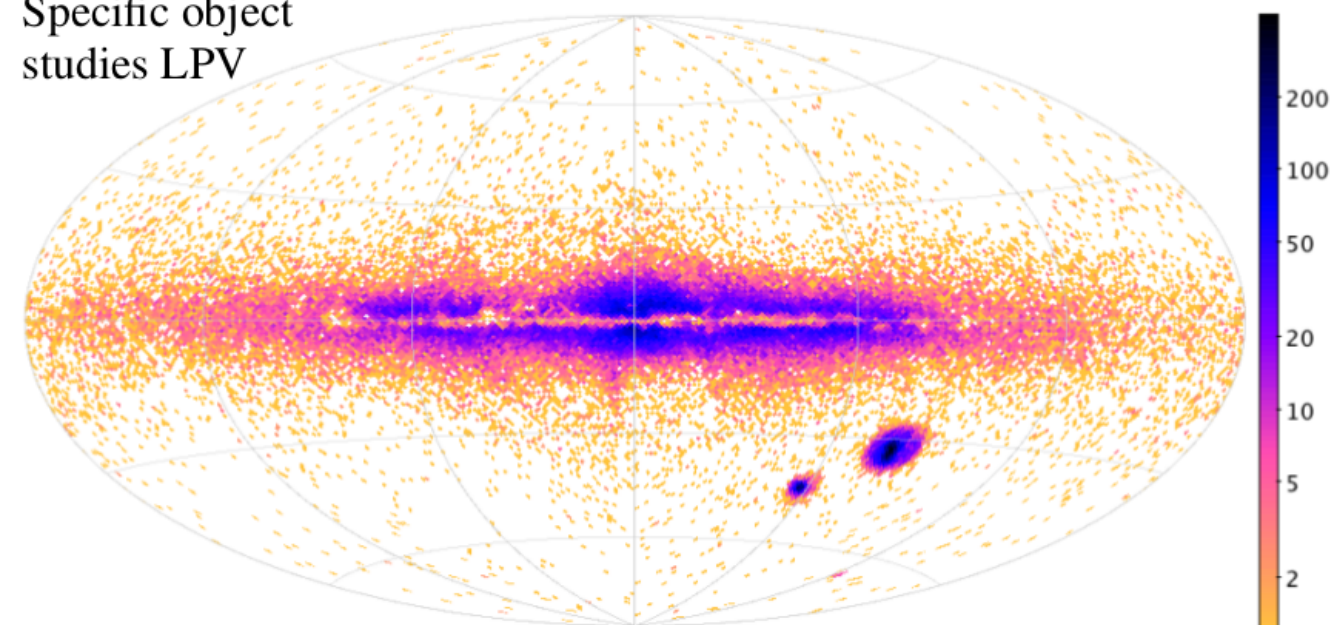
Specific object
studies RRL



Specific object
studies CEP

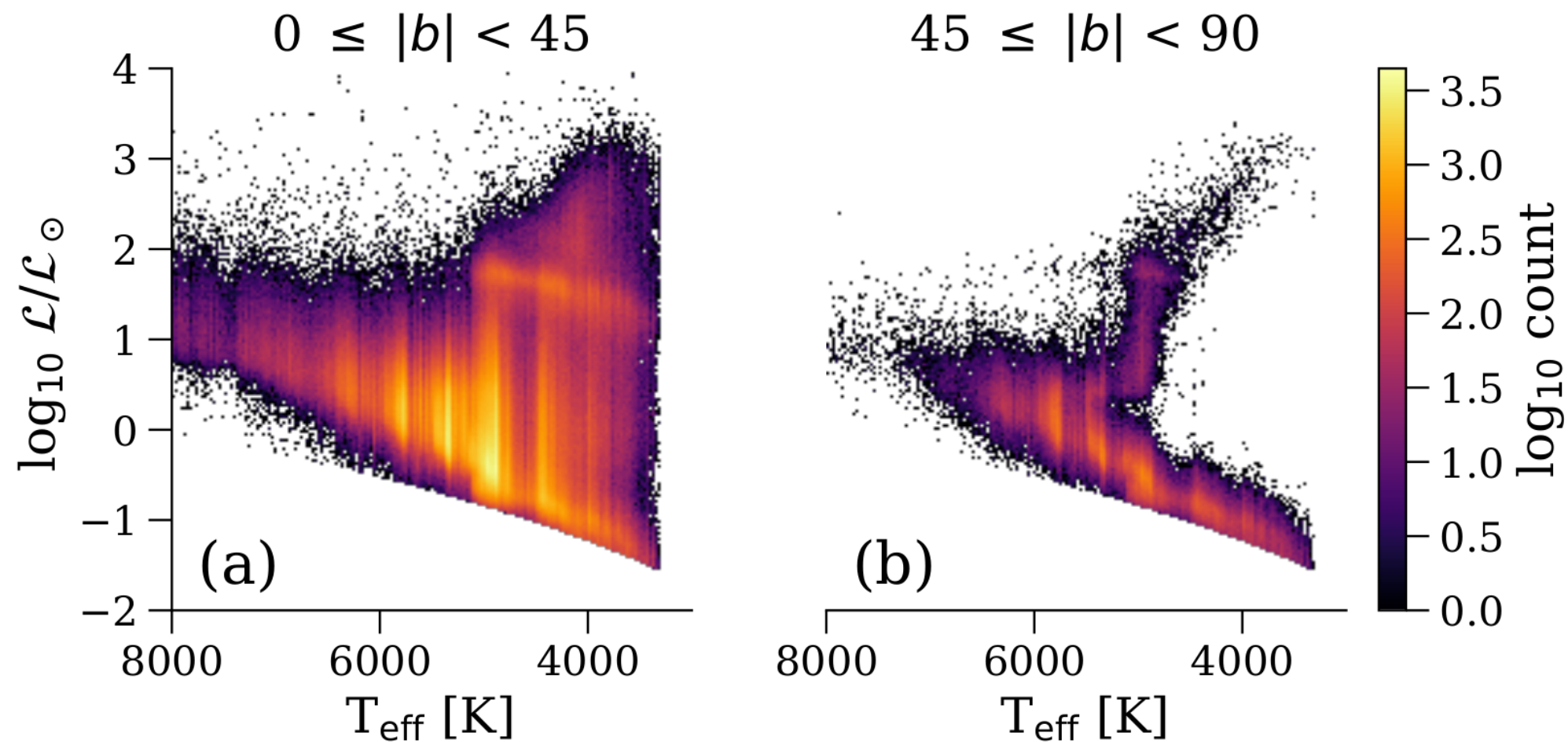


Specific object
studies LPV



- 551 thousand variables identified
 - ▶ many more to come in future
- Subset classified by variability type
 - ▶ based on 2+ transits
- Overlapping subset studied in detail
 - ▶ based on 12+ transits

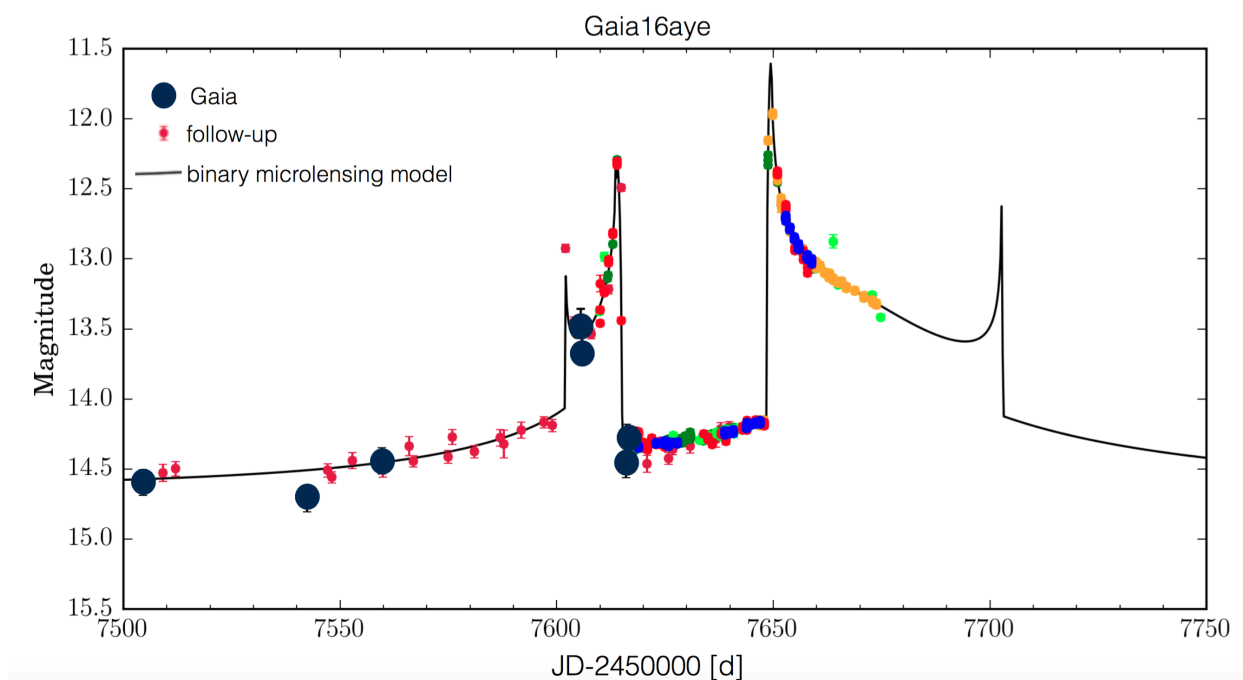
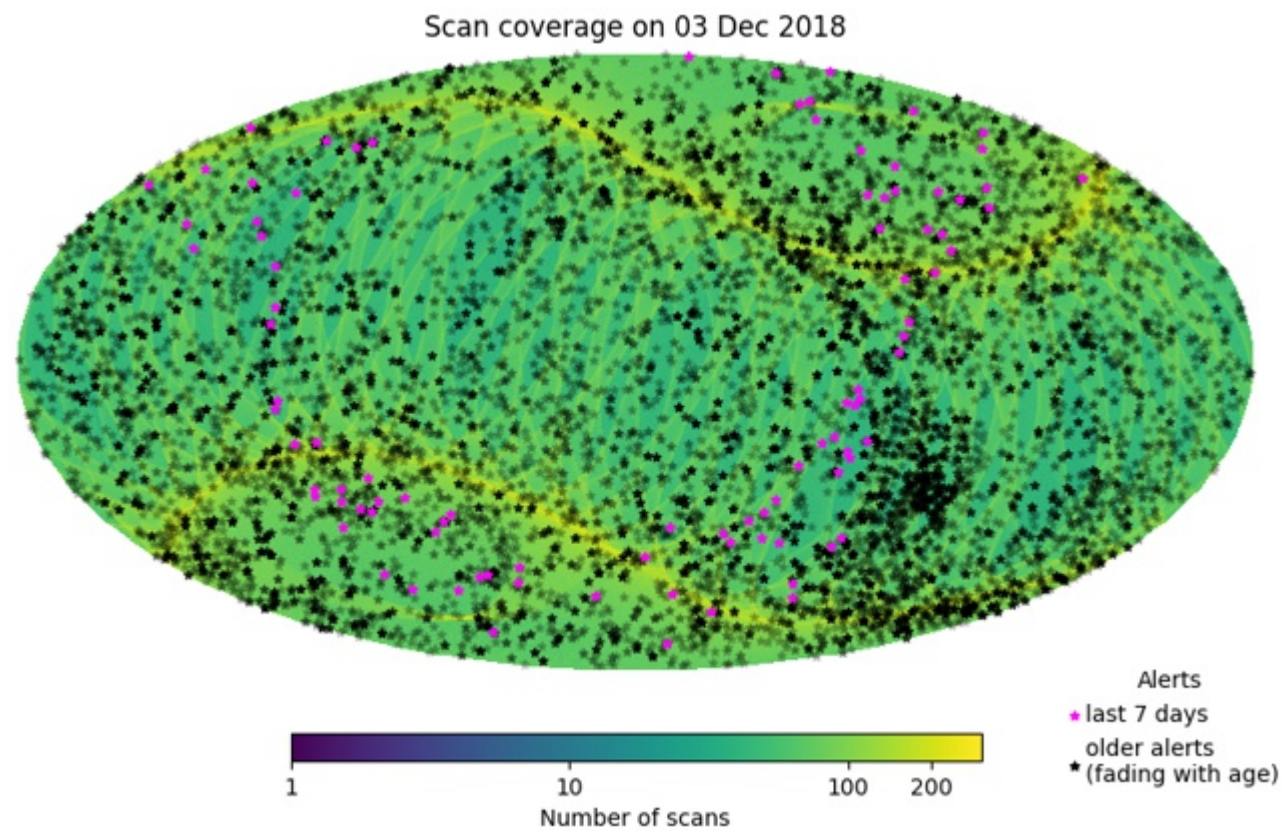
DR2 astrophysical parameters



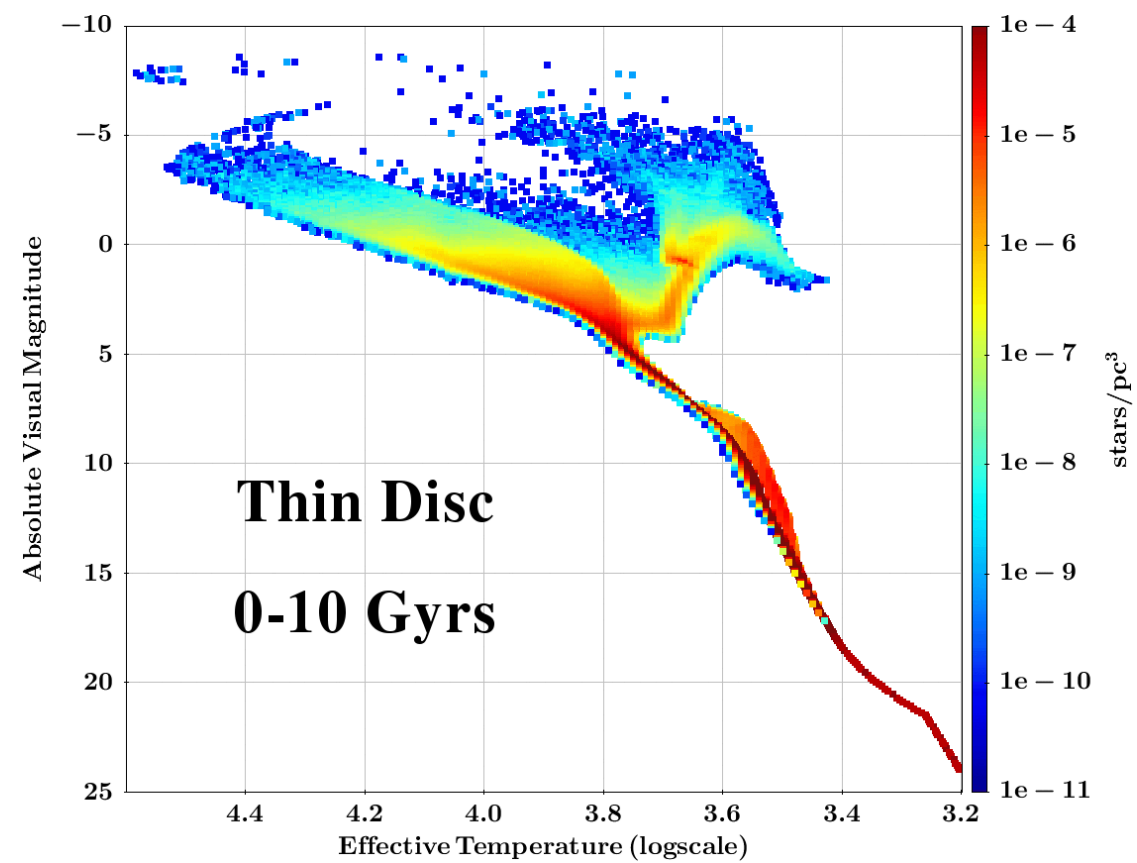
T_{eff} , A_G , $E(G_{\text{BP}} - G_{\text{RP}})$, luminosity, radius based only on G , G_{BP} , G_{RP} and parallax
→ strong degeneracies

Gaia Photometric Science Alerts

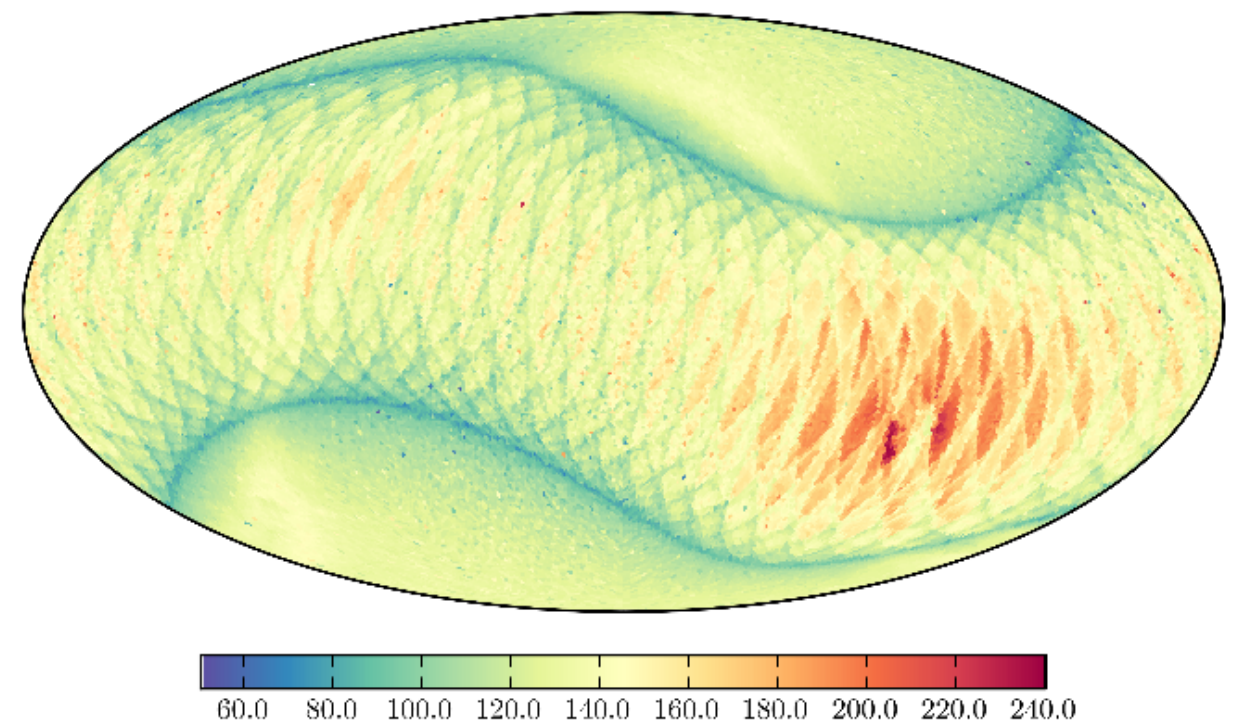
started publishing alerts in July 2014



Gaia Simulations



GUMS (Robin et al. 2013)



GOG (Luri et al. 2014)

<https://wwwhip.obspm.fr/gaiasimu/>
TAP queries, HDF5 format

Gaia EDR3/DR3 schedule

Same input data
Same source list

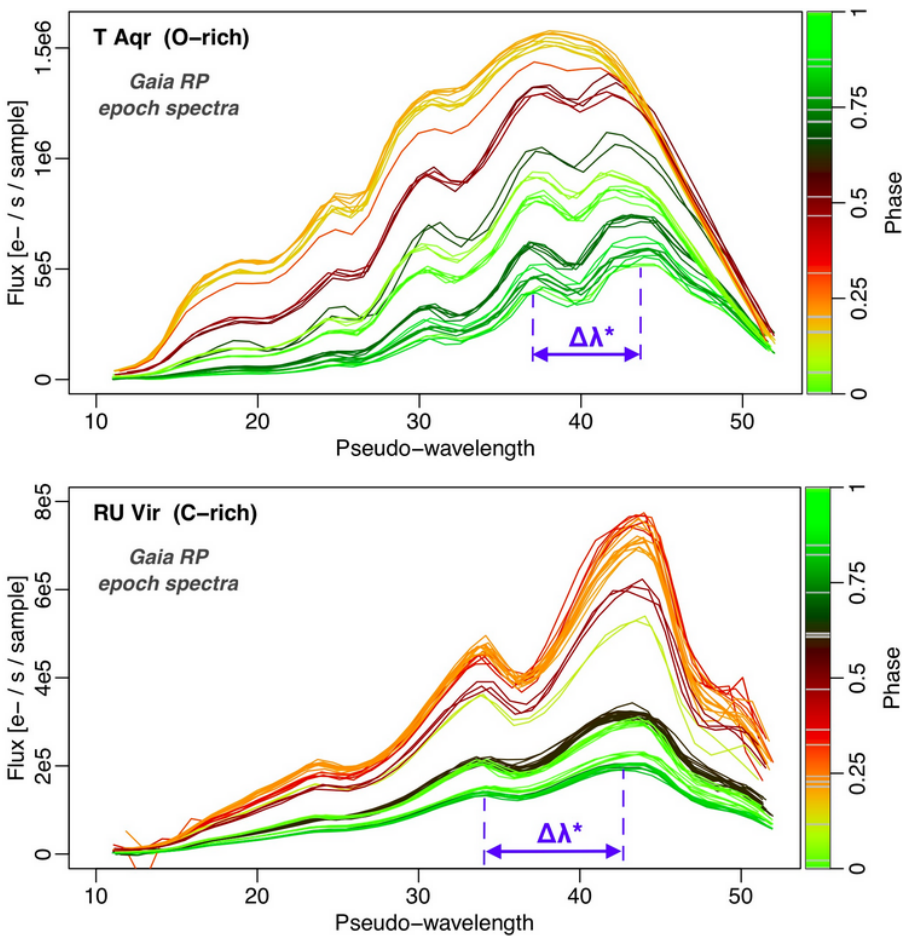
	DR2 (25 April 2018)	EDR3 (Q3 2020)	DR3 (second half 2021)
Parallaxes and proper motions	Full Sample	++ Incl. RUWE, image quality	
Photometry	G, GBP, GRP	++	
Variables	550 000		Eclipsing, transients, pulsating, spotted, evolved, quasars
Radial velocities	RVs at $G \lesssim 12$		RVs goal $G \lesssim 14$
SSOs	pre-selected asteroids		New SSOs
Astrophysical parameters	for $G < 17$: T_{eff} , A_G Radii and luminosities <i>from integrated phot</i>		Classification + parameters from <i>BP/RP</i> & <i>RVS spectra</i> (A_0 , logg, [M/H], [X/H])
Non-single stars	-		Astrometric, spectroscopic, eclipsing binaries
Extended objects		QSO and galaxy morpholy (input list)	
Spectra	-		Mean BP/RP spectra Mean RVS spectra
Epoch data	-		-

+ passbands, X-match, Gaia-CRF, DR2-toDR3 match table

Gaia DR4

	DR3 (2021)	DR4 (TBD)
Parallaxes and proper motions	Full Sample	++
Photometry	G, G _{BP} , G _{RP}	++
Variables	~ 7 million	All
Radial velocities	RVs goal $G \lesssim 14$	All
SSOs	~100 000	All
Astrophysical parameters	Classification + parameters from <i>BP/RP</i> & <i>RVS</i> spectra (A_0 , logg, [M/H], [X/H])	++
Non-single stars	Astrometric, spectroscopic, eclipsing binaries	All (incl. exoplanets)
Extended objects	Selected QSO and galaxy	Image reconstruction
Spectra	Mean BP/RP spectra Mean RVS spectra	All
Epoch data	-	All (astrometry, photometry, BP/RP & RVS spectra)

All data from the nominal mission



ESA/Gaia/DPAC, Mowlavi et al.

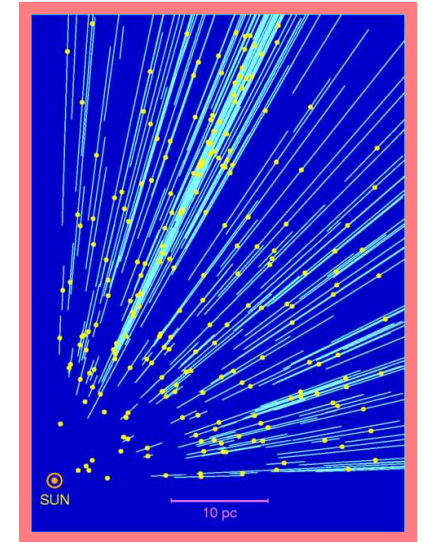
Mission Extension

- Nominal mission ends mid-2019 (5 years of measurements)
 - Mission can continue to ~ end-2024 (limiting factor: micro-propulsion fuel)
→ **5 year extension** proposal to ESA (preliminary approval to end 2022)
-
- Parallaxes, photometry, radial velocities **improve by 40%** with respect to DR4
 - Proper motions improve by factor of 2.8 with respect to DR4
Improvement of **more complex motions** (e.g., planets) up to factors of 20
 - Accurate tangential motions over $22.6\times$ **larger volume**

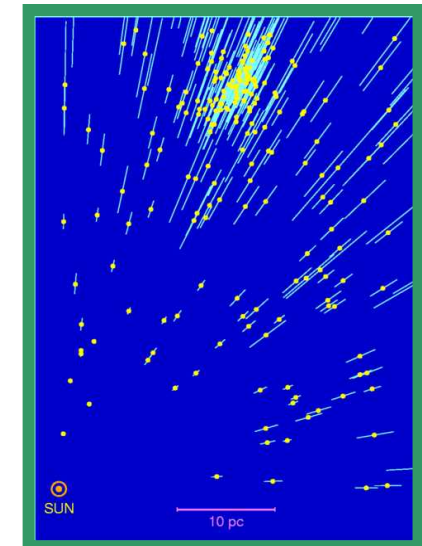
Your papers are the best argument for an extended mission



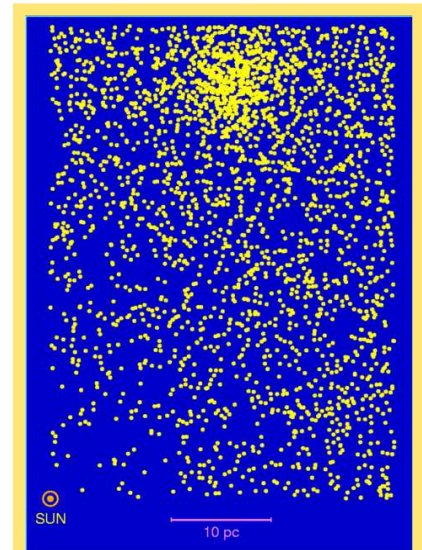
Hyades



1960



1990 (Hipparcos)



2023 (Gaia)

- Stay tuned:
<https://www.cosmos.esa.int/web/gaia/dr2-known-issues>
- Acknowledge DPAC/ESA's work
<https://gea.esac.esa.int/archive/documentation/credits.html>
- Communicate your Gaia results:
<https://www.cosmos.esa.int/web/gaia/communicating-your-results>

Gaia DR2 Science applications

~ 2 papers / day on astro-ph using Gaia DR2

