

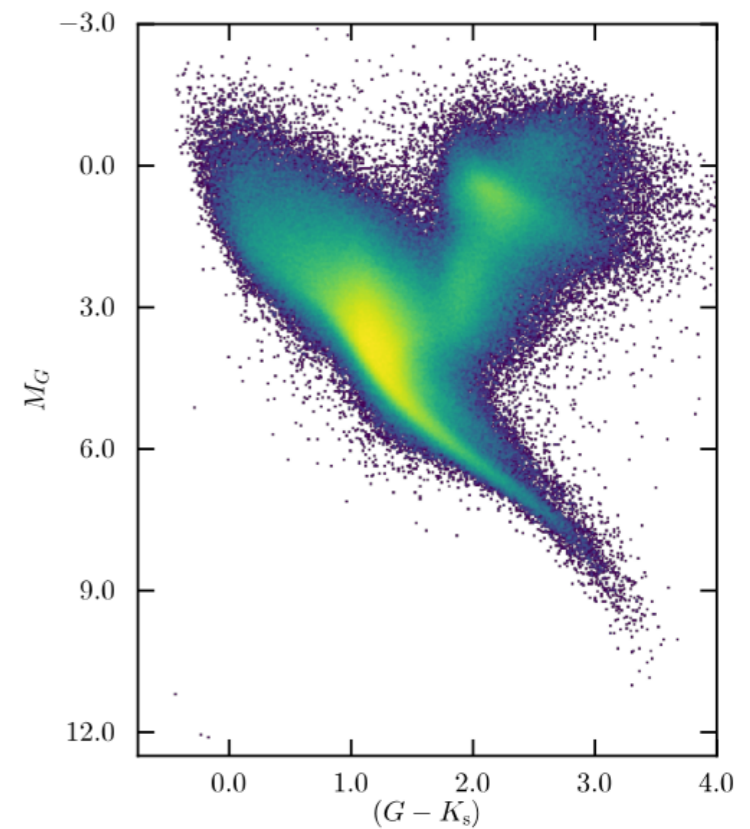
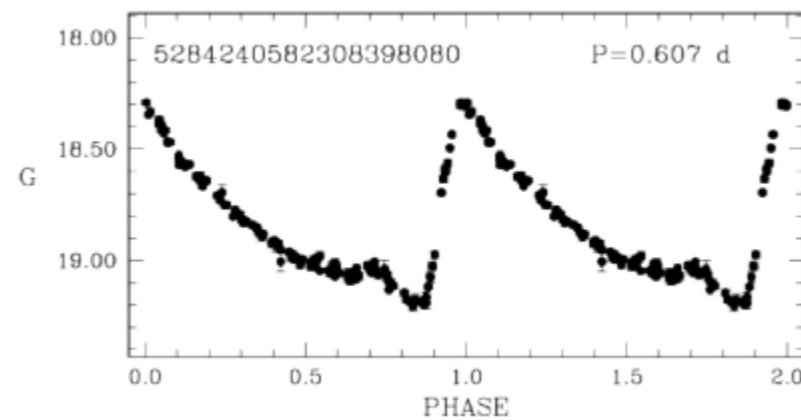
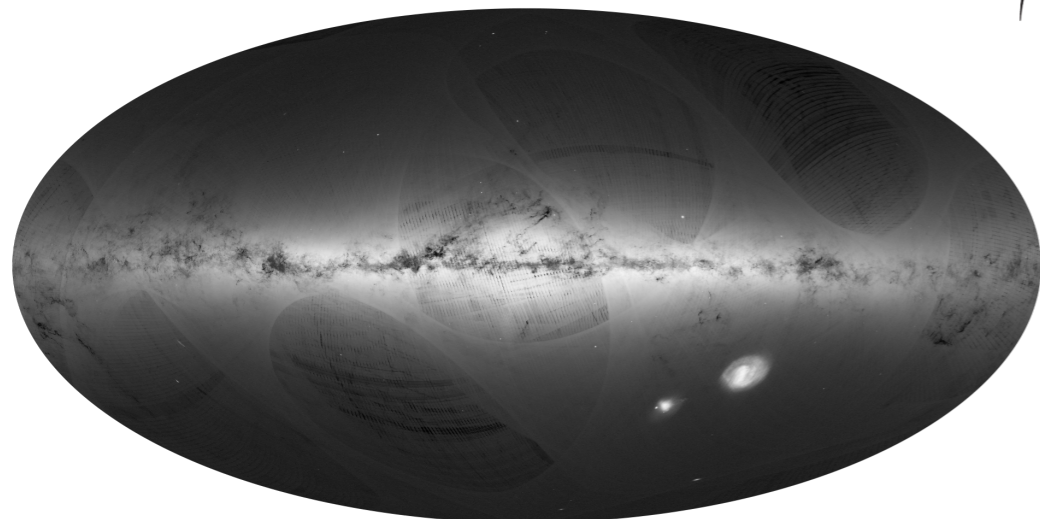


Gaia

DR1 PNCG science overview

DR2 preview

Carine Babusiaux



The Gaia mission

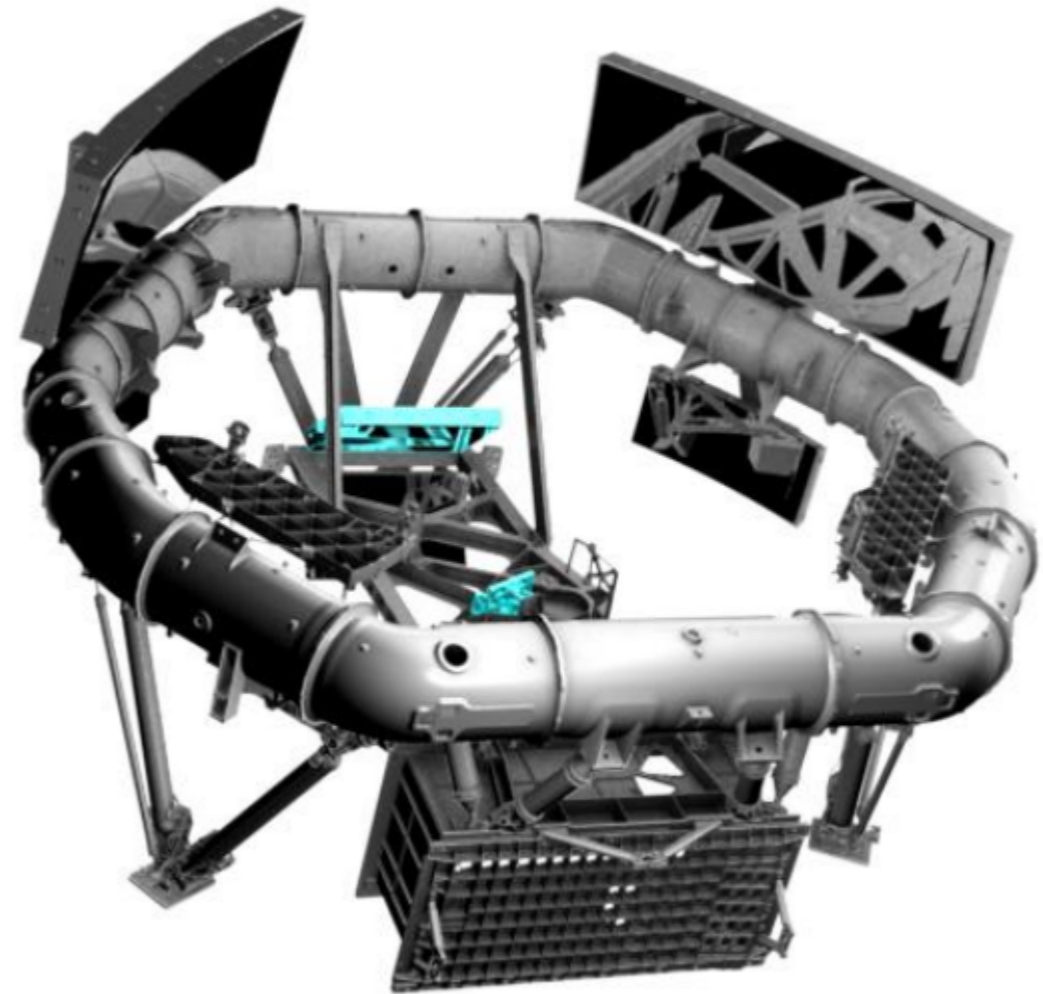
ESA cornerstone mission

5 years of mission, launched in 2013

3 instruments

- Astrometry
- Spectrophotometry
- Spectroscopy (RVS)

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



The Gaia schedule

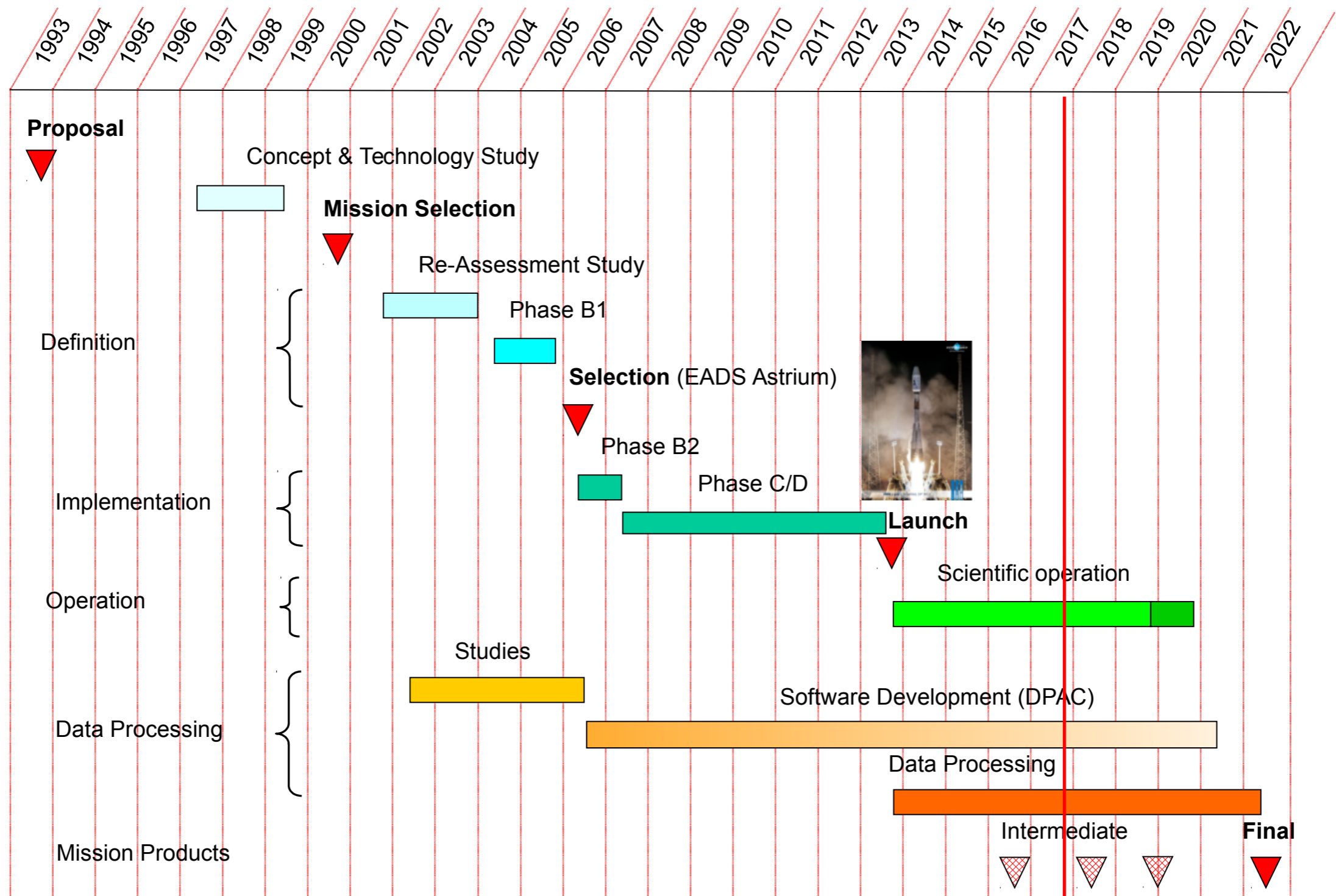
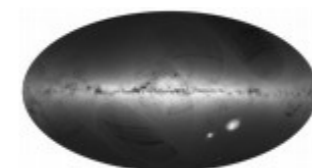


Figure adapted from Michael Perryman and François Mignard

Today



Gaia DR1 Data access

Main portal: `http://archives.esac.esa.int/gaia`

- Online documentation, VO compatible, TAP interface, visualization apps
- Pre-computed cross-match to large catalogues: UCAC4, 2MASS, SDSS, GSC2, WISE, PPMXL, URAT1

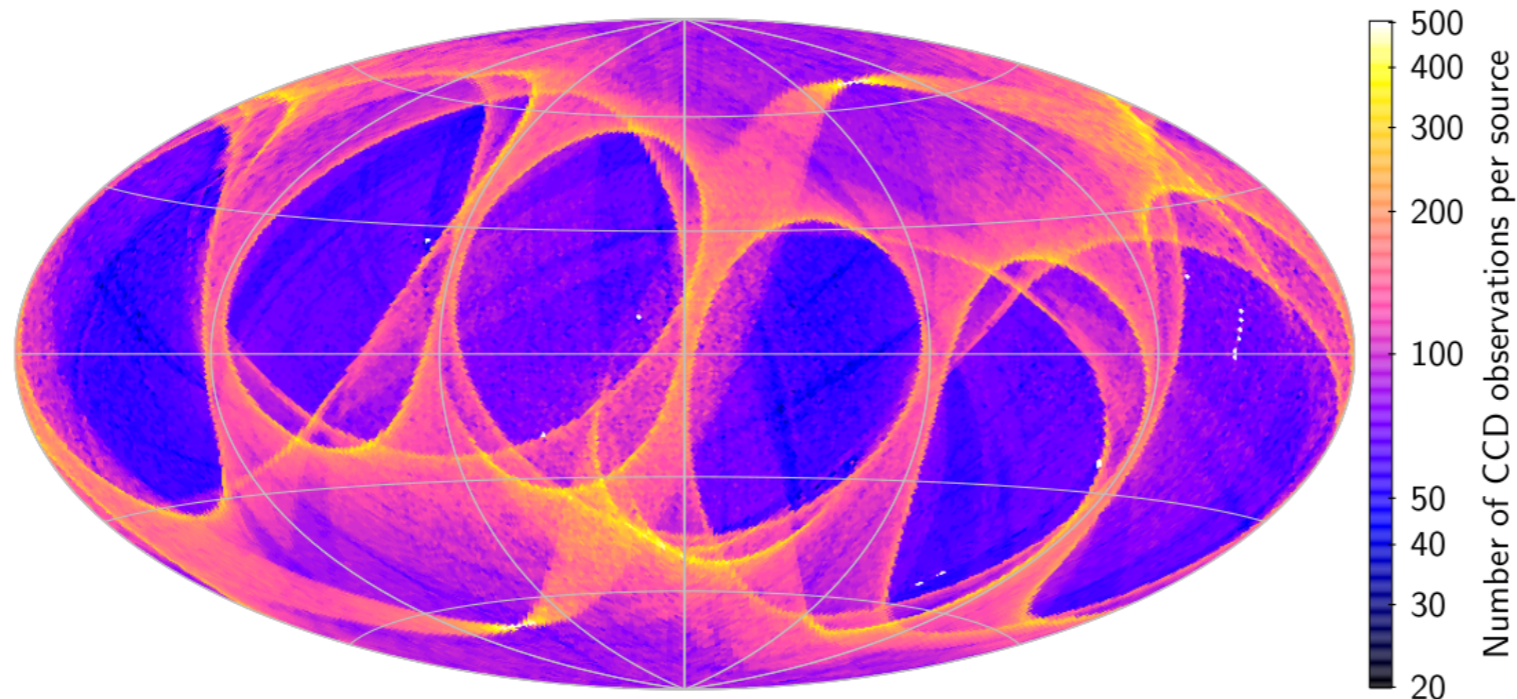
Partner data centres

CDS: `http://cds.unistra.fr/gaia`

...

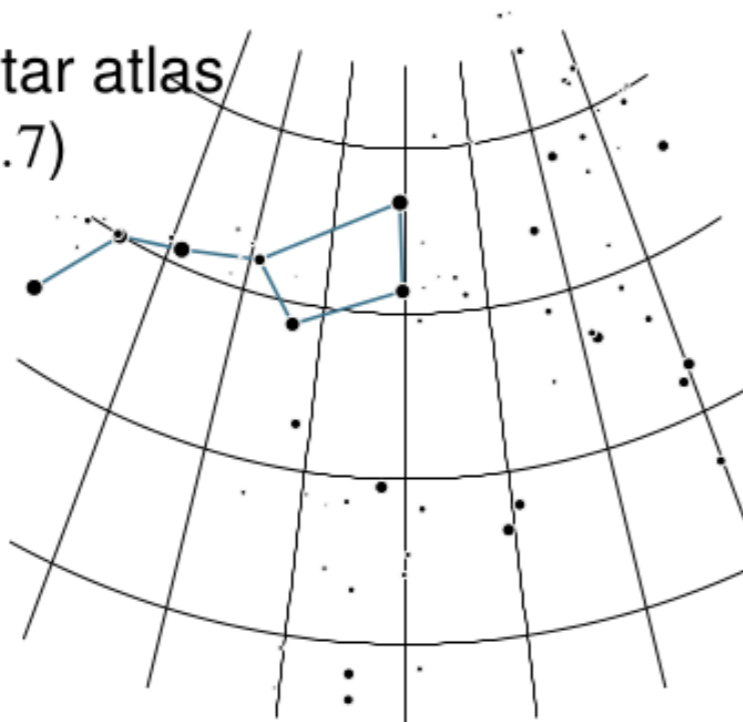
Gaia DR1 input data

- 14 months of input data used
- $\sim 2.3 \cdot 10^{10}$ transits (1 month EPSL than Nominal Scanning Law)
- all sources treated as single stars
- uncomplete calibration, sub-optimal cross-match
- TGAS: bright stars position prior from Hipparcos / Tycho-2

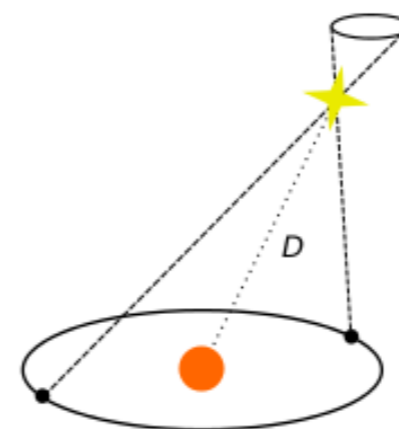


What's in the Gaia DR1 delivery

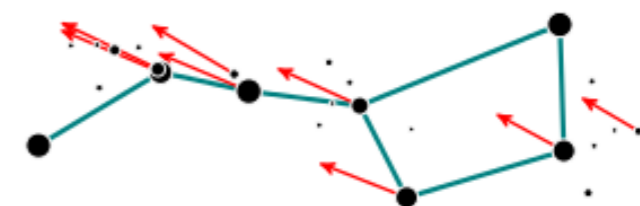
Billion star atlas
($G \lesssim 20.7$)



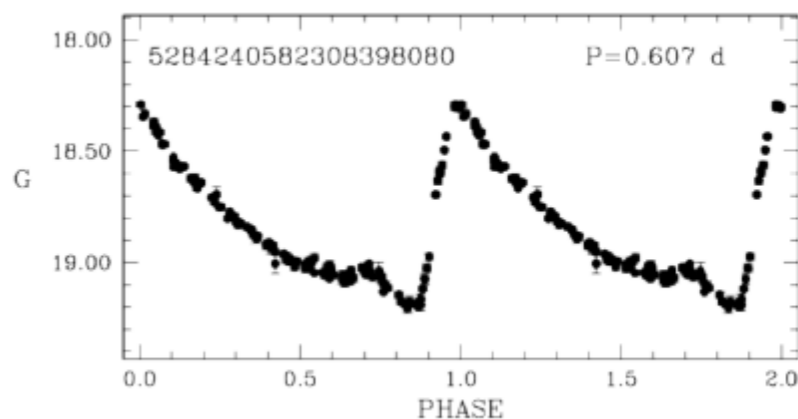
Positions (~ 10 mas)
G photometry (syst. 3 mmag)



Tycho-Gaia
Astrometric Solution
(~ 2 million, $G \lesssim 12$)

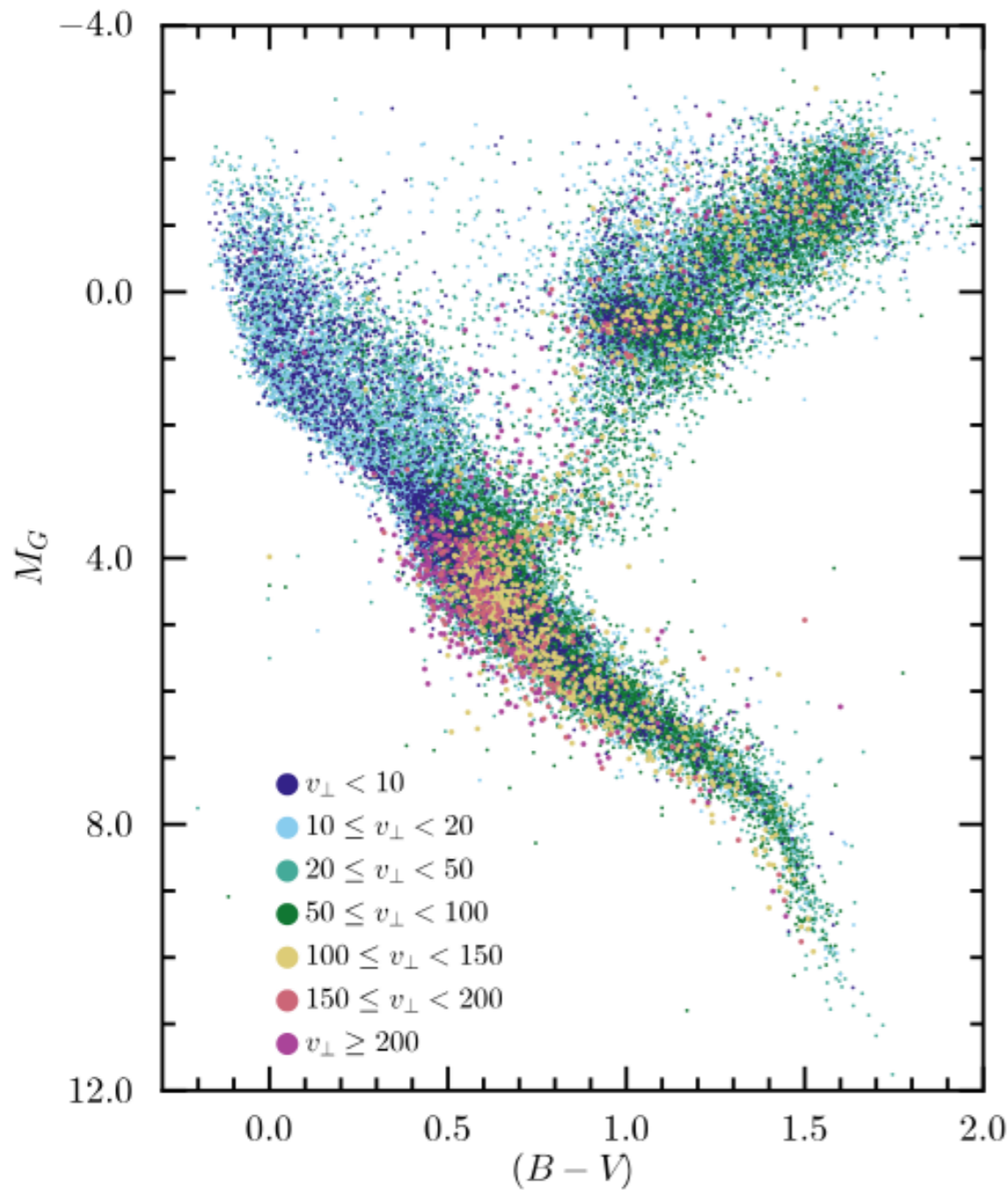


Parallaxes & Proper motions
(\sim uncertainty & systematics 0.3 mas,
zero point ~ 0.04 mas)



Variable stars near
south ecliptic pole
(~ 600 Cepheids,
 ~ 2600 RR Lyrae)

TGAS HR diagram & tangential velocity

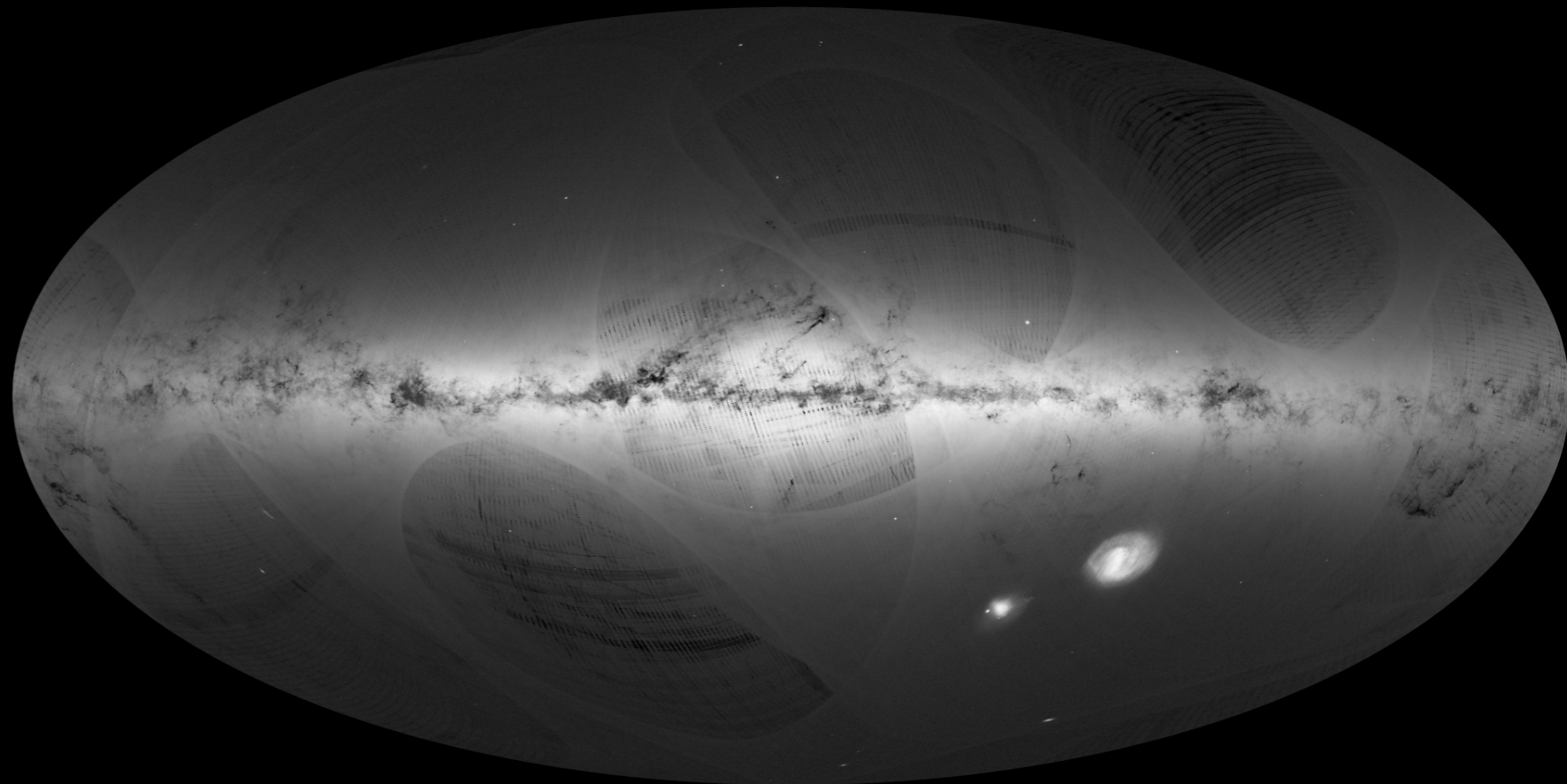


HR diagram colour coded by tangential velocity

- 41 136 stars with $(B - V)$ photometry selected according to: $G \leq 7.5$ or $\mu \geq 200 \text{ mas yr}^{-1}$ or $\varpi \geq 10 \text{ mas}$
- 90% inside 360 pc

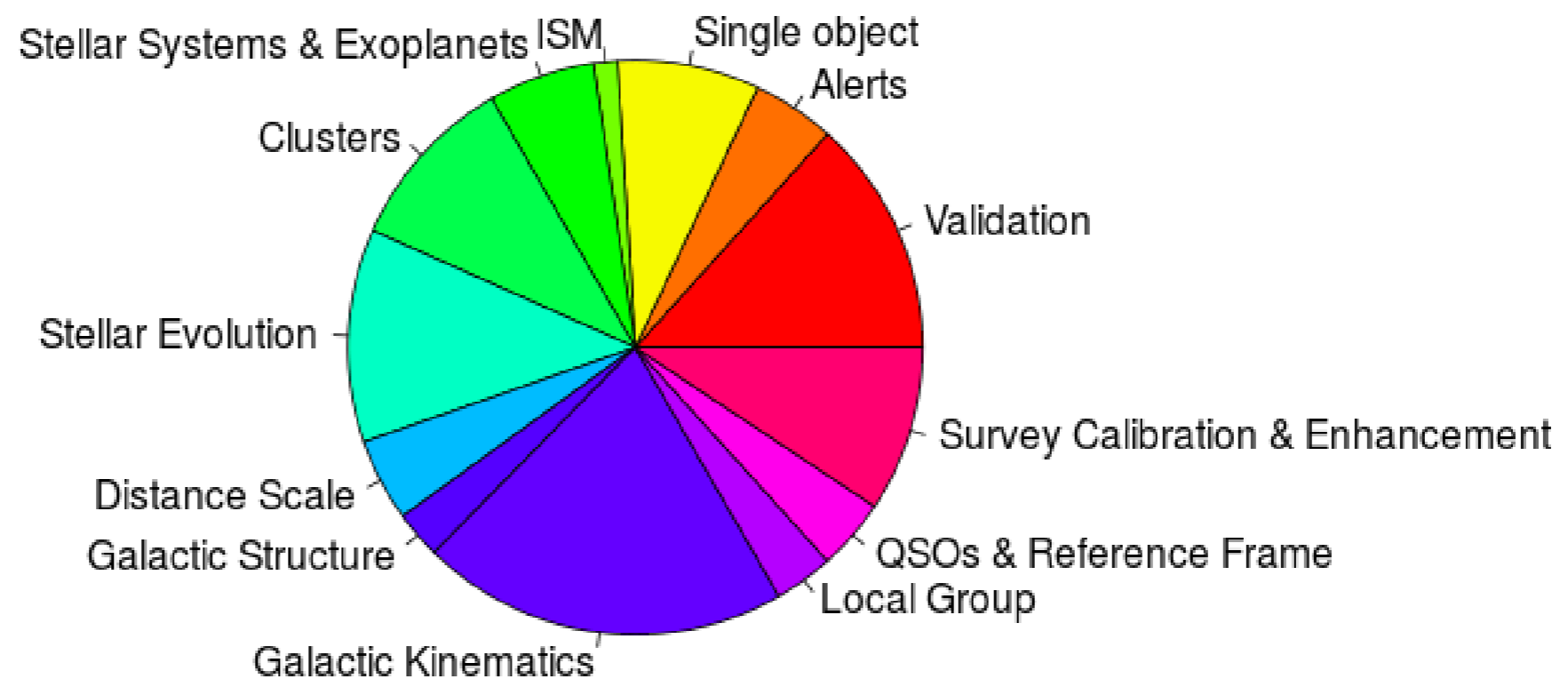
Gaia Collaboration, 2016, A&A

- Gaia DR1 content
- **First results**
- Gaia DR2 preview

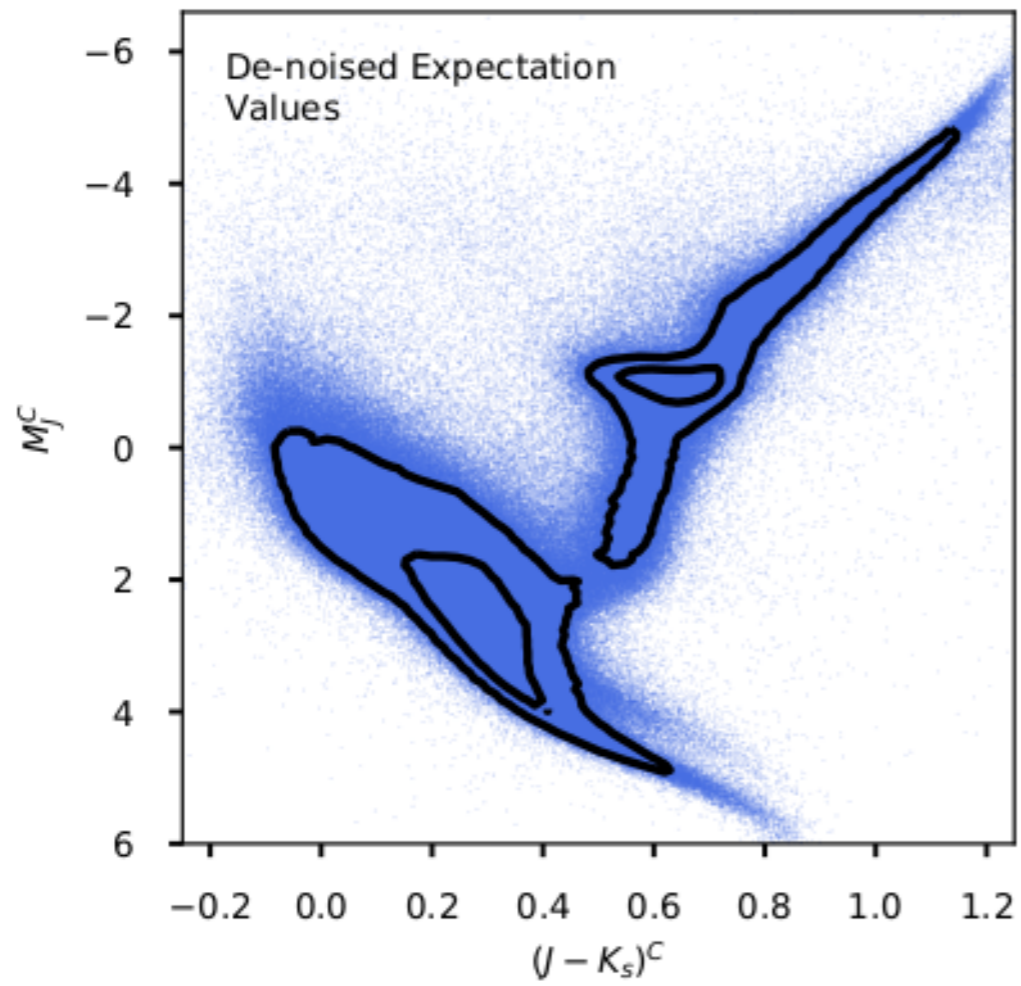


Gaia DR1 – current applications

More than 150 papers directly using Gaia DR1

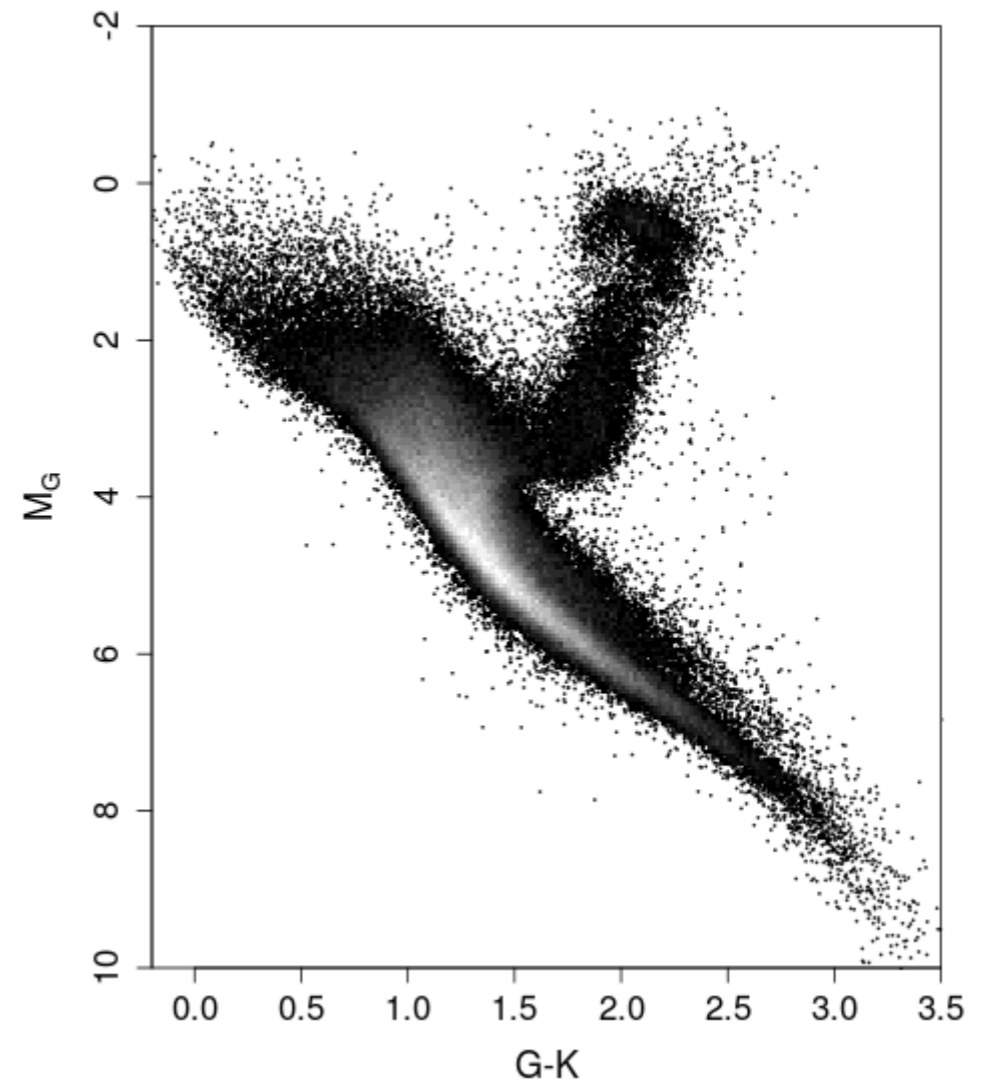


The Gaia TGAS HR diagram



Anderson et al. 2017

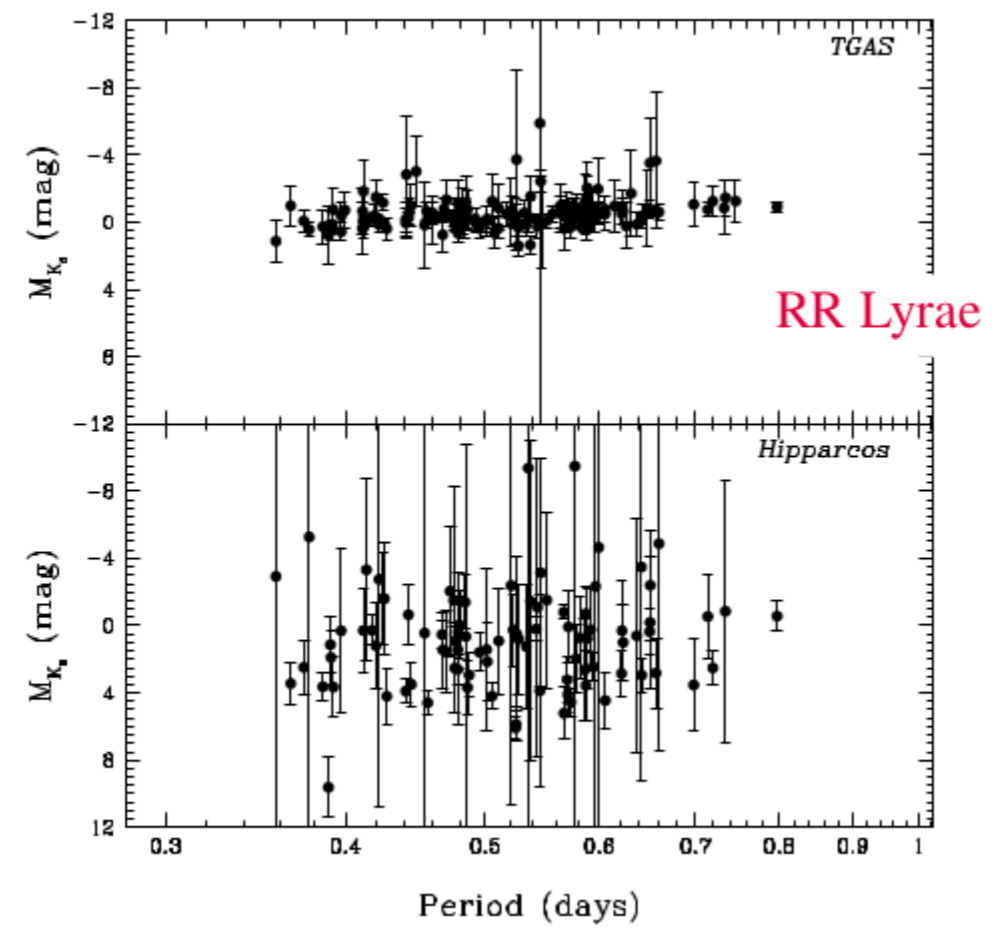
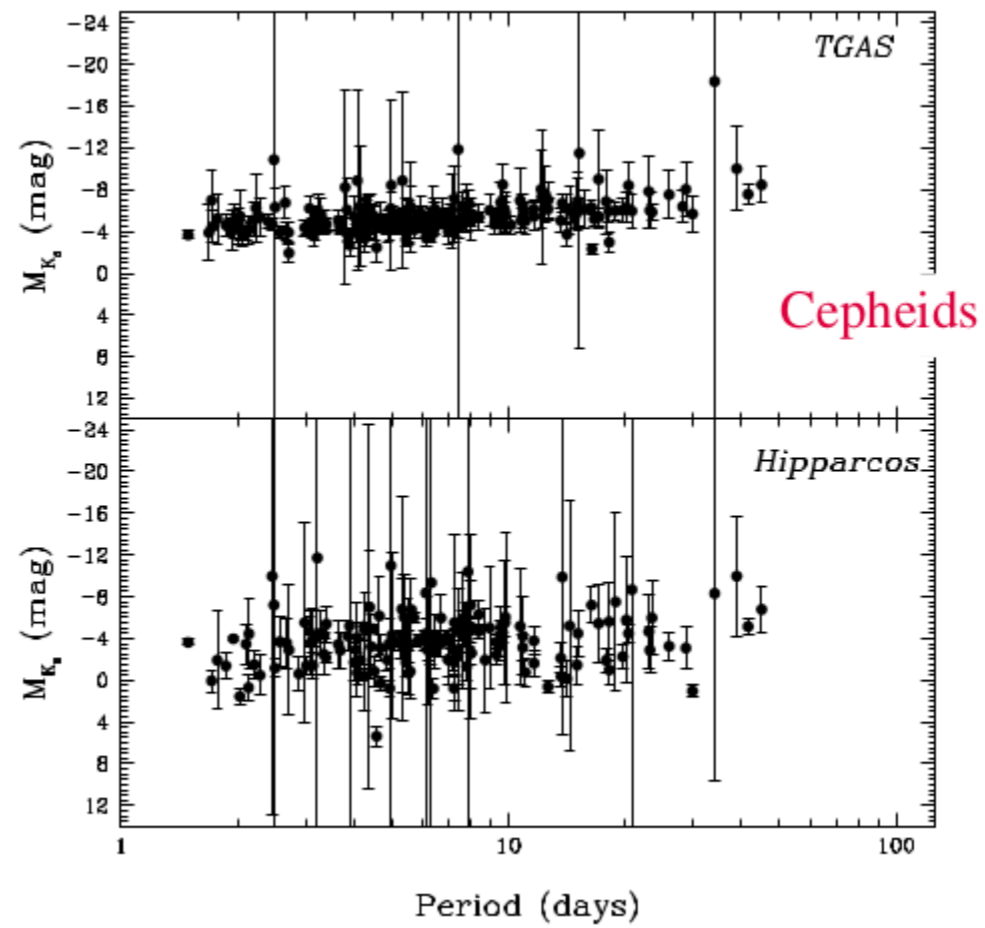
→ empirical Bayesian HRD



Ruiz-Dern et al. 2017

→ low extinction HRD

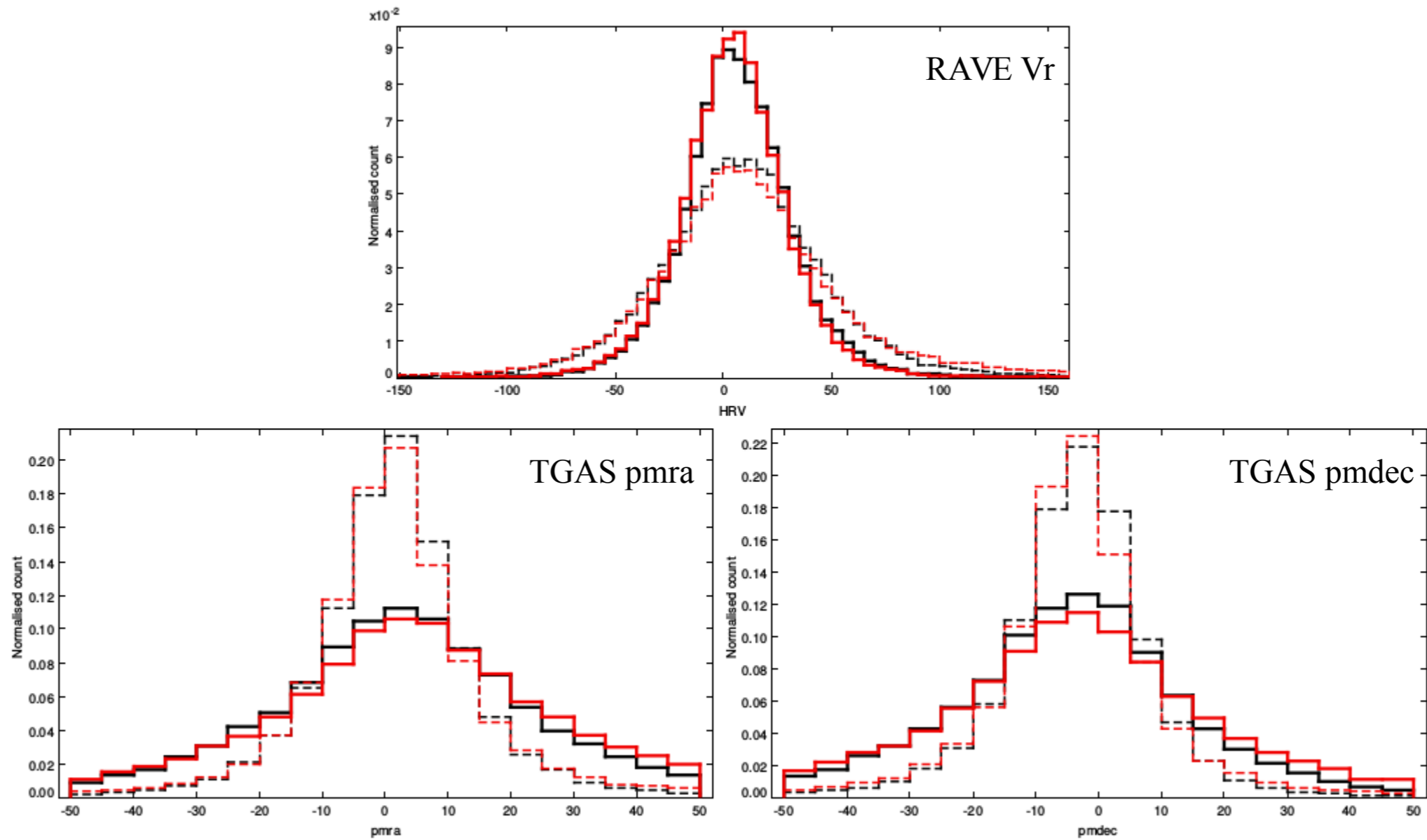
Cepheids and RR Lyrae



Gaia Collaboration, Clementini et al. 2017

Updates in the Besançon model kinematics

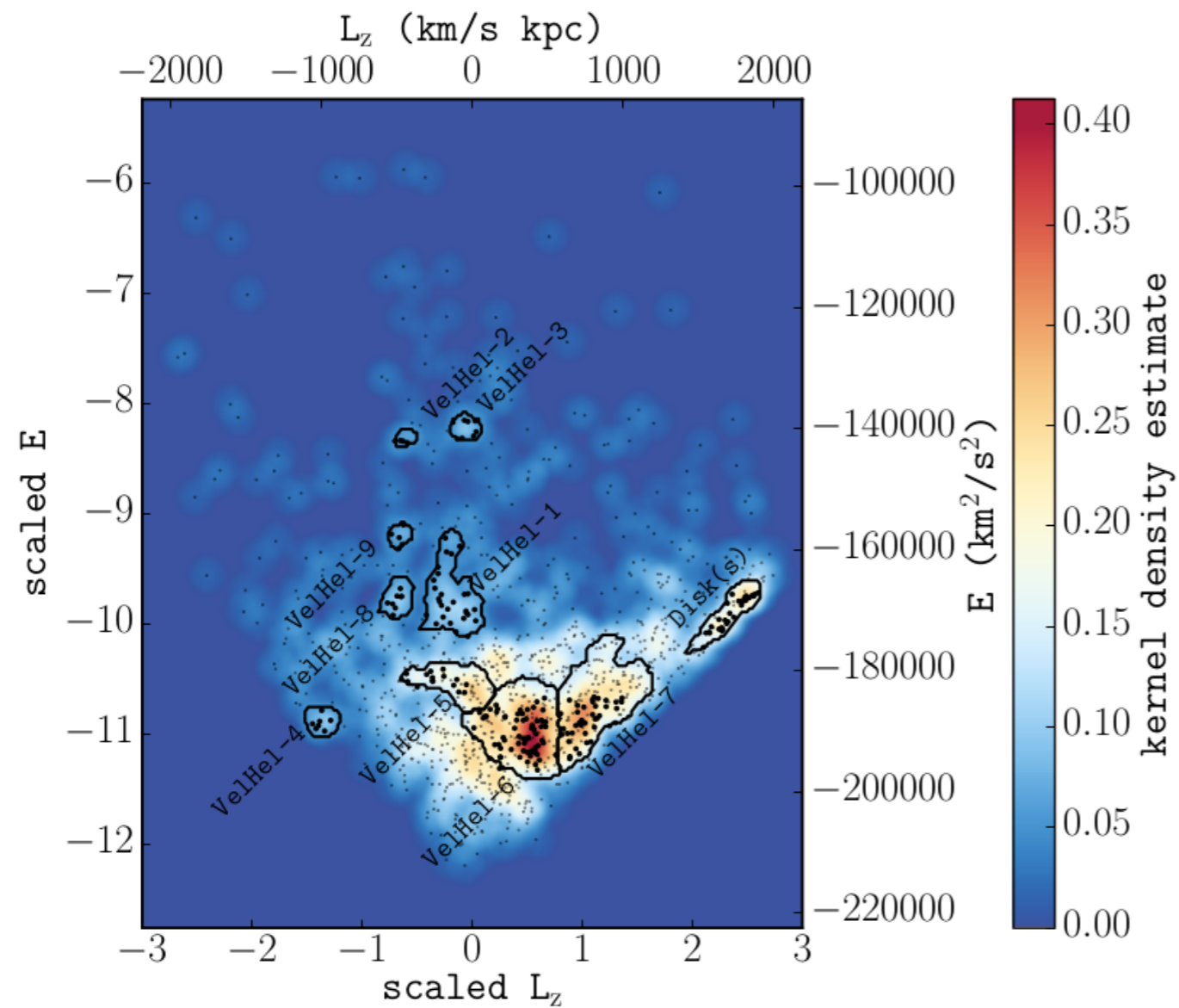
Gaia + RAVE



Robin et al. 2017

Substructures

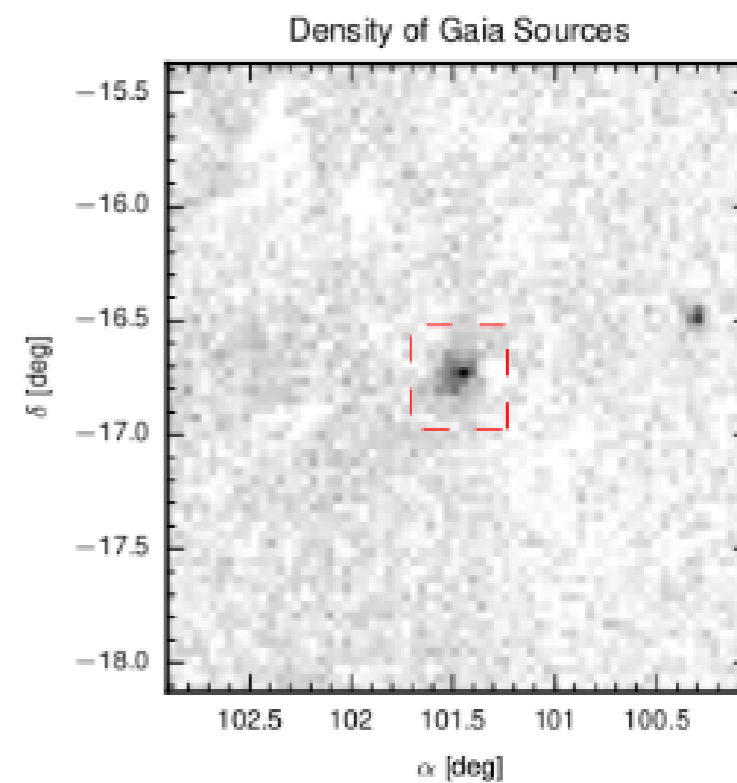
Gaia + RAVE



Helmi et al. 2017

→ kinematic substructures

Gaia 1 cluster hiding behind Sirius

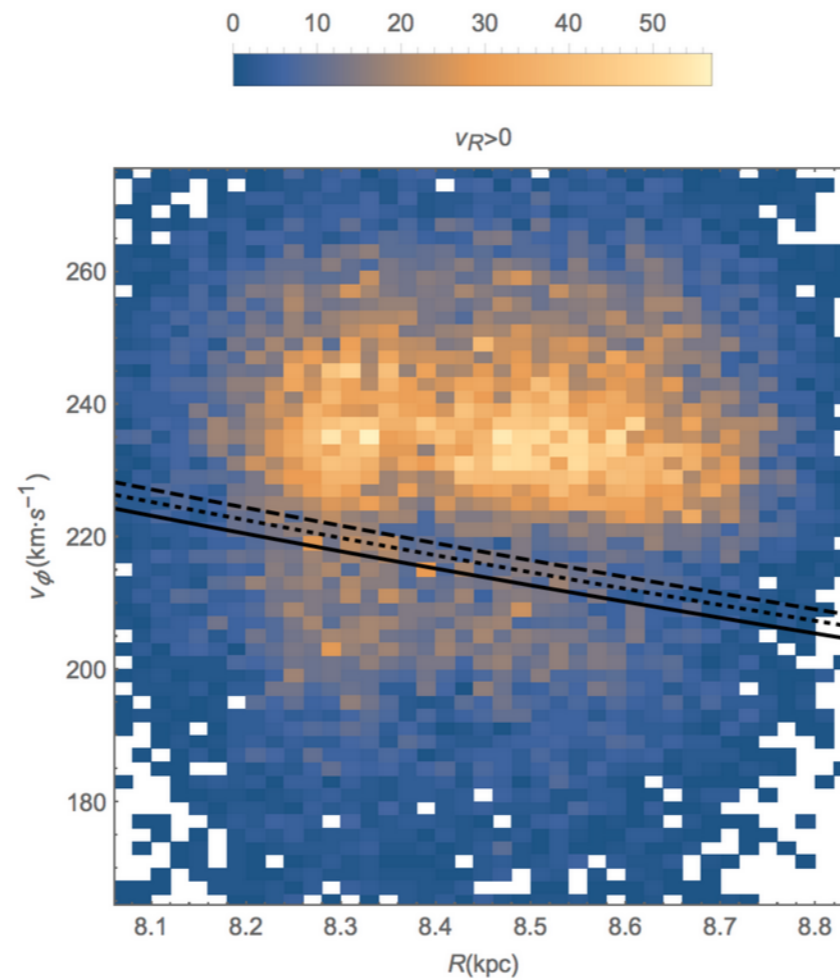


Koposov et al. 2017

→ sky density substructures

Bar and spiral arms kinematic signatures

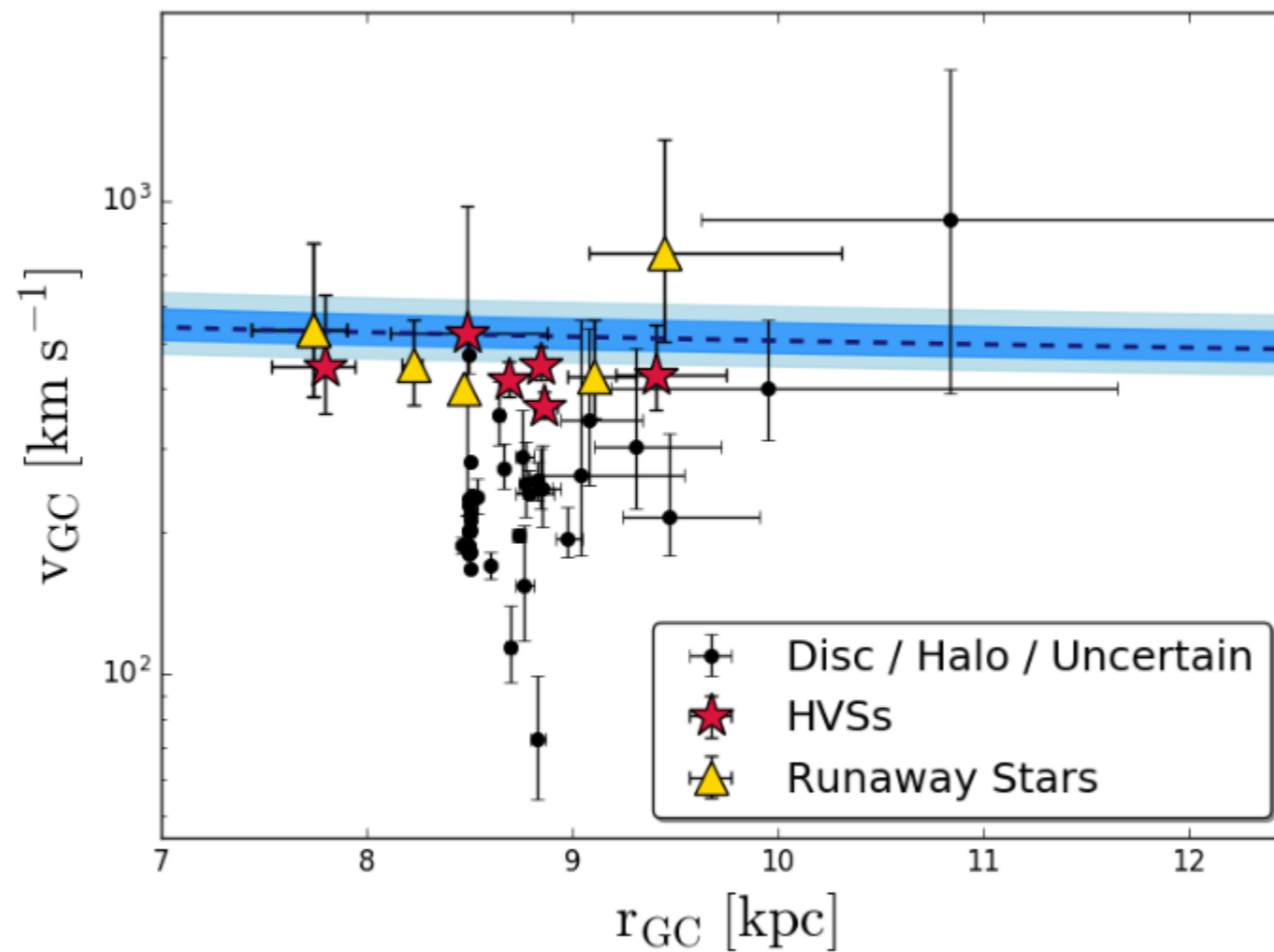
Gaia + LAMOST



Monari et al. 2017

→ signature of the fast rotation of the Galactic Bar in the outer Milky Way

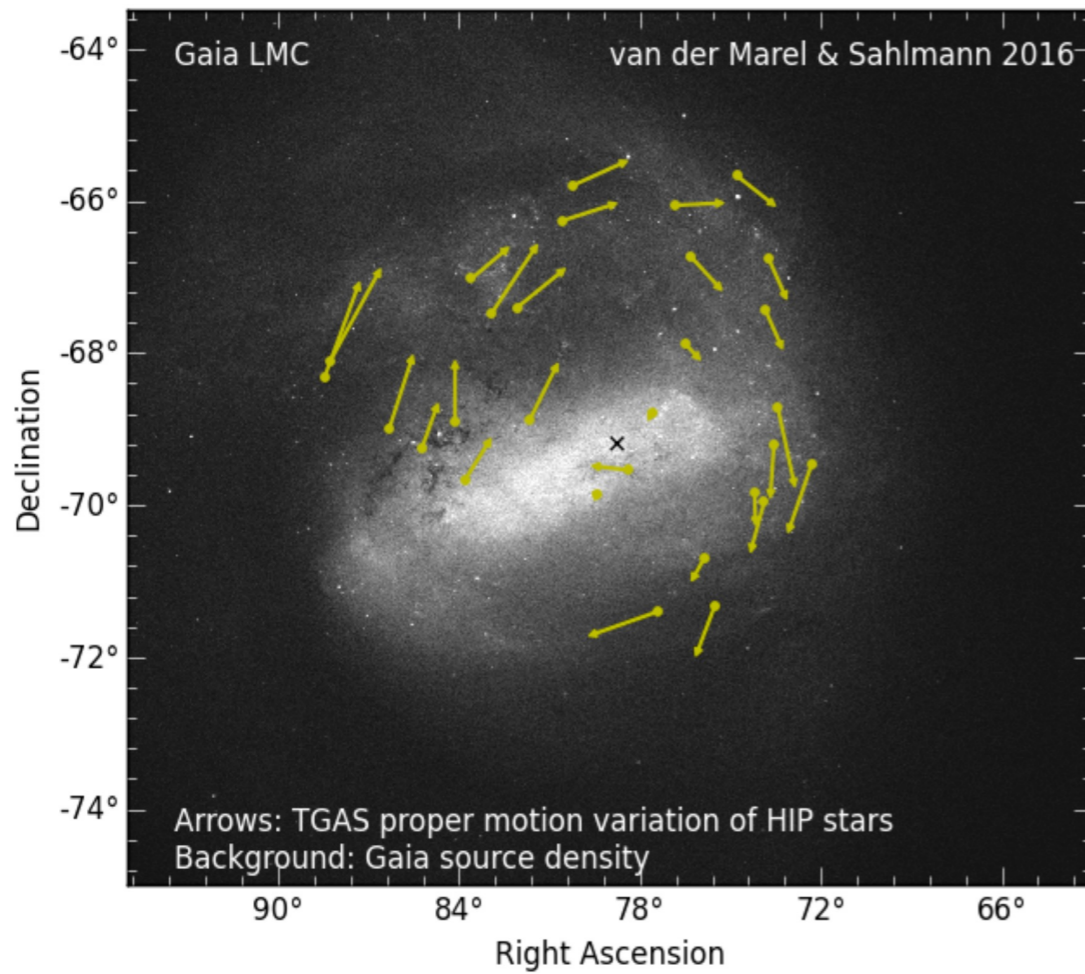
Hyper-velocity stars



Marchetti et al. 2017

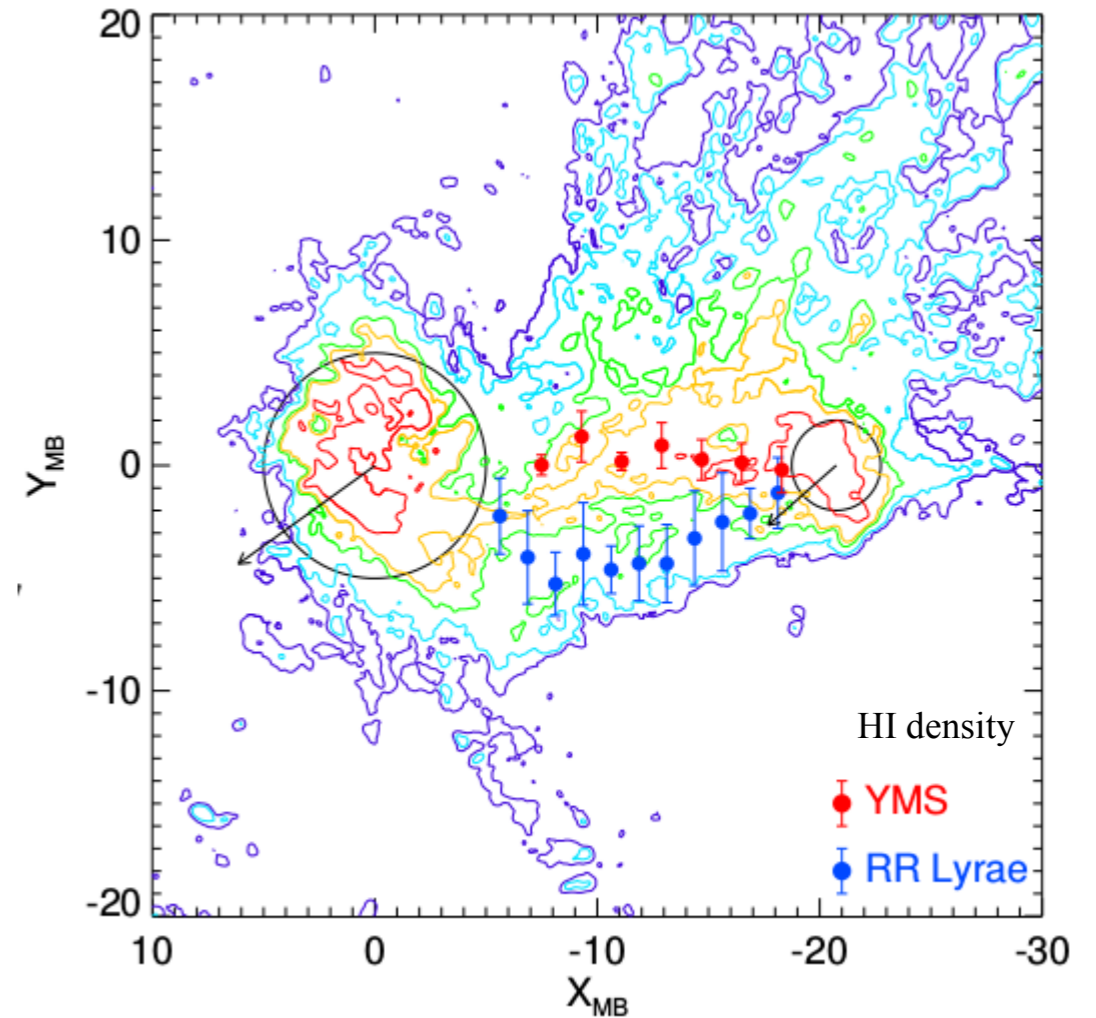
→ 5 run-away stars

Large Magellanic Cloud



Van der Marel & Sahlmann 2016

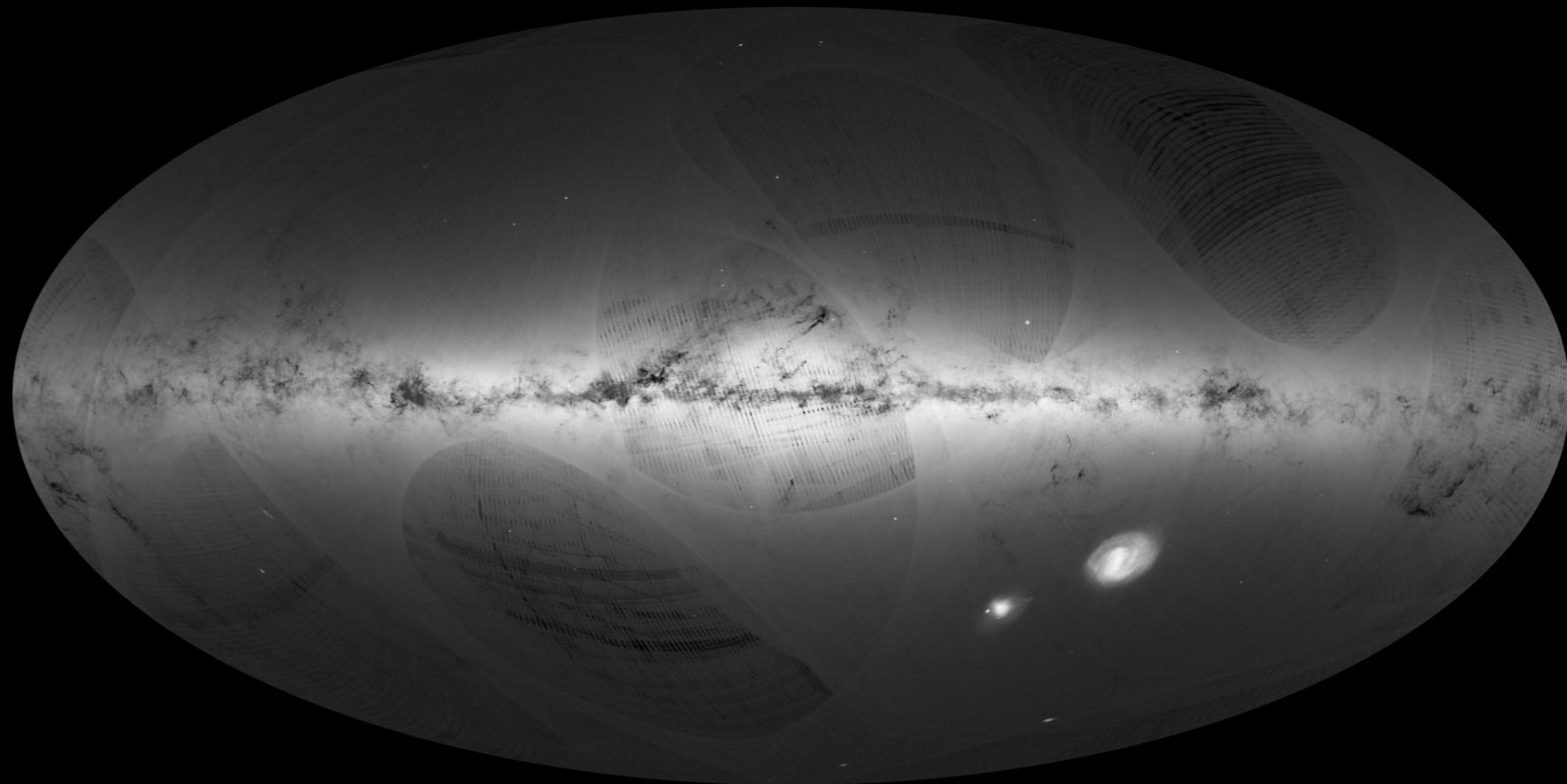
→ kinematics consistent with HST results



Belokurov et al. 2017

→ three Magellanic bridges

- Gaia DR1 content
- First results
- Gaia DR2 preview

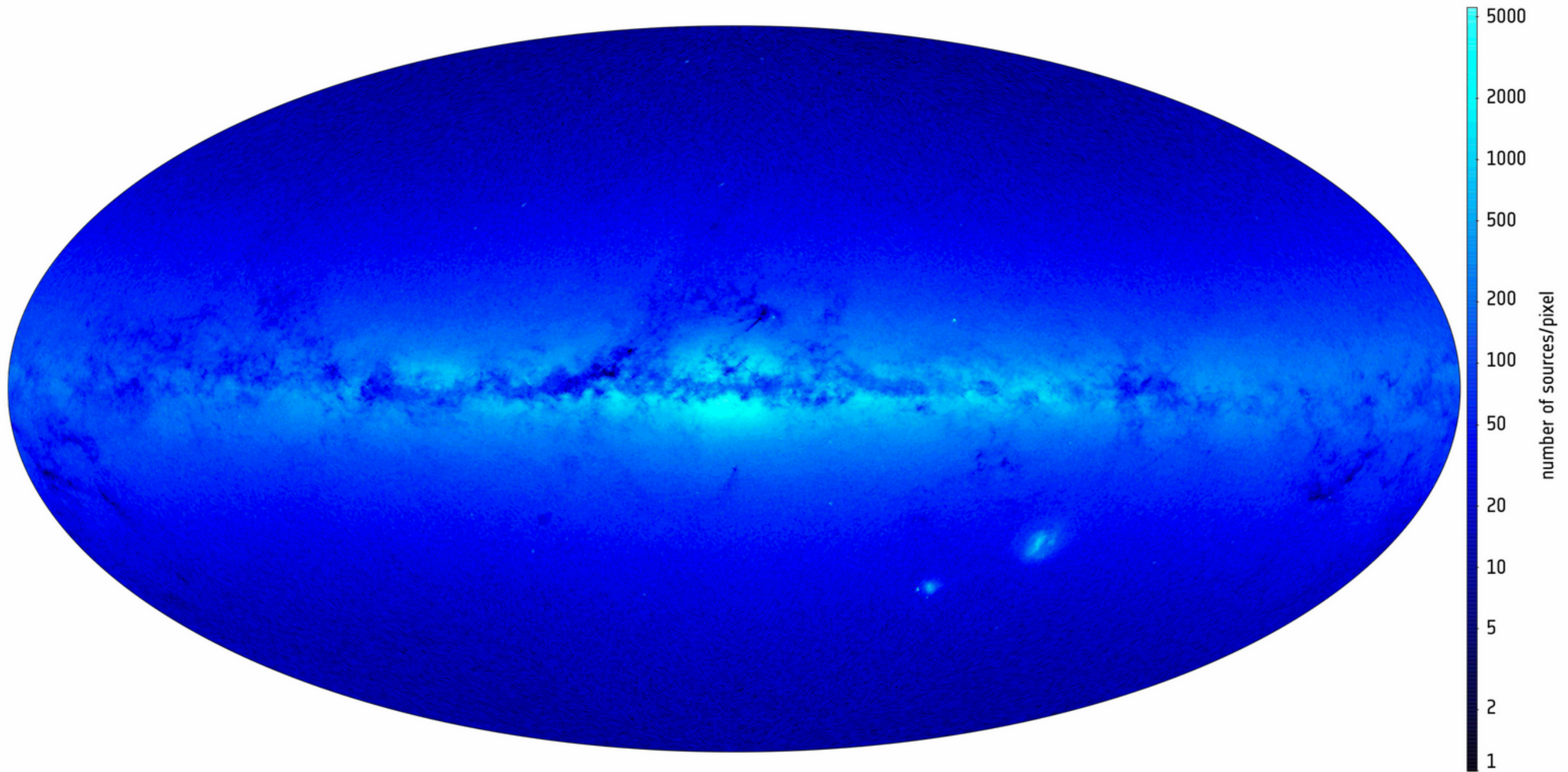


A big step from Gaia DR1 to DR2

	DR1	DR2
Input telemetry	14 months	22 months
Calibrations	Limited	Improved
Parallaxes and proper motions	Using Hipparcos/Tycho positions	Stand-alone for the full sample
Photometry	G	G, GBP, GRP
Variables	Small set	Much expanded
Radial velocities	-	RVs at $G_{RVS} < 12$
SSOs	-	Epoch astrometry for pre-selected asteroids
Astrophysical parameters	-	for $G < 17$: T_{eff} , possibly A_G Radii and luminosities for a subset

DR2 appetizer

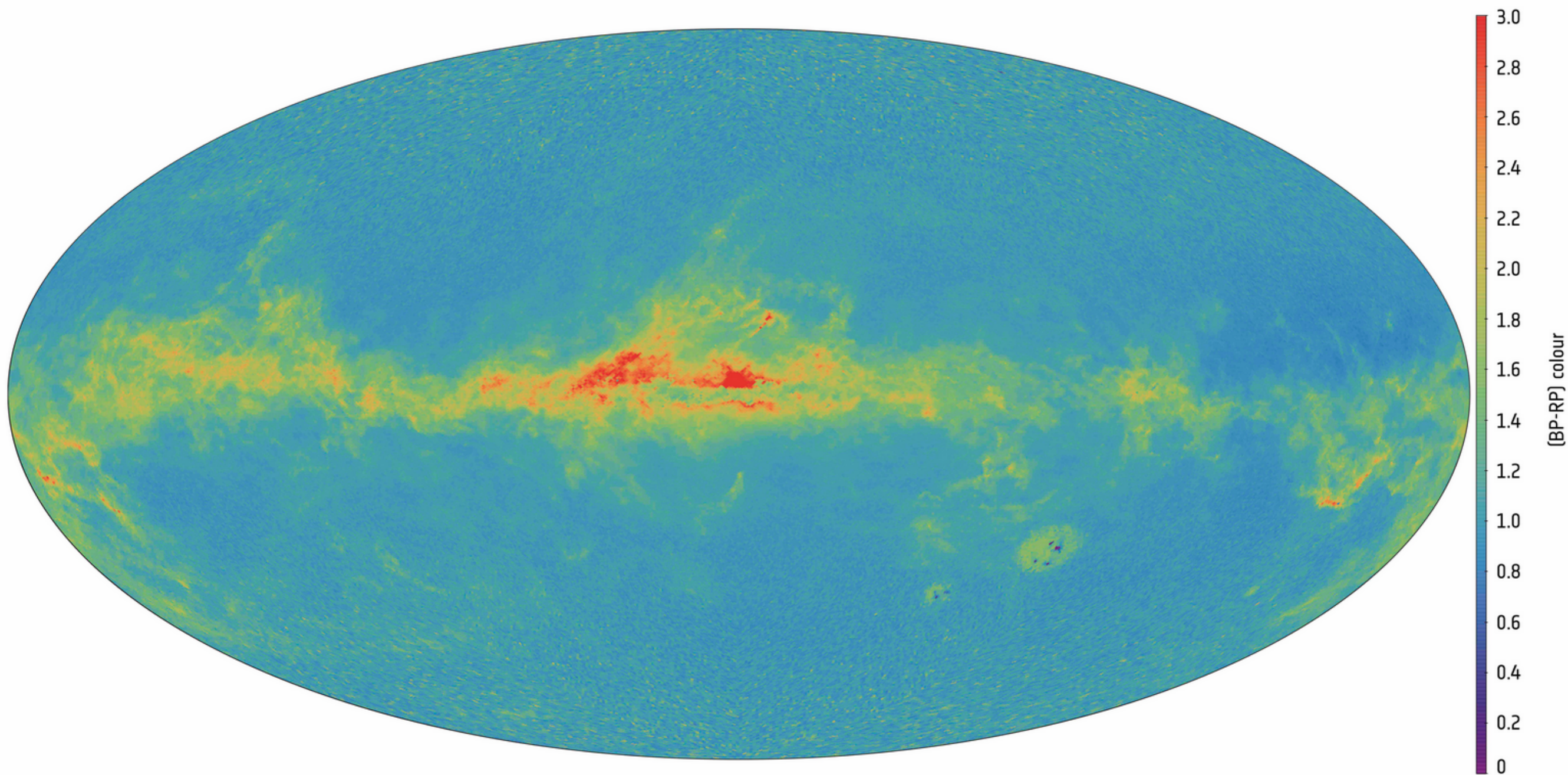
G<17 density plot



https://www.cosmos.esa.int/web/gaia/iow_20170816

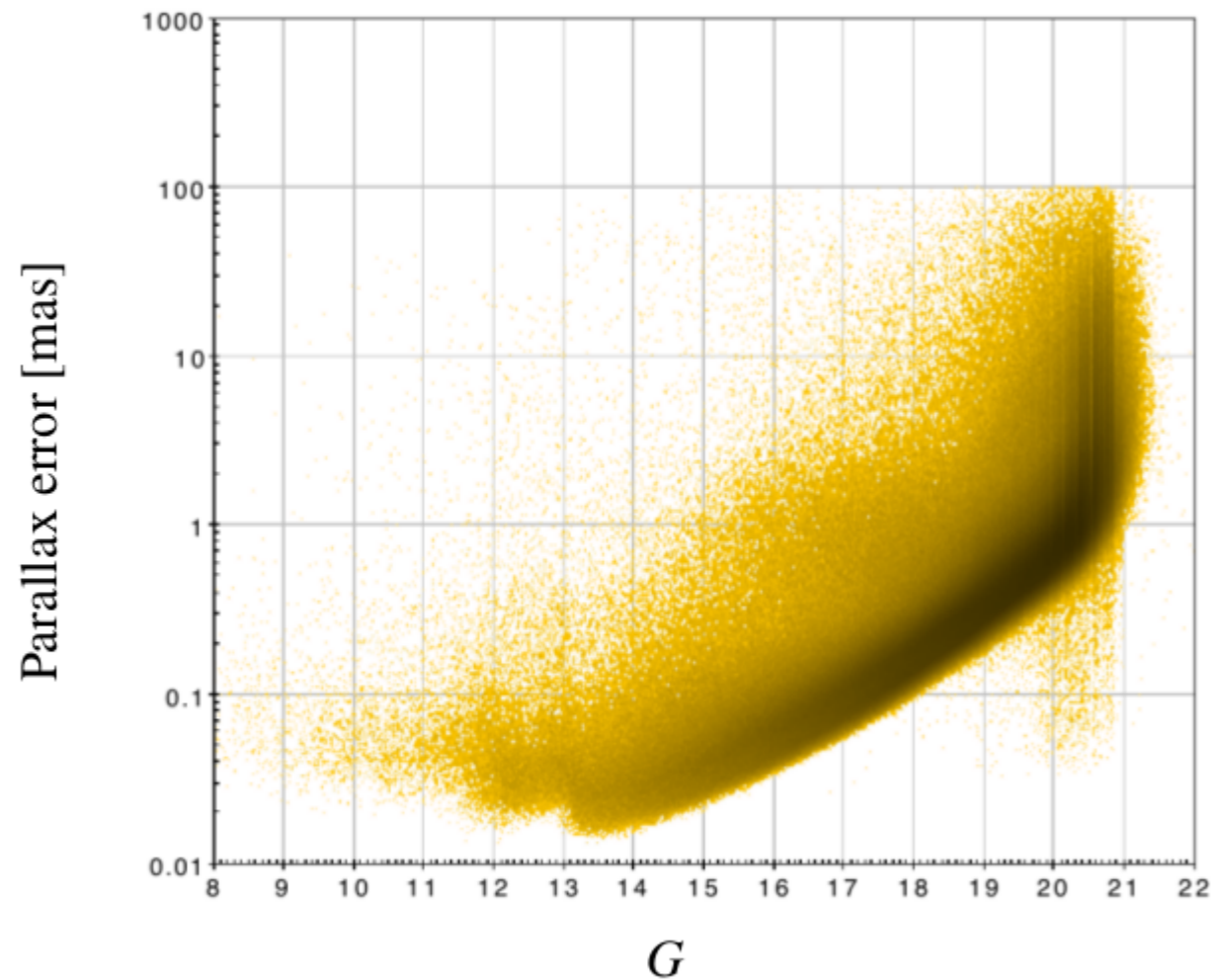
DR2 appetizer

G<17 mean colour plot



https://www.cosmos.esa.int/web/gaia/iow_20170816

Preliminary astrometric solution (AGIS 2.1)



Versus DR1:

Gaia-only solution

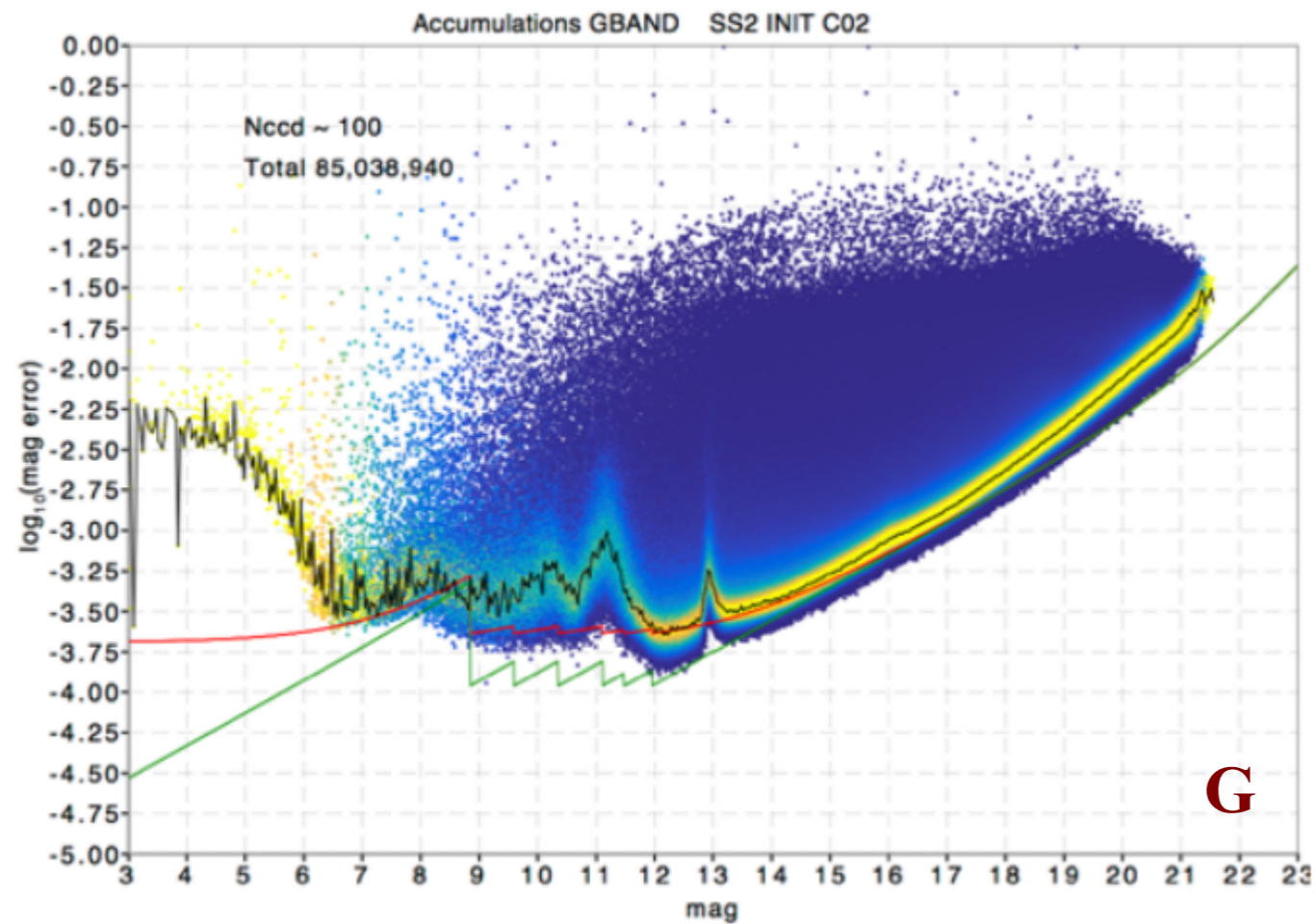
More data

Improved calibrations (colour term added)

Still single-star solution

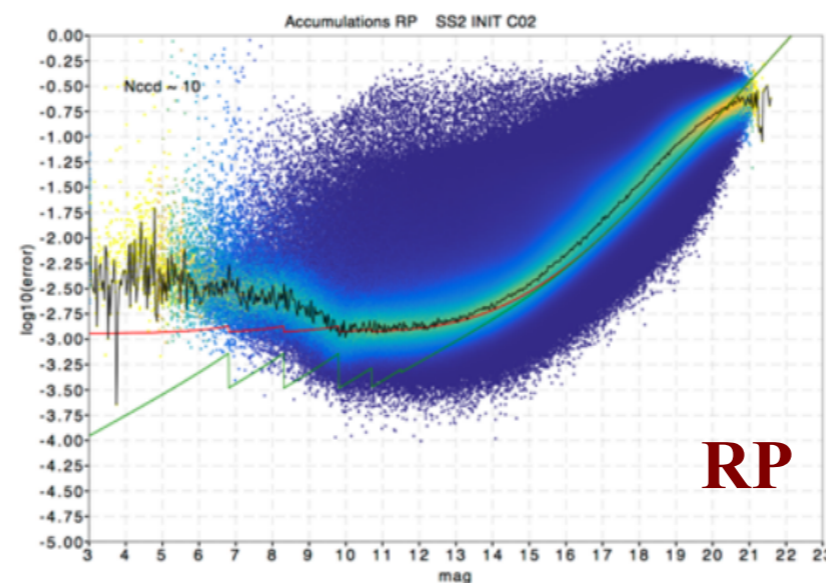
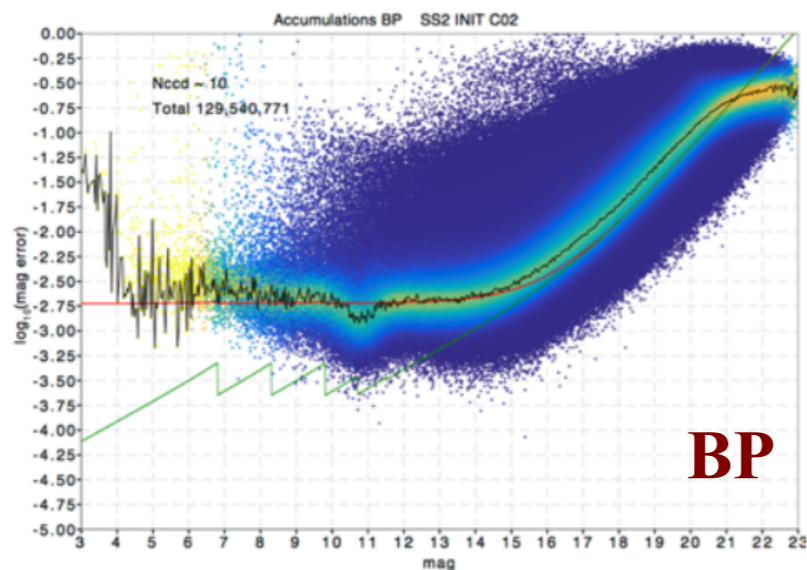
Systematics below 0.1 mas

Preliminary photometry

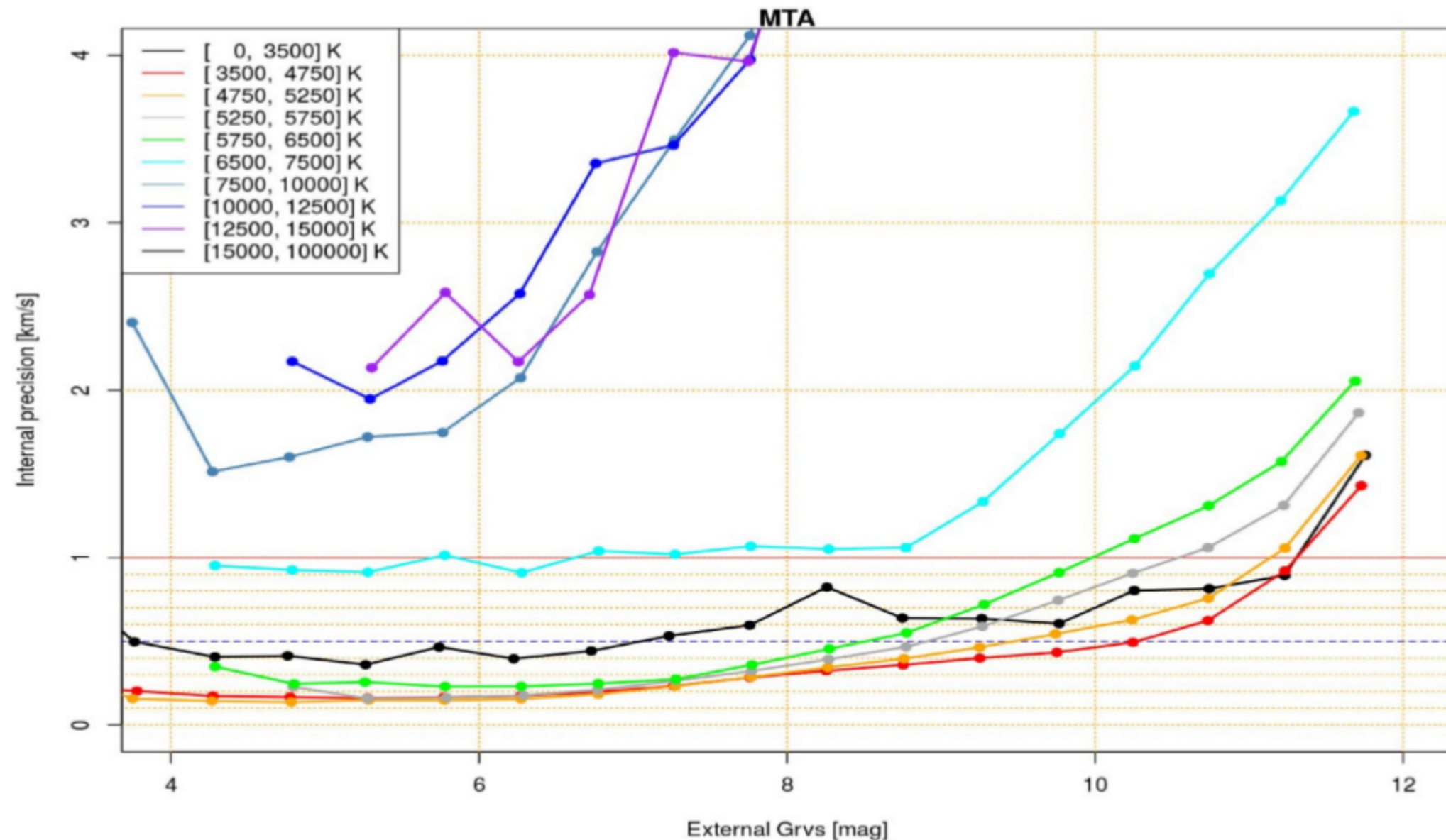


Versus DR1:
More data
Improved calibrations

BP & RP integrated photometry
No deblending



Preliminary radial velocity results



- Performances against ground-based standards
- Hot stars worse performances lack of sharp spectral lines

DR2: Much better but not yet optimal !

- Extensive tests currently underway.
- Documentation being prepared
(Validation paper : Arenou et al.)

Longer term data release schedule

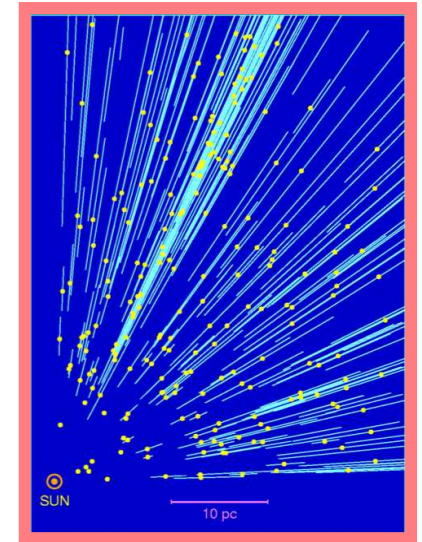
- Gaia DR3 (mid to late 2020)
 - Source classification and astrophysical parameters
 - BP/RP and RVS spectra for the above sources
 - Non-single stars solutions

- Gaia DR4 (end 2022)
 - Final release for the nominal mission
 - includes epoch data

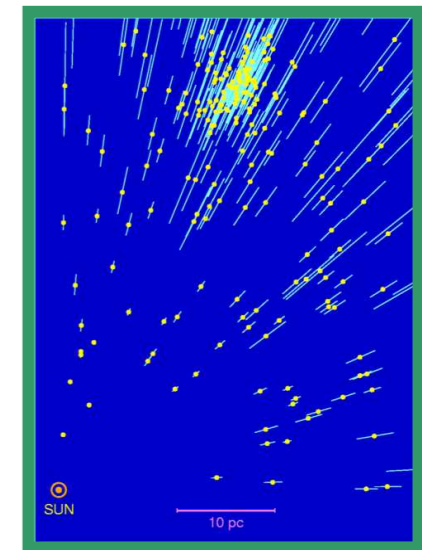
More than yesterday, less then tomorrow...

Hyades

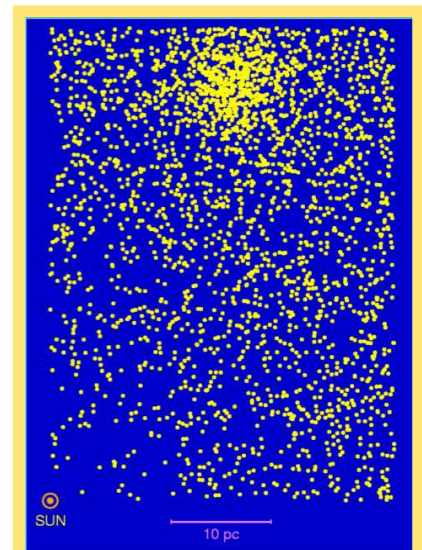
	Hipparcos	Gaia
Magnitude limit	12 mag	20.7 mag
Completeness	7.3 – 9.0 mag	20 mag
Bright limit	0 mag	3 mag
Number of objects	120,000	47 million to $G = 15$ mag 1.2 billion to $G = 20$ mag
Effective distance limit	1 kpc	50 kpc
Quasars	1 (3C 273)	500,000
Galaxies	None	1,000,000
Accuracy	1 milliarcsec	5-16 μ arcsec at $G = 10$ mag 26 μ arcsec at $G = 15$ mag 600 μ arcsec at $G = 20$ mag
Photometry	2-colour (B and V)	Low-res. spectra to $G = 20$ mag
Radial velocity	None	15 km s ⁻¹ to $G_{RVS} = 16$ mag
Observing	Pre-selected	Complete and unbiased



1960



1990



2022