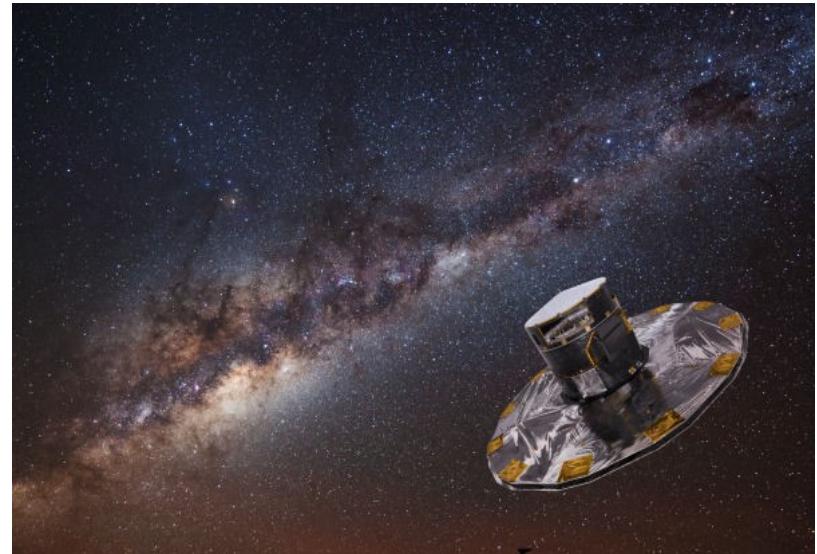


Gaia DR3

a pinch of catalogue,
a teaspoon of spectroscopy
a cup of Milky-Way



D. Katz on behalf of
F. Arenou, C. Barache, N. Bauchet,
J. Berthier, S. Bouquillon, E. Caffau,
T. Carlucci, P. Correira De Matos,
P. Di Matteo, R. Haigron, M. Haywood,
D. Hestroffer, C. Hottier, P. Kervella,
V. Lainey, S. Lambert, Y. Lebreton,
N. Leclerc, A. Mastrobuono Battisti,
P. Panuzzo, N. Robichon, F. Royer,
P. Sartoretti, J. Souchay, O. Snaith,
D. Souami, F. Taris, S. Thomas,
W. Thuillot, C. Turon, O. Vanel

Gaia Early-DR3

- Full astrometric solution → 1.5×10^9 sources
- Photometry: G, G_{BP}, G_{RP} → $1.8 \times 10^9 / 1.5 \times 10^9$ sources

Classification

- 1.6×10^9 sources

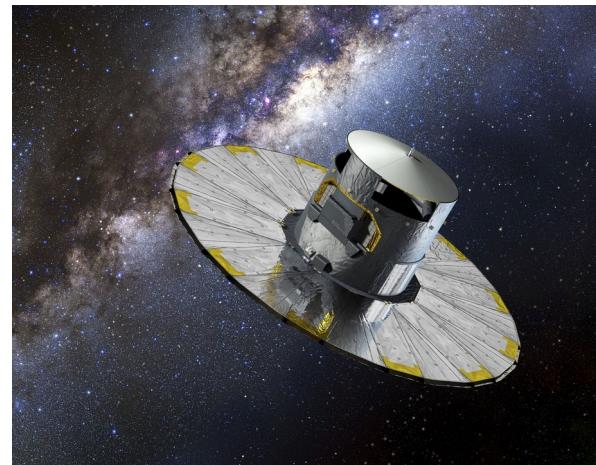
Asteroids

- 154 000 orbital solutions
- 60 000 reflectance spectra
- ...

Stars

- 34×10^6 radial velocities
- 3.5×10^6 broadening velocities
- 10^6 spectra
- 470×10^6 parameters
- 2.5×10^6 chemical abundances
- ...

Gaia DR3



Binary stars

- 814 000 binaries
- 169 000 astrometric orbits
- 187 000 spectroscopic orbits
- ...

Milky Way and local group

Galaxies and Quasars

- 6.4×10^6 QSO redshifts
- 4.8×10^6 galaxy candidates
- 1.4×10^6 galaxy redshifts
- ...

Interstellar medium

- 472 000 DIBs

Variable stars

- 10×10^6 classified variables
- 15 000 Cepheids
- 272 000 RR Lyrae
- ...

“Pipeline et traitements de données”

- DR3 → 5 years work
- 20 people / 12.5 FTE
- Broad range of skills

→

- Architecture
- Software development
- Numerical analysis
- Machine/deep learning

- Big data
- Database
- Quality insurance
- Management

Classification

- 1.6×10^9 sources

Asteroids

- [D. Hestroffer](#) talk

Stars - spectroscopy

- [Next slides](#)

Gaia DR3



Binary stars

- [P. Panuzzo](#) talk

Galaxies and Quasars

- 6.4×10^6 QSO redshifts
- 4.8×10^6 galaxy candidates
- 1.4×10^6 galaxy redshifts
- ...

Interstellar medium

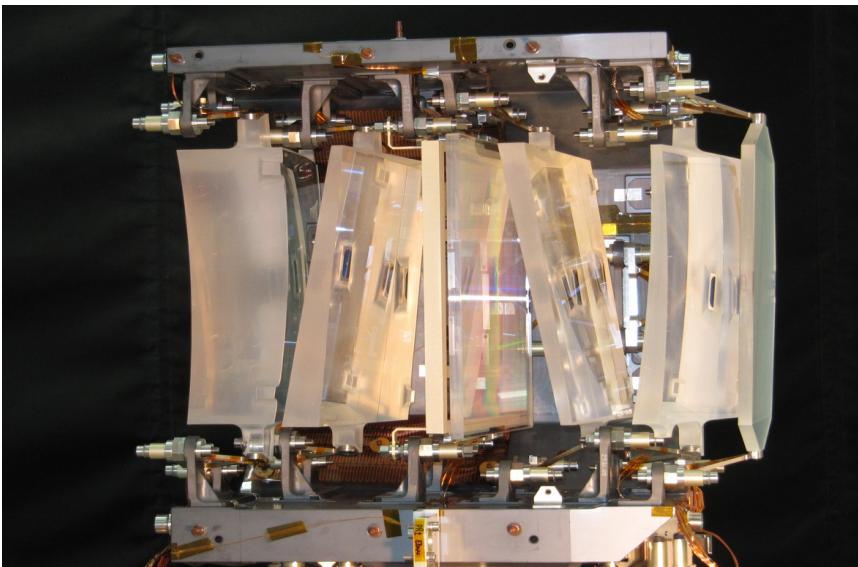
- 472 000 DIBs

Variable stars

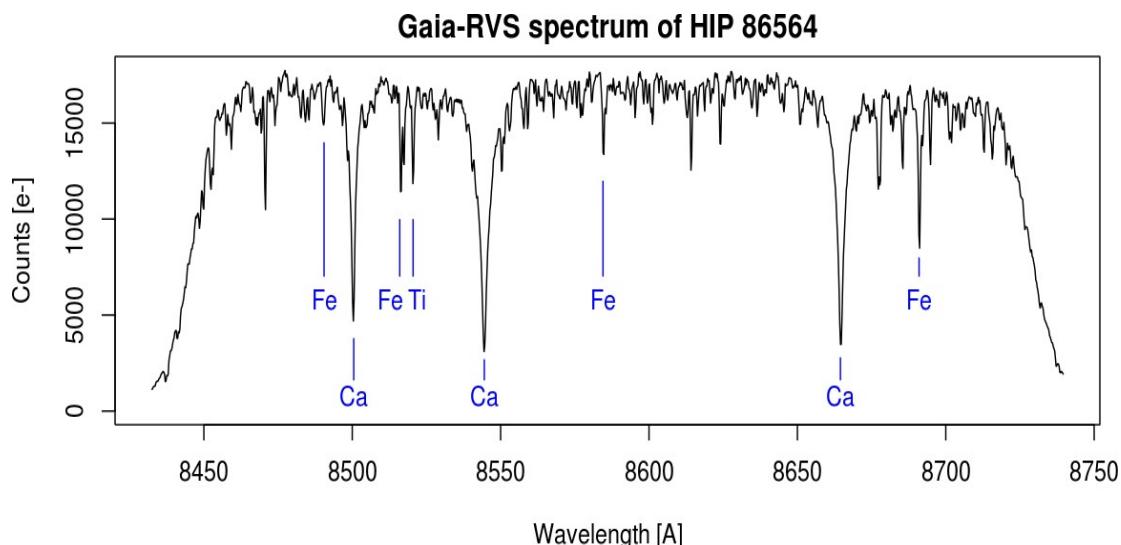
- 10×10^6 classified variables
- 15 000 Cepheids
- 272 000 RR Lyrae
- ...

Milky Way and local group

Radial Velocity Spectrometer (RVS)



- $R \sim 11\,500$
- $\lambda = [845,872] \text{ nm}$



Gaia DR3

Processing

- 12 mag (DR2) → 14 mag (DR3)
- 34 months of data
- 2.8 billion spectra
- 2500 core Hadoop cluster (CNES)
- 3 million CPU hours / 120 days

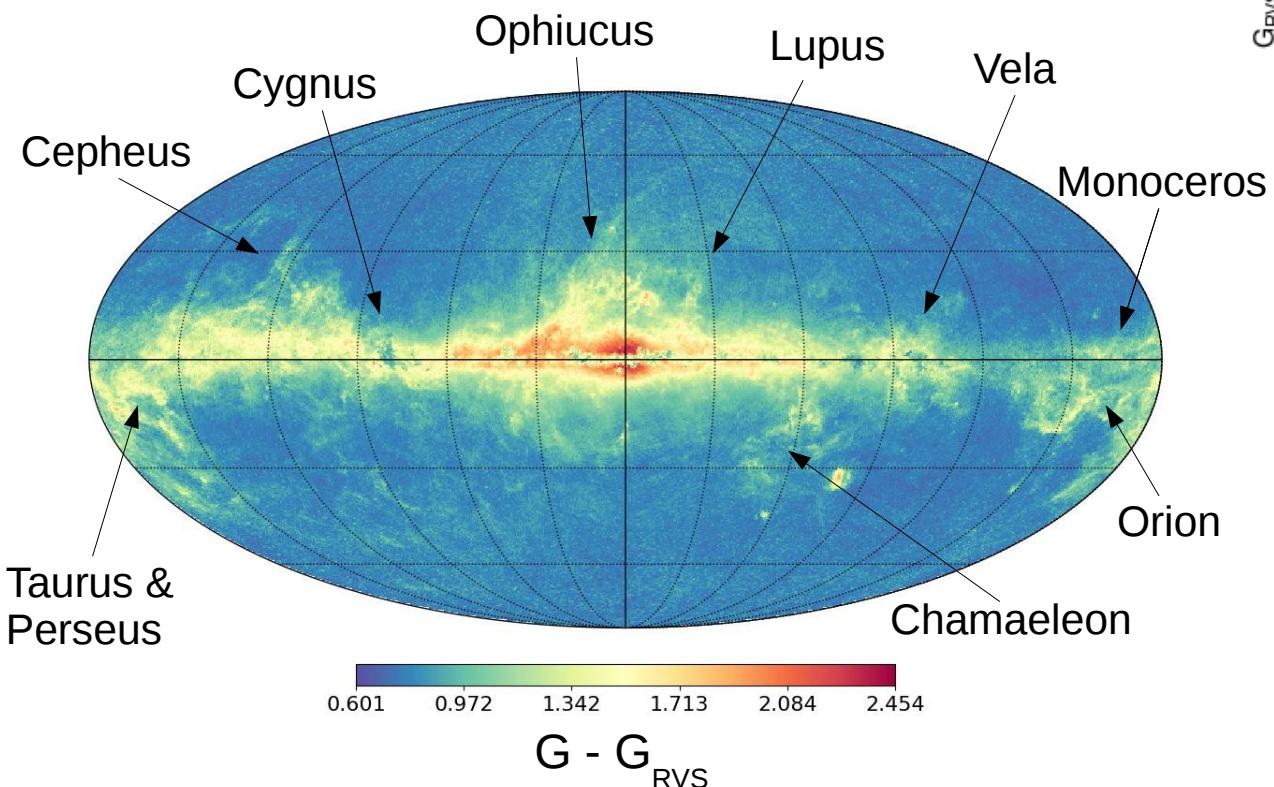


Products

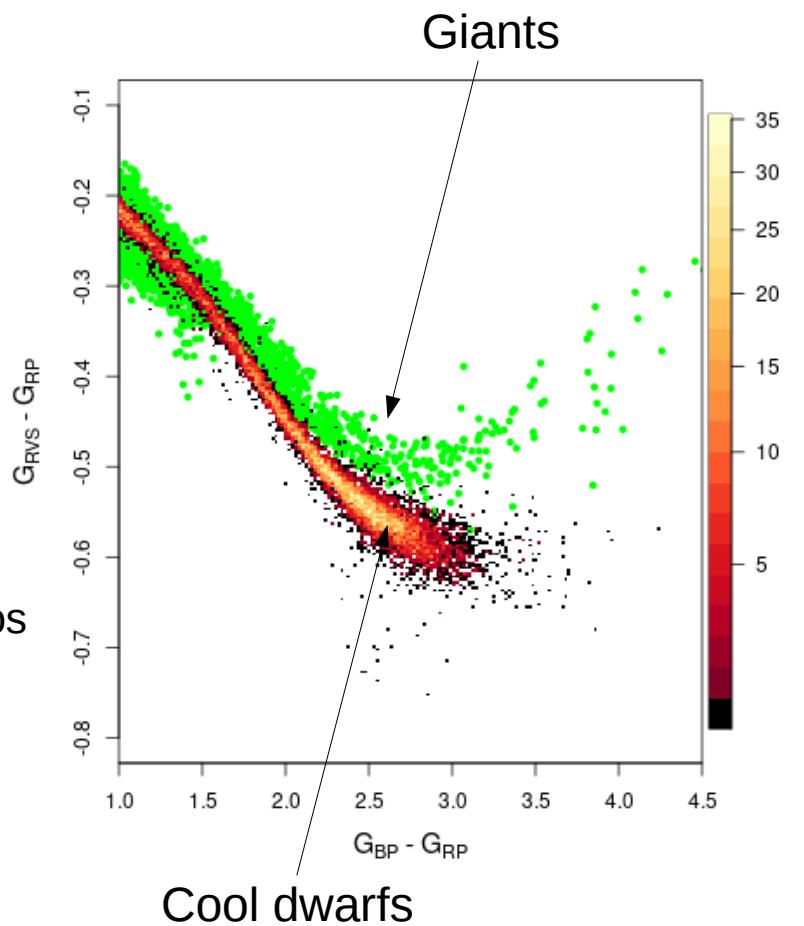
- 34 million radial velocities
- 32 million G_{RVS} magnitudes
- 3.5 million broadening velocities
- 1 million spectra

- 32.2 million G_{RVS}
- Narrow band: [846, 870] nm

Sartoretti, Marchal, Babusiaux et al.,
2022, A&A, accepted



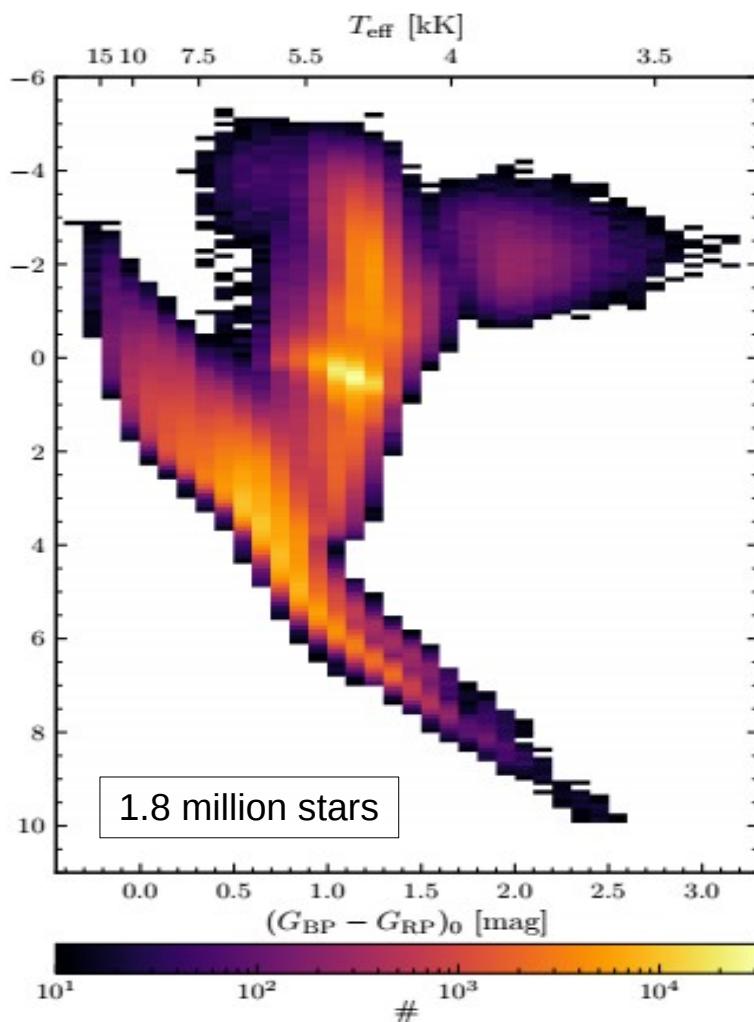
$G - G_{RVS} \rightarrow$ interstellar dust



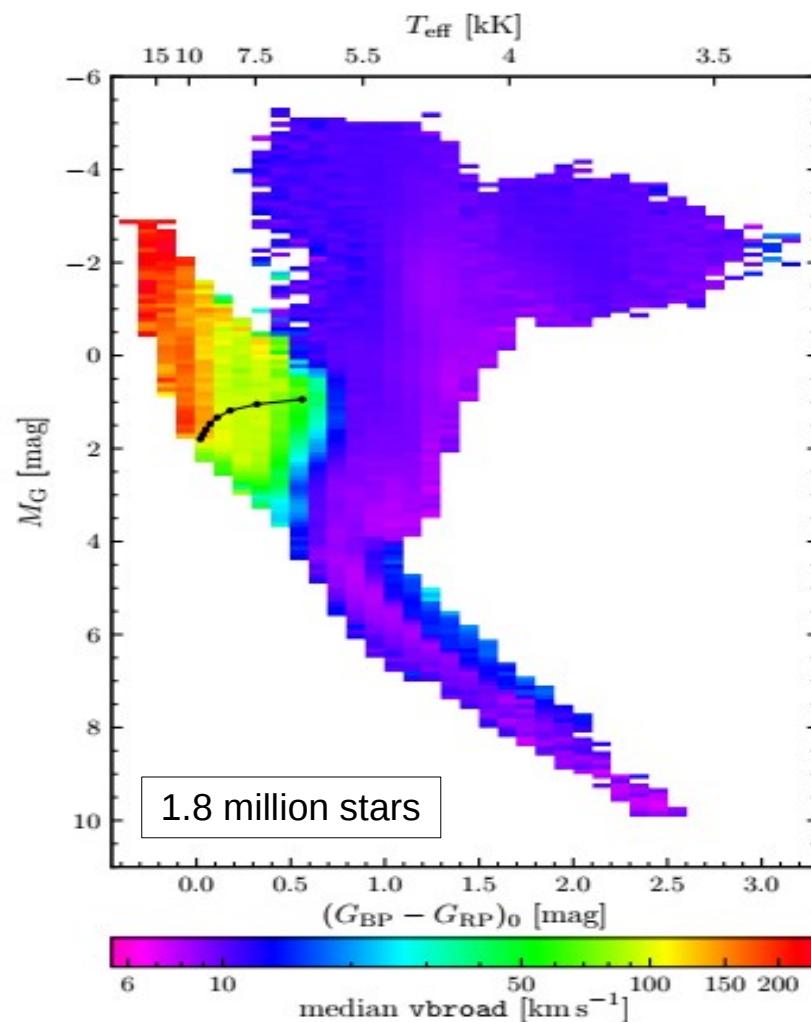
- $G_{RVS} - G_{RP}$ vs $G_{BP} - G_{RP} \rightarrow$ surface gravity
- Separate cool dwarfs / giants

- 3.5 million broadening velocities

Frémat, Royer, Marchal et al., 2022,
A&A, accepted



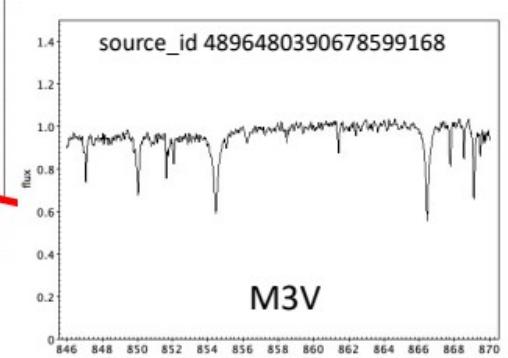
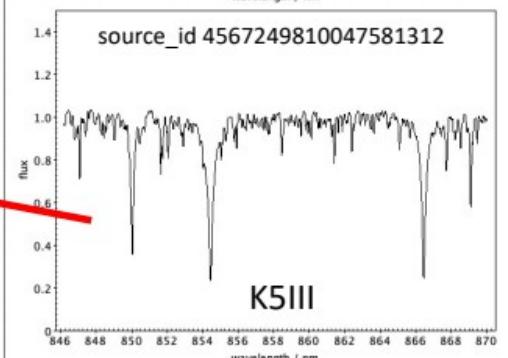
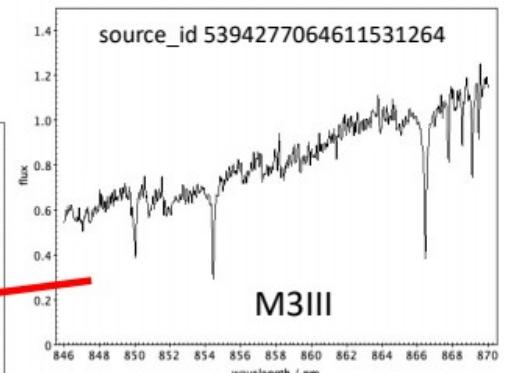
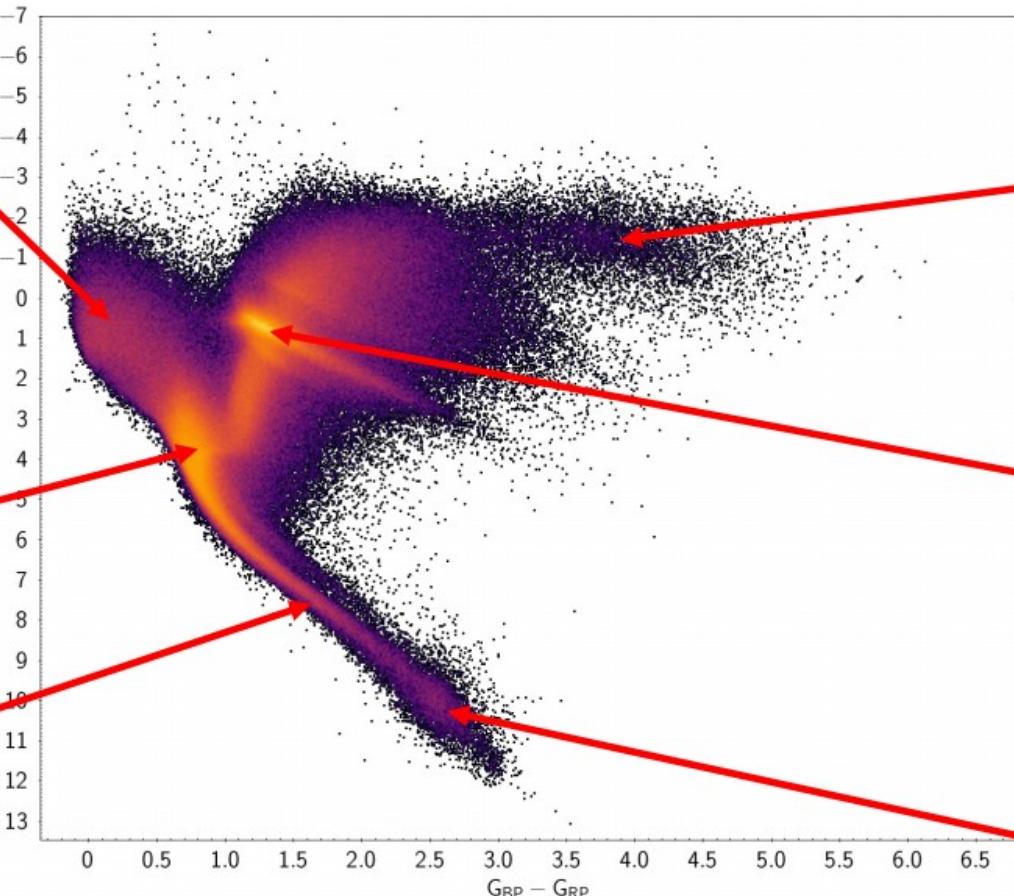
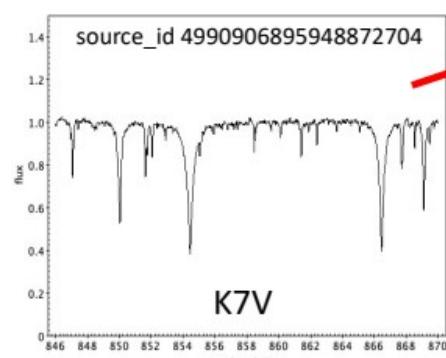
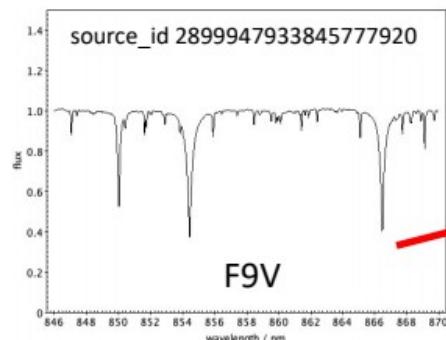
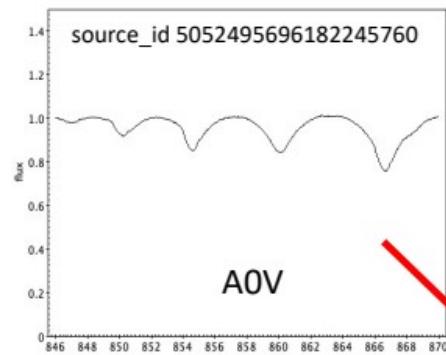
Large sample → statistical studies

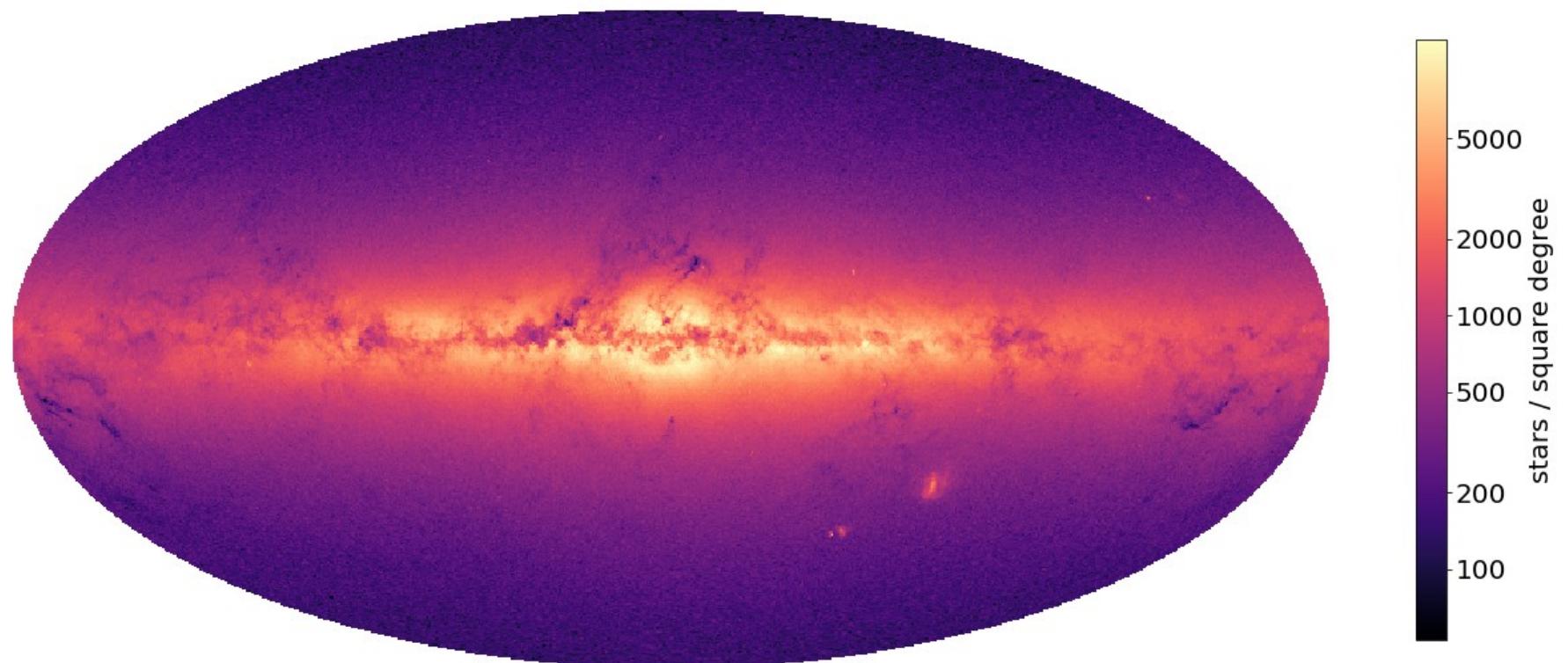


v_{broad} across HR diagram

- 1 million calibrated spectra

Seabroke, Frémat, Marchal et al.,
2022, A&A, in prep

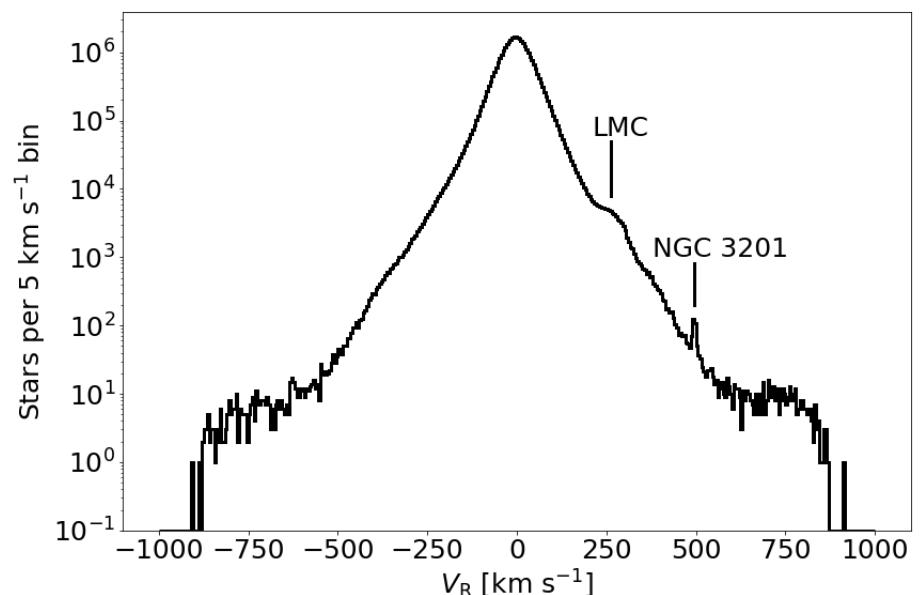




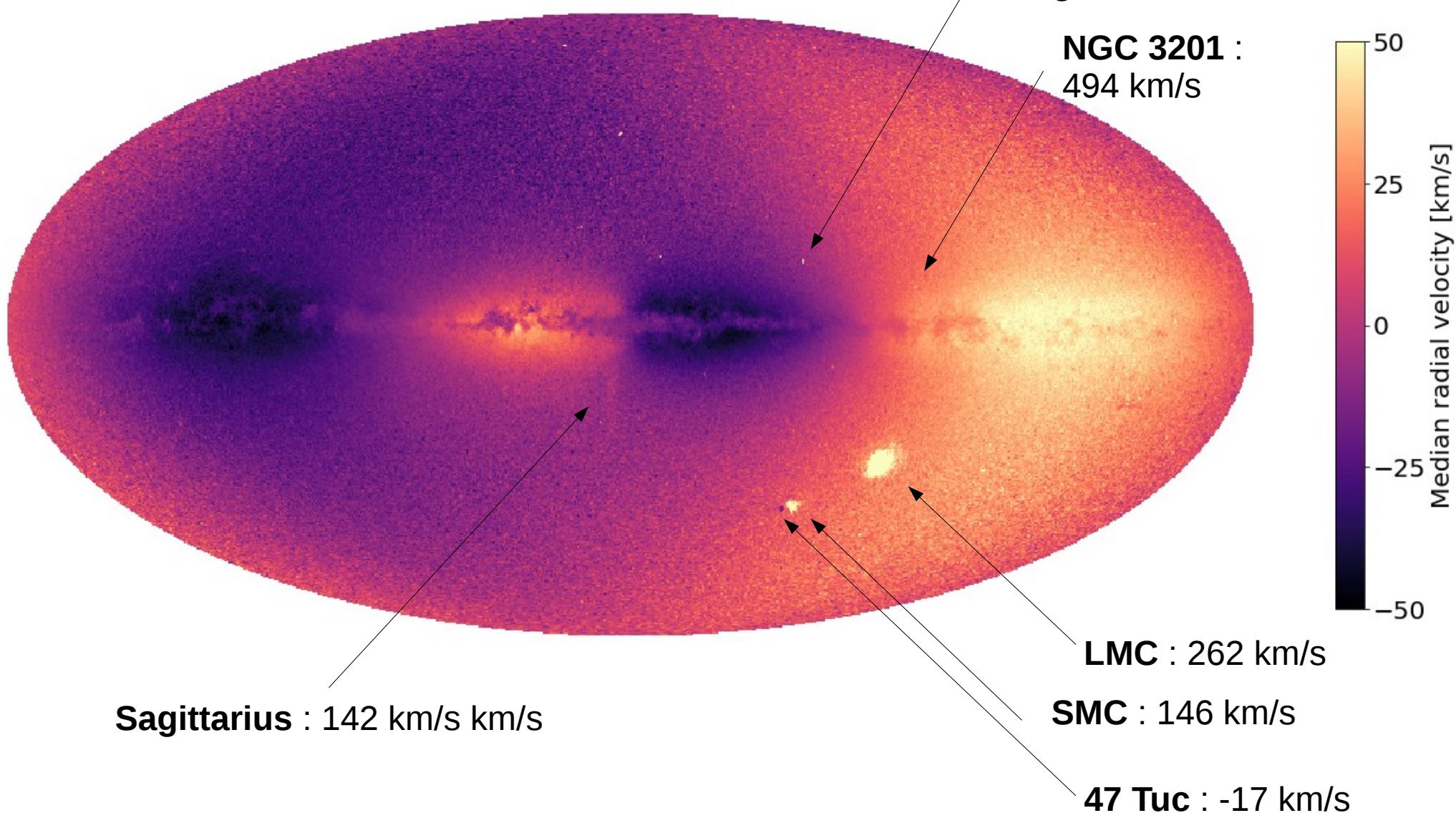
Radial velocities

- DR2 → 7 millions
- DR3 → 34 millions

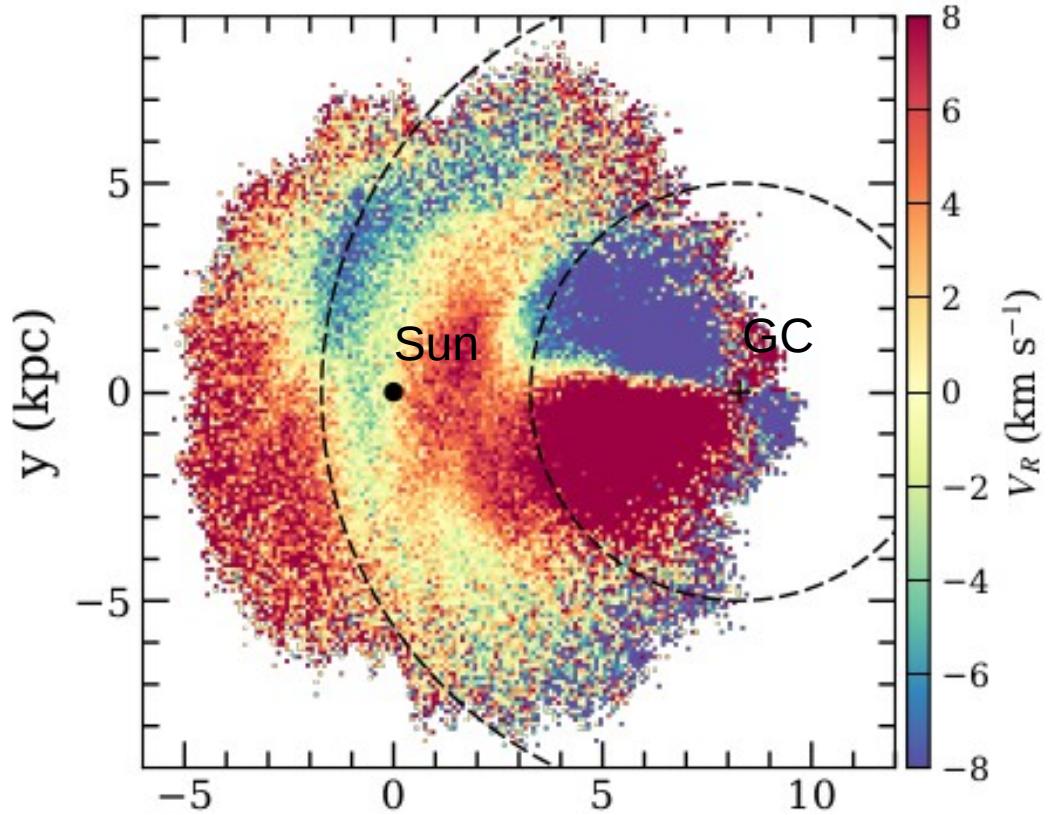
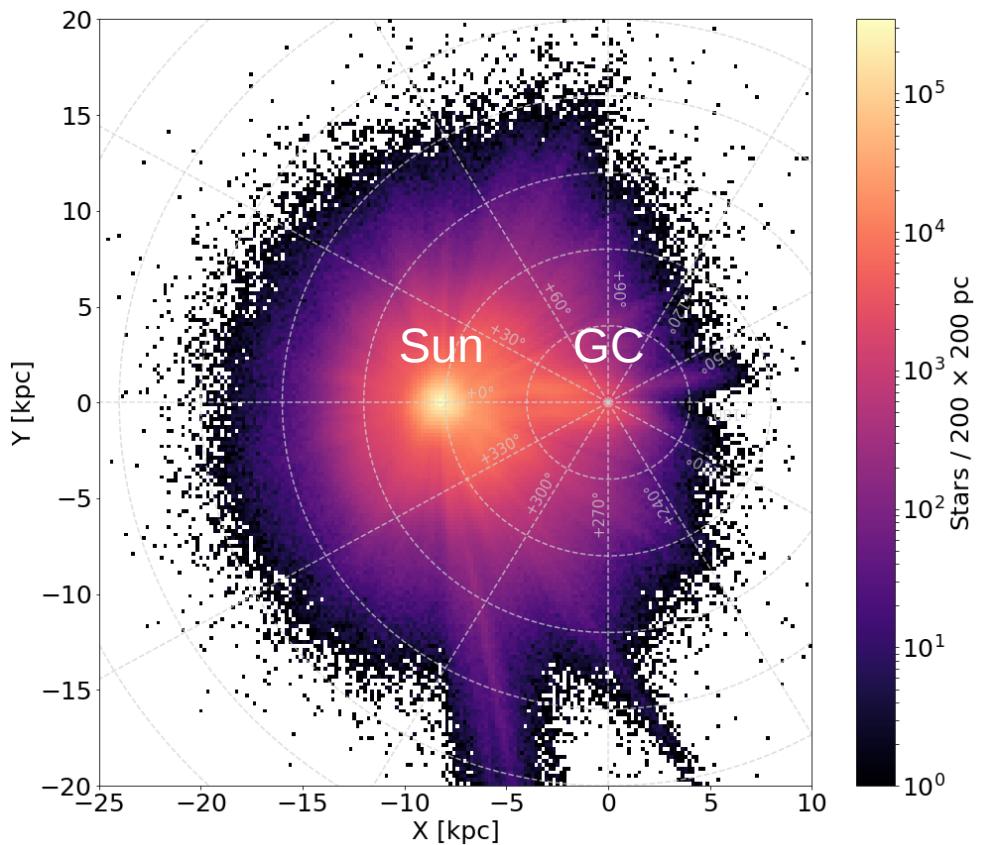
Katz, Sartoretti, Guerrier et al., 2022,
A&A, submitted



Median radial velocity →
rotation of the Milk Way disc



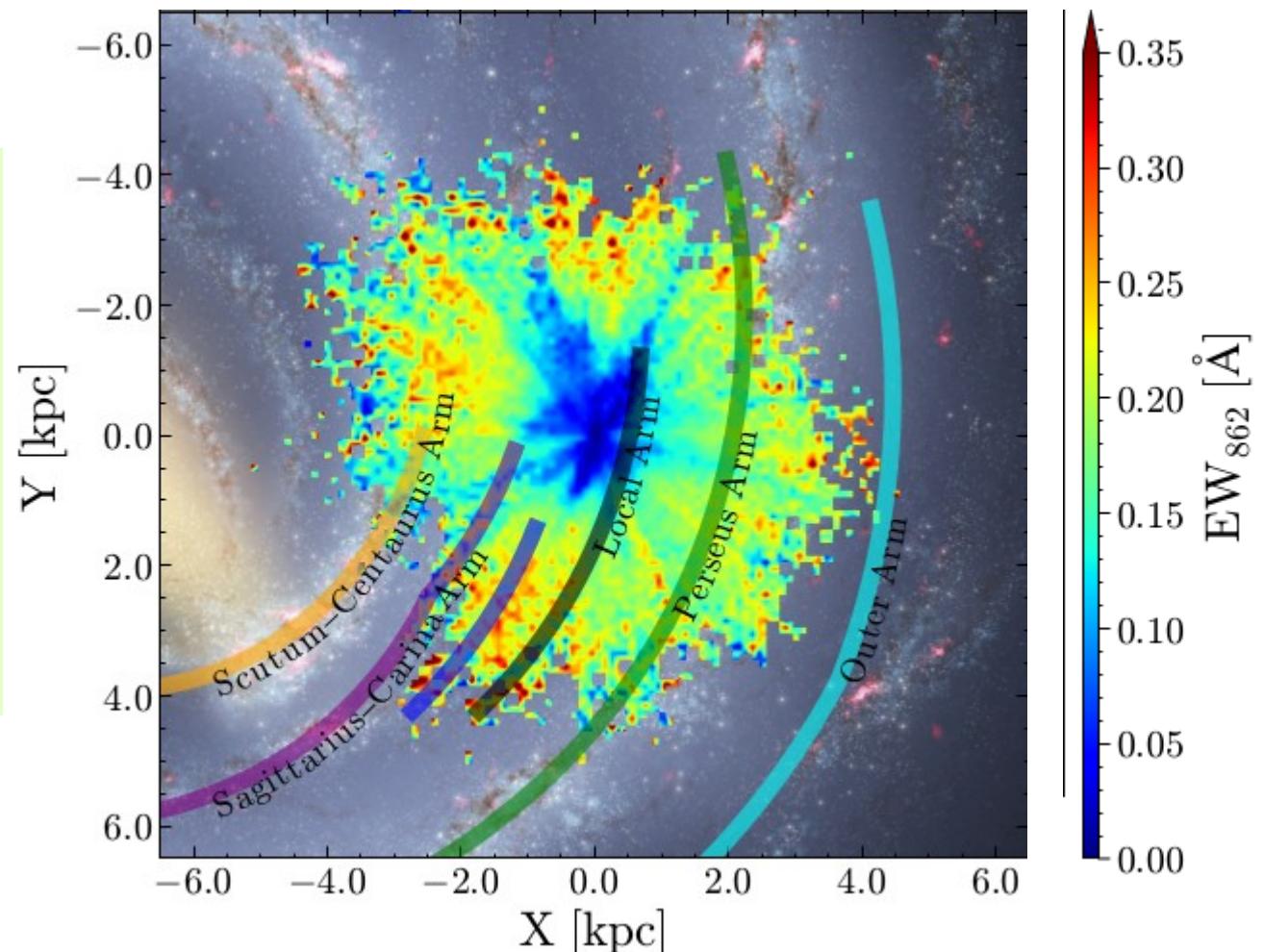
- 6D parameters → 29 million stars
 - 1/3 to 1/2 of the MW disc
-
- MW “seen” from the Galactic north pole
 - Milky Way rotates clockwise



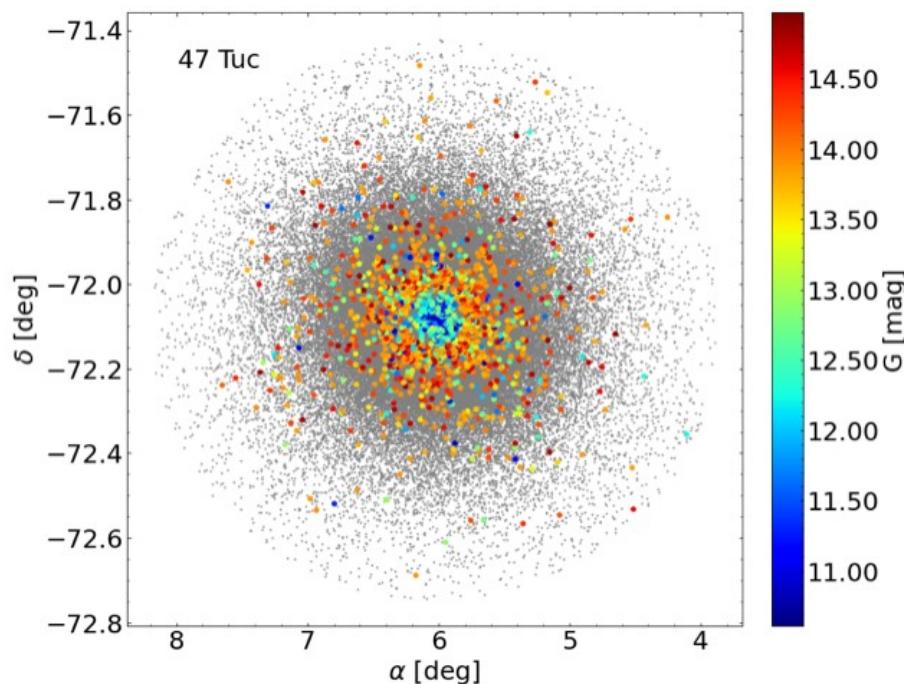
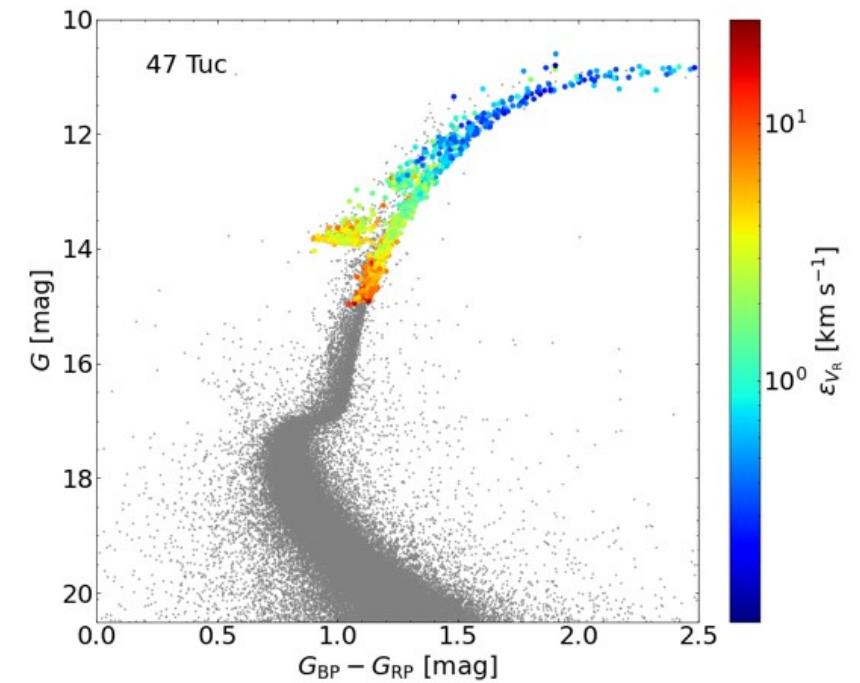
- Radial motion wrt. Galactic centre → **red outward / blue inward**
- Disc velocity field → perturbations
- Kinematic signature of the bar

Gaia collaboration, Drimmel, Romero-Gomez et al., 2022, A&A, accepted

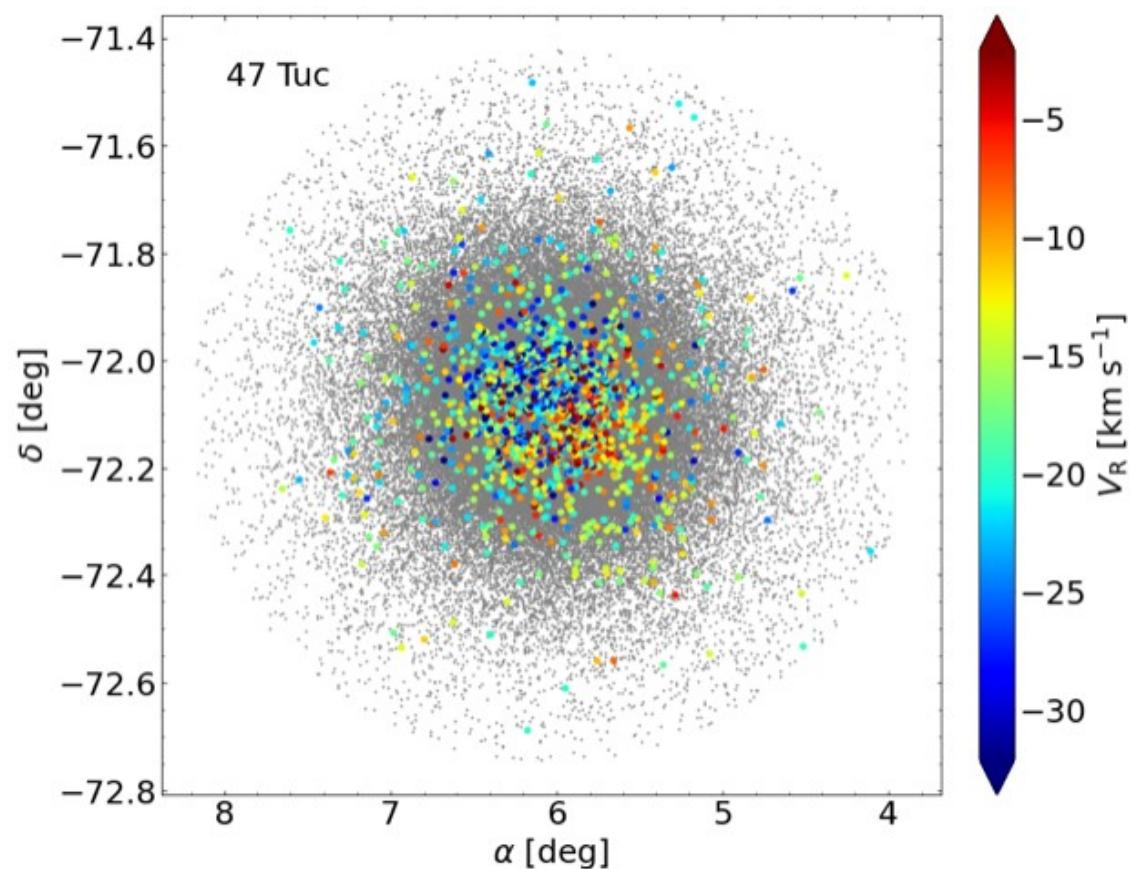
- RVS wavelength range → **Diffuse Interstellar Band** (DIB): 862 nm
- 472 000 stars
- EW correlates with reddening → interstellar medium



Gaia collaboration, Schultheis, Zhao et al., 2022, A&A, accepted



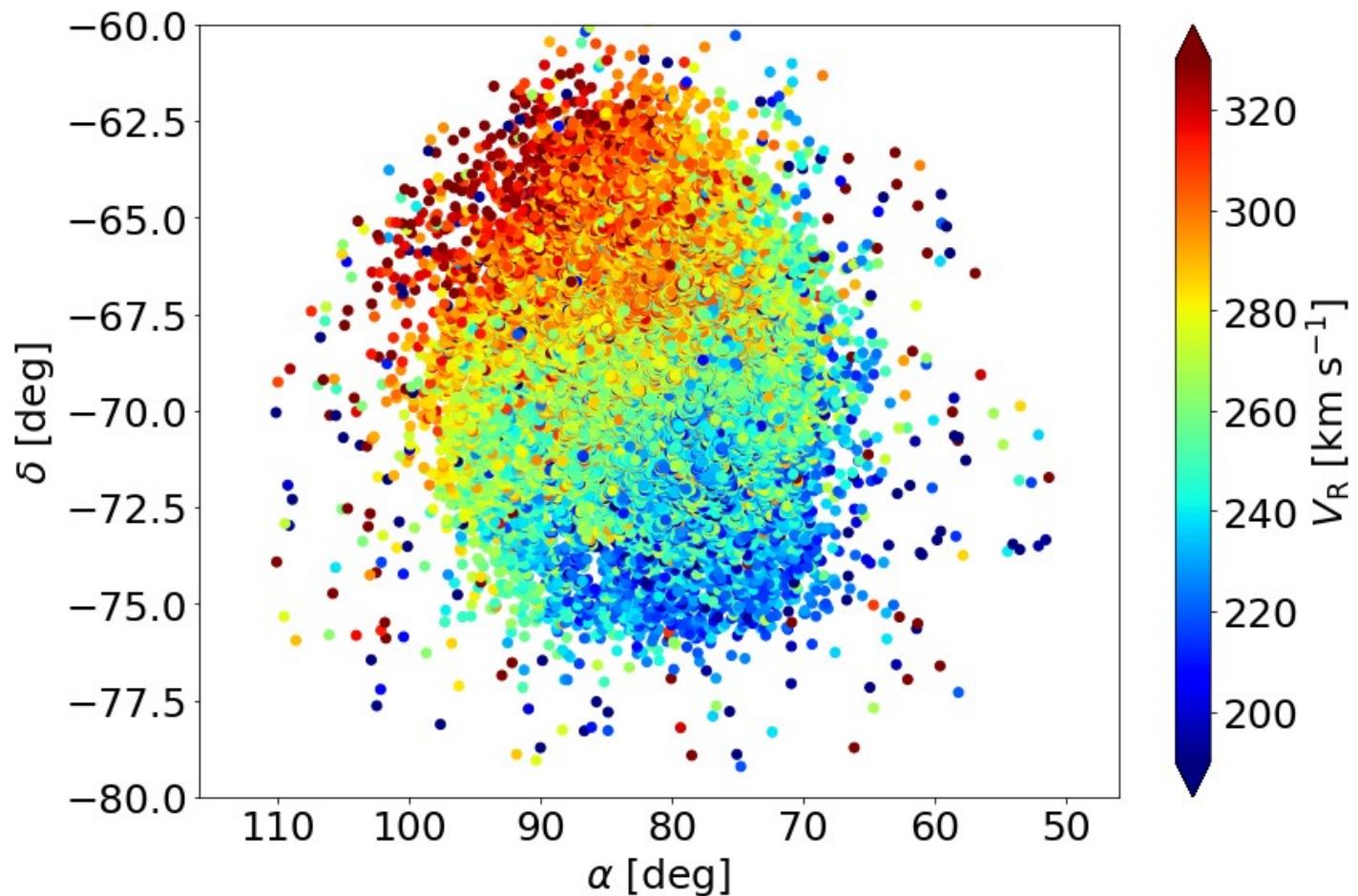
- 111 Globular clusters in GDR3
- 1000 measures (47 Tuc, Omega Cen)
→ 5 measures (Terzan 5, NGC6522)



47 Tuc → line-of-sight rotational velocity

Katz, Sartoretti, Guerrier et al., 2022,
A&A, submitted

- 10 degree radius
 - $\omega / \sigma_\omega < 5$
 - $V_R > 150 \text{ km/s}$
- 29 600 stars



LMC → line-of-sight rotational velocity

Katz, Sartoretti, Guerrier et al., 2022,
A&A, submitted

GDR4 (2025)

- Work started about a year ago
- New products, such as:
 - astrometric, photometric and radial velocity **time series**
 - **150 million radial velocities** down to Grvs = 16
- Challenge: very low signal-to-noise → machine learning / deep learning

GDR5 (2030)

- Final catalogue → processing of **10 years of data** (2014 - 2025)
- Final accuracy / precision / number of epochs / products

