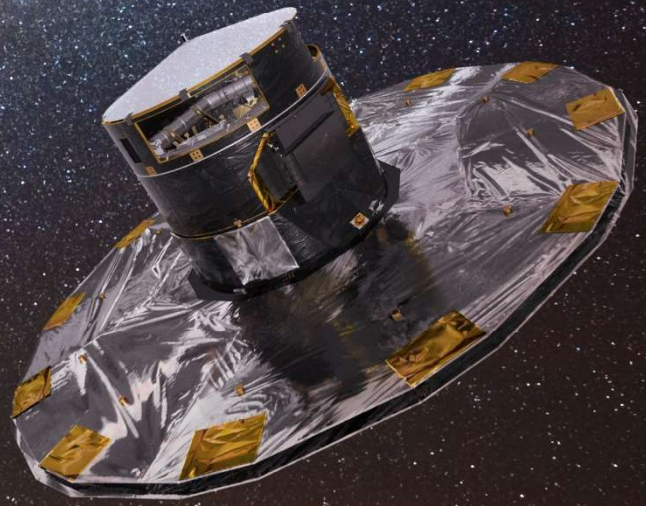
Gaia Science



Ronald Drimmel, INAF – OATo
: @rdrimmel
: ronald.drimmel@inaf.it

15/03/2022
NASA Stars SIG seminar

The Past

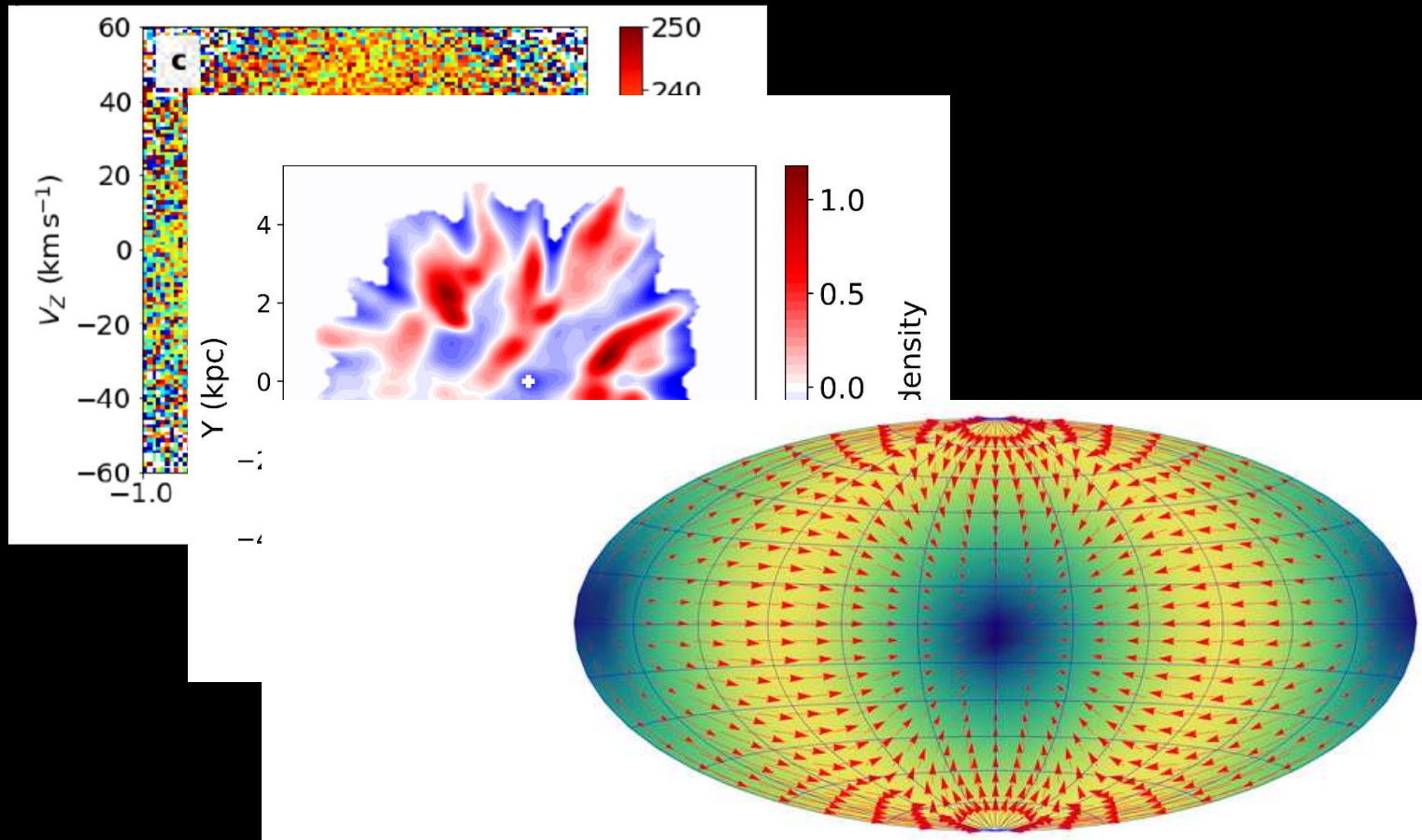


Figure 2: The pattern of quasar proper motions due to the measured acceleration, i.e. slightly offset from the galactic centre, and given in galactic coordinates. The galactic centre is in the middle at l=0 deg. The Hammer-Aitoff projection allows to see the entire sky. The arrows represent the size and direction of the acceleration, and the underlying colour represents the size as well. Image credit: ESA/Gaia/DPAC - CC BY-SA 3.0 IGO

Gaia data release scenario

	DR1	DR2	DR3	DR4
	2016	2018	2022	2024 (TBD)
Astrometry				
Spectro-photometry				
Spectroscopy				
Variability				
Binary solutions				
Astrophysical parameters				

Ronald Drimmel, 30/09/2016

Details of future releases: https://www.cosmos.esa.int/web/gaia/release

End-of-mission performances: https://www.cosmos.esa.int/web/gaia/science-performance

Total number of sources	# sources in Gaia DR3 1,811,709,771	# sources in Gaia DR2 1,692,919,135
	Gaia Early Data Release 3	
Number of sources with minimally 5 astrometric parameters	1,467,744,818	1,331,909,727
Number of 5-parameter sources	585,416,709	
Number of 6-parameter sources	882,328,109	
Number of 2-parameter sources	343,964,953	361,009,408
Gaia-CRF sources	1,614,173	556,869
Sources with mean G magnitude	1,806,254,432	1,692,919,135
Sources with mean G_{BP}-band photometry	1,542,033,472	1,381,964,755
Sources with mean G_{RP}-band photometry	1,554,997,939	1,383,551,713
	New data in Gaia Data Release 3 (pending validation)	
Sources with radial velocities	≈ 33,000,000	7,224,631
BP/RP spectra	> 100,000,000	-
RVS spectra	≈ 1,000,000	-
Variable source classifications	≈ 13,000,000	550,737
Object classifications	≈ 1,000,000,000	-
Sources with astrophysical parameters	≈ 500,000,000	161,497,595
Non-single stars	≈ a few 100,000	-
QSO host and galaxy morphological characterisation	≈ a few 1,000,000	-
Solar system objects	≈ 150,000	14,099
Reflectance spectra for solar system objects	≈ 50,000	-
Average BP/RP reflectance spectra of asteroids	≈ 10,000	-
Gaia Andromeda Photometric Survey (GAPS)	≈ 1,000,000	-

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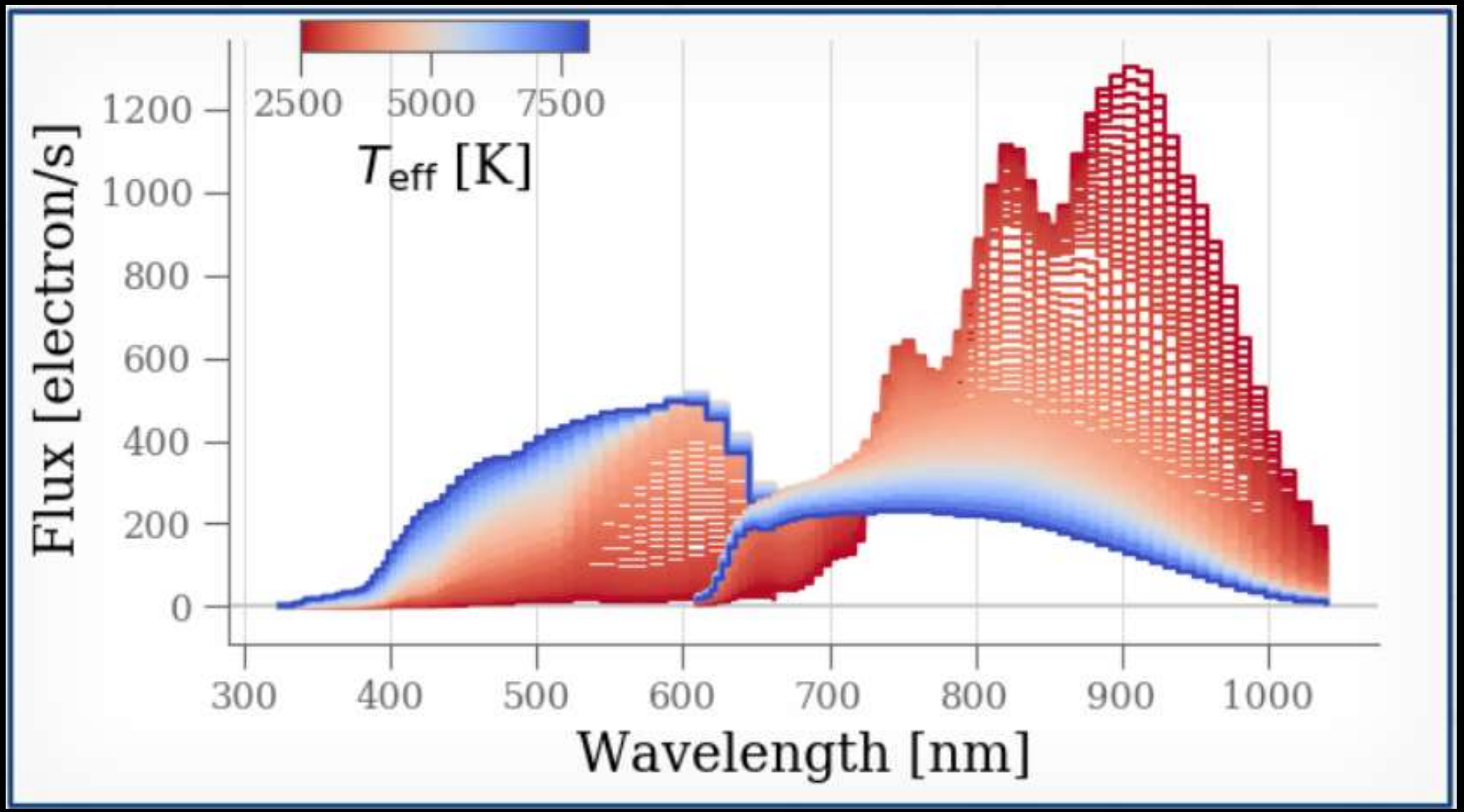
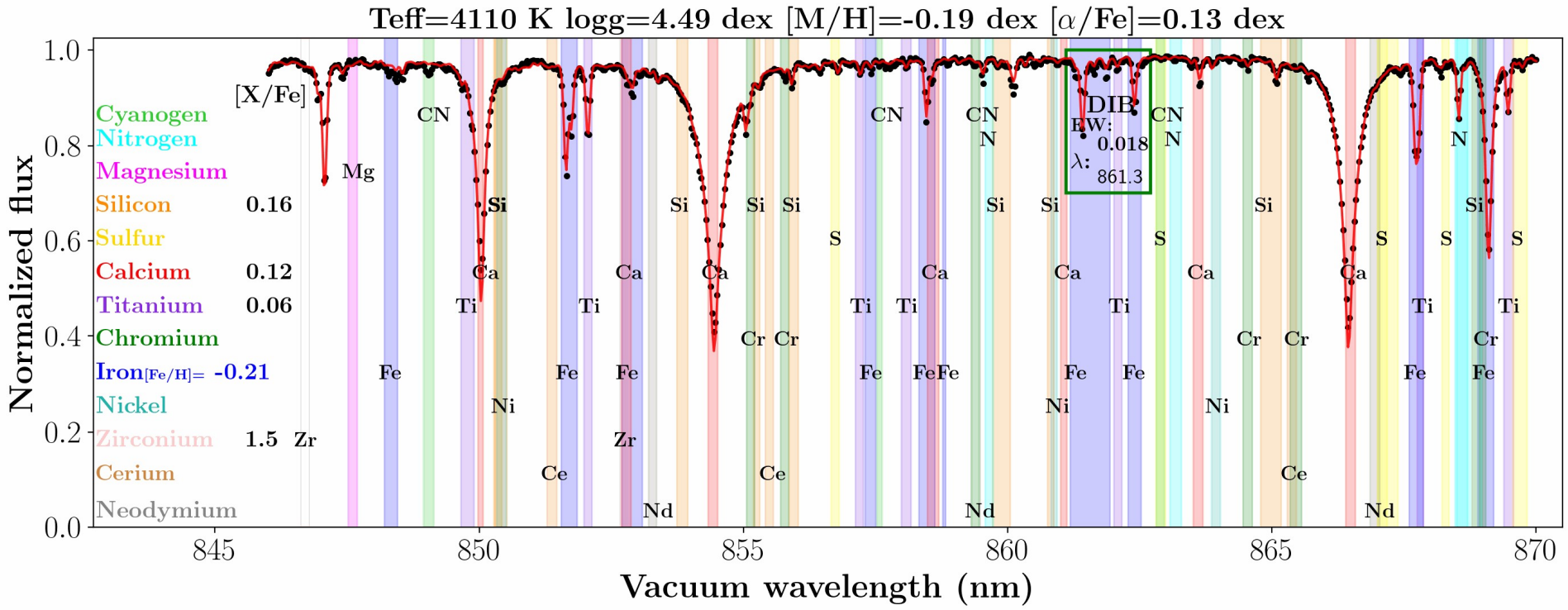
Spectra!

BP/RP



Spectra!

RVS



ESA/Gaia/DPAC-CU8, Recio-Blanco and the GSP-Spec team

https://www.cosmos.esa.int/web/gaia/iow_20210709

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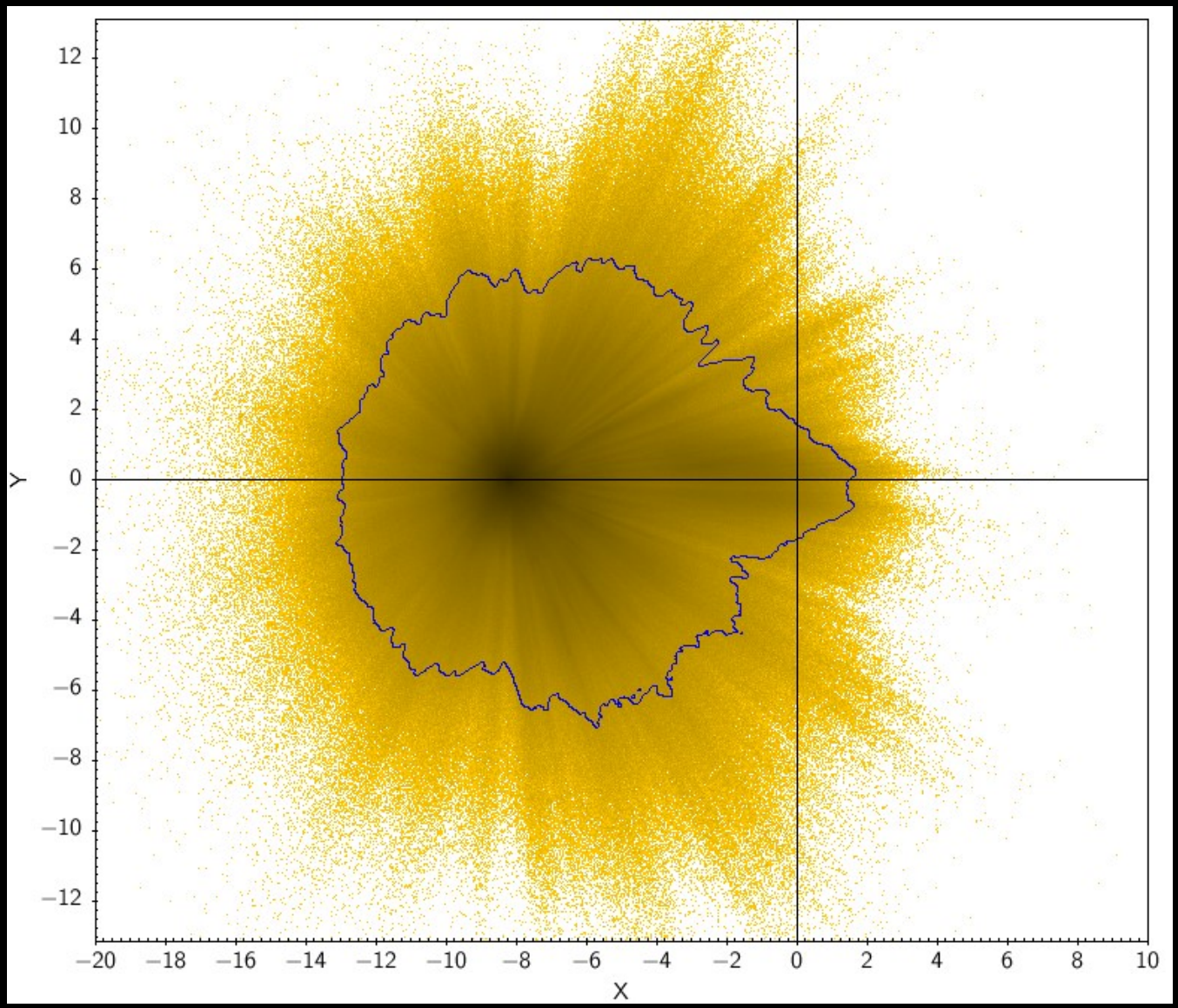
Gaia sources with RVs (est.)

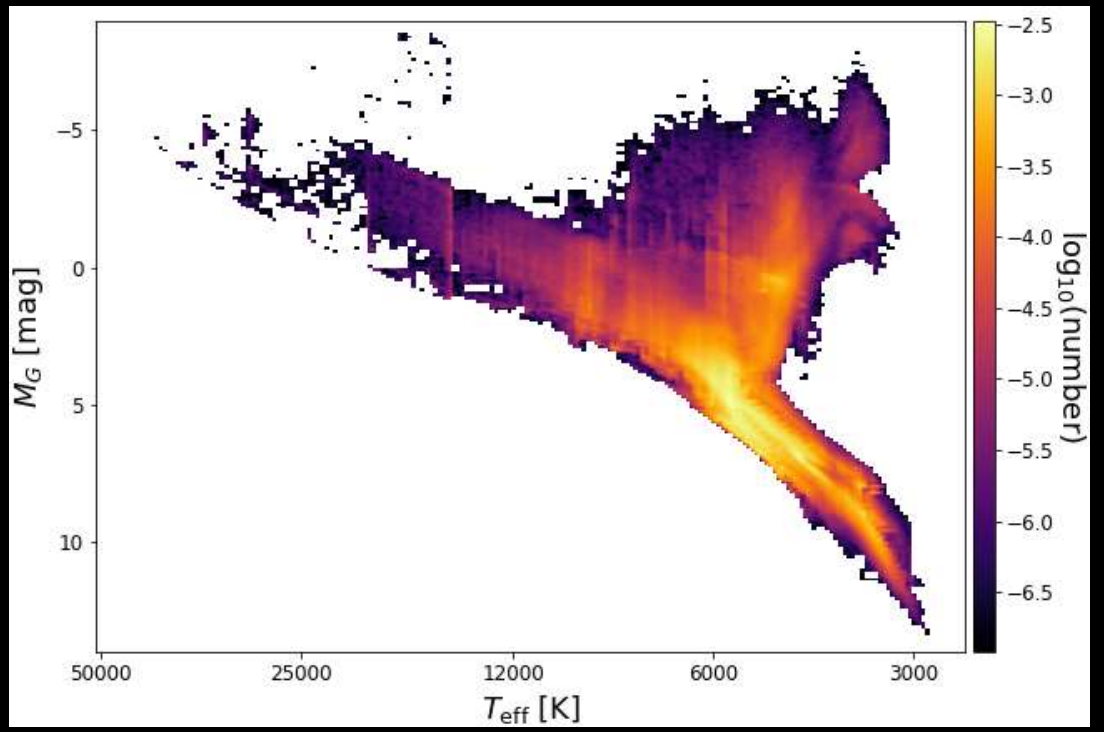


Stellar APs!

from XP spectra:

T_{eff}, logg, [M/H], A_G

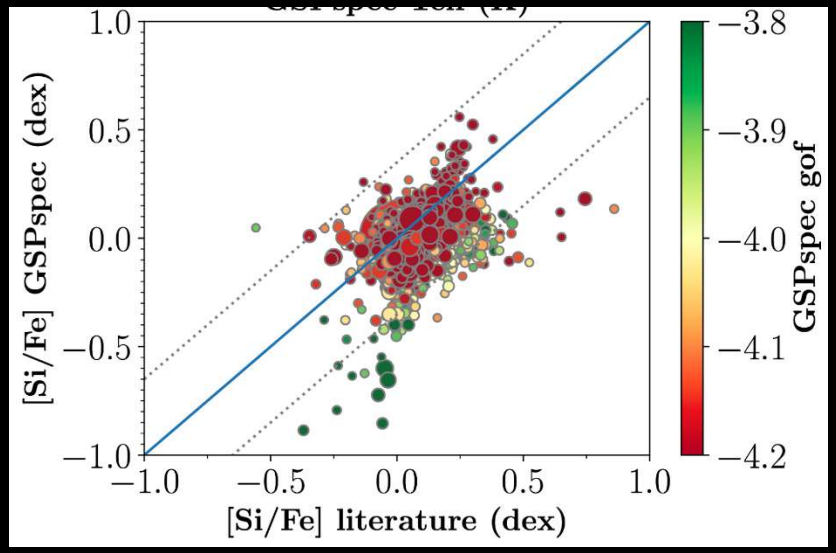
- $2{,}500 < T_{eff} < 55{,}000$ K
- $0 < A_G < 10$
- $G < 19$

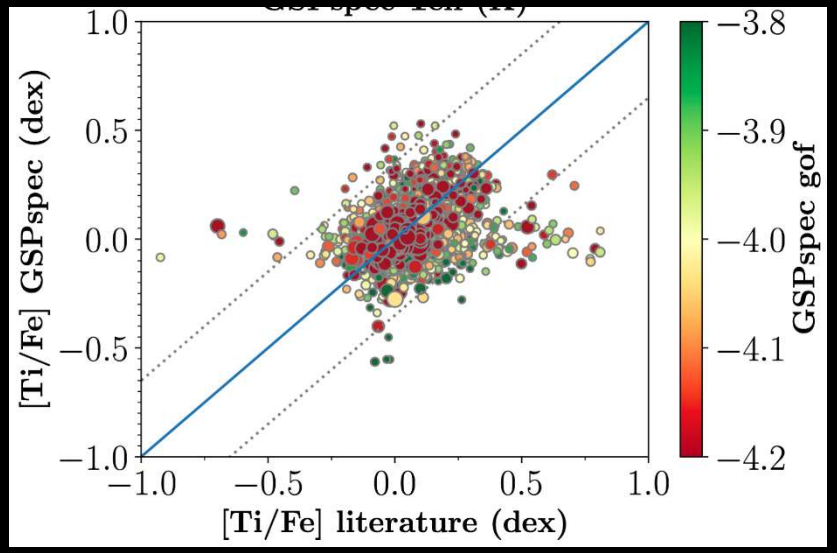


From isochrones:

M_G, distance

Stellar Abundances

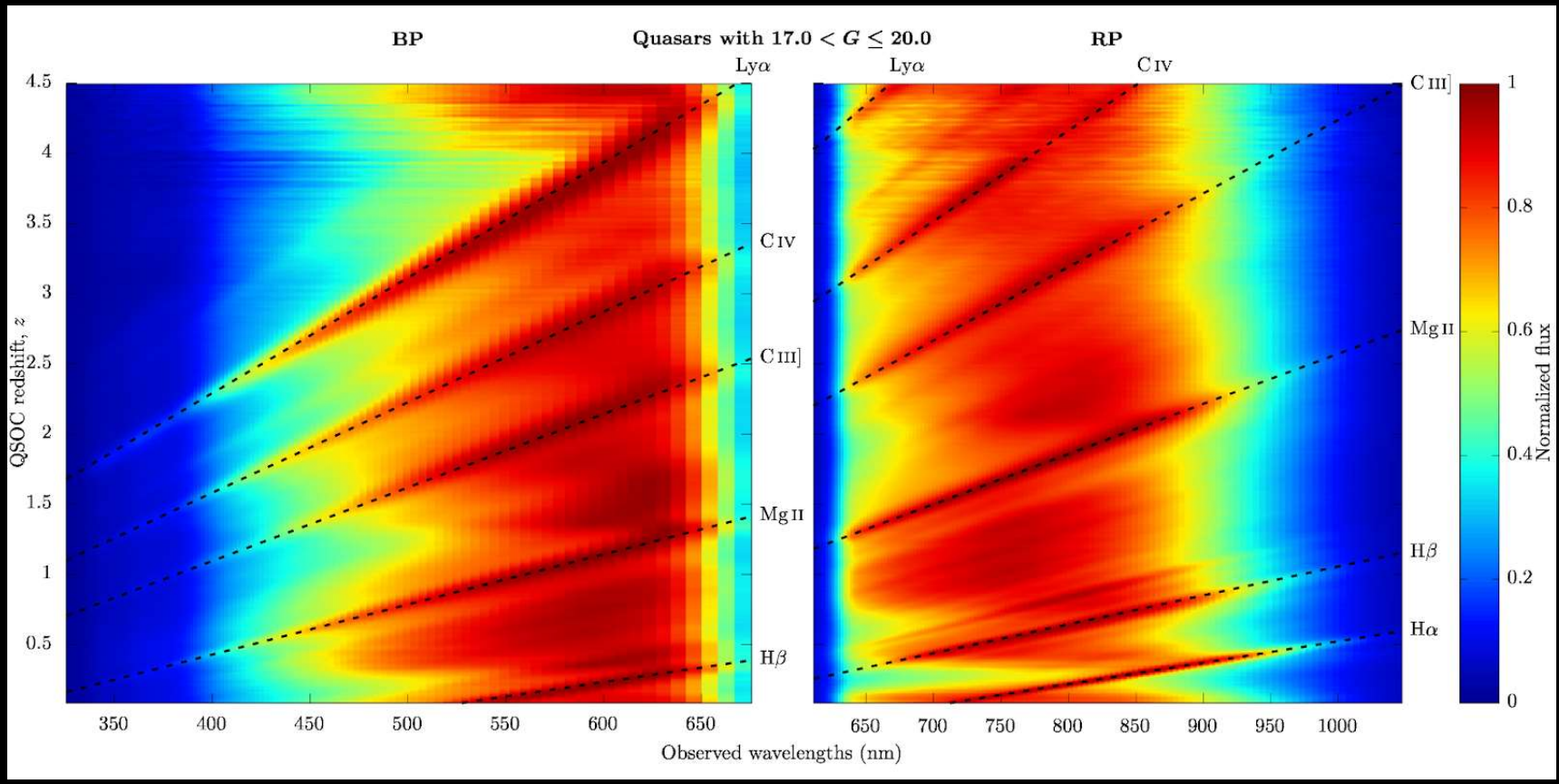




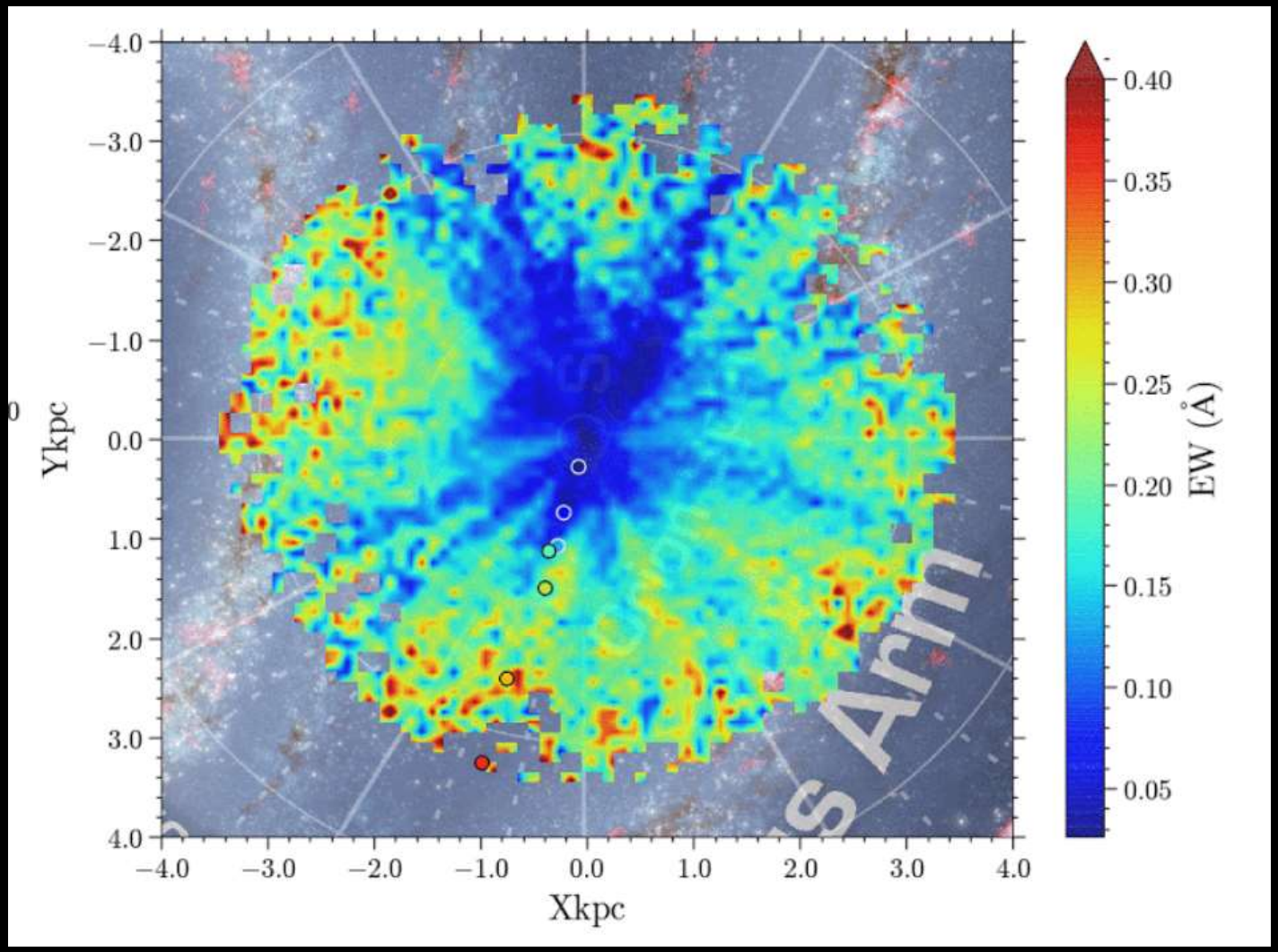
Chemical abundances of FGK stars from RVS spectra by GSP-Spec (Recio-Blanco+ 2016)

N, Mg, Si, S, Ca, Ti, Cr, Fe, FeII, Ni, Zr, Ce, Nd

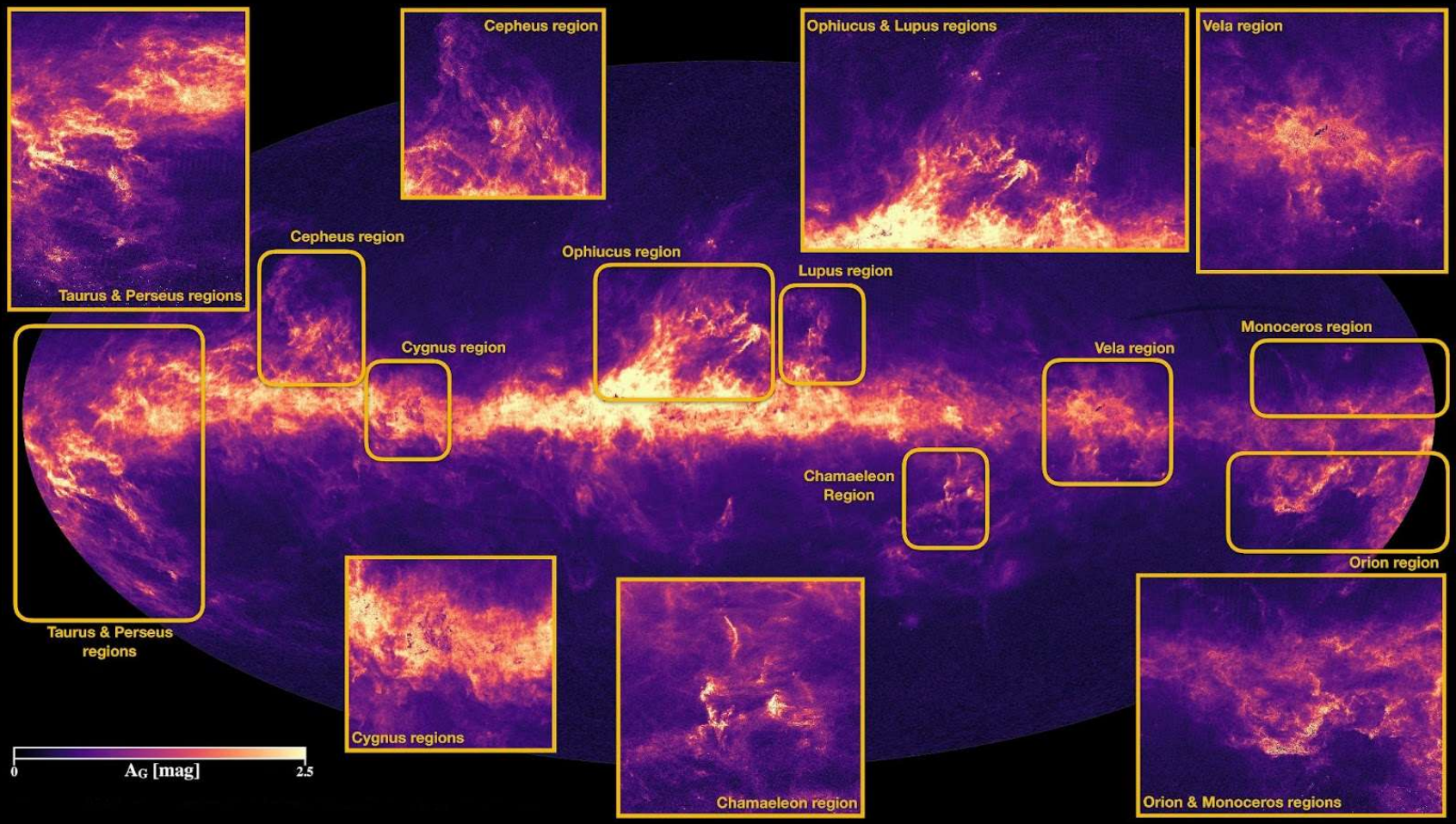
Not only stars: QSO redshifts



Not only stars: mapping DIBs



Not only stars: Extinction Map



Sources with APs

What can be expected in Gaia DR3?	Expected amount
Object classifications	~ 1,500,000,000
Stellar parameters based on BP/RP with T_{eff}, logg, [M/H], A_G, age, distance, ...	~ 480,000,000
Stellar parameters based on RVS with T_{eff}, logg, [M/H], [X/M], DIB, ...	~ 5,500,000
Hot stars	~ 2,500,000
Ultra cool dwarfs	~ 94,000
Emission line stars	~ 60,000
Diffuse Interstellar bands based on RVS	~ 500,000
Redshifts for unresolved galaxies	~ 1,300,000
Redshifts for QSOs	~ 6,300,000
Total Galactic Extinction Map at different resolution - Healpix level 6,7,8,9	-
Outlier analysis	~ 56,000,000

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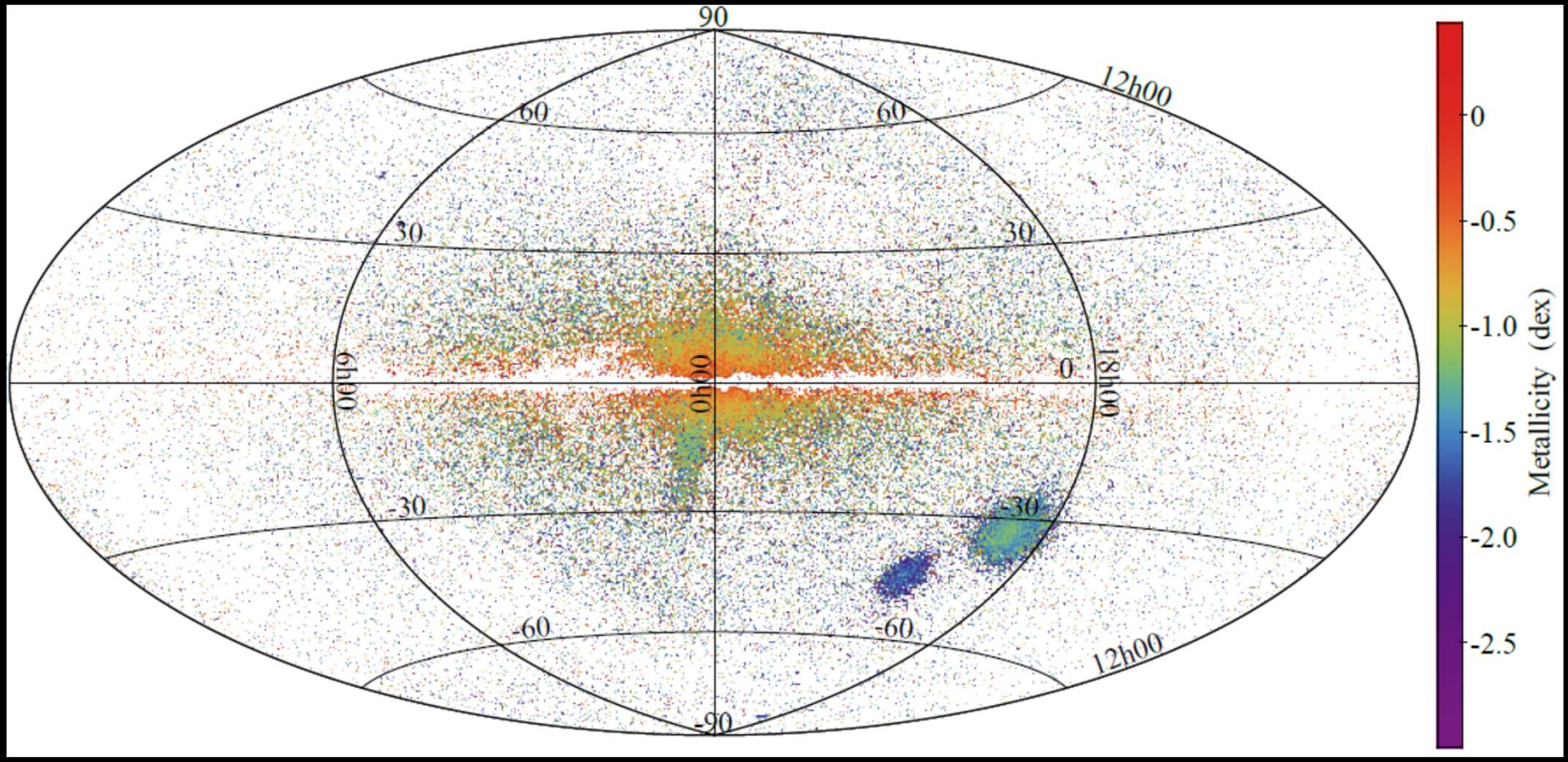
RR Lyrae in DR3



https://www.cosmos.esa.int/web/gaia/iow_20220225

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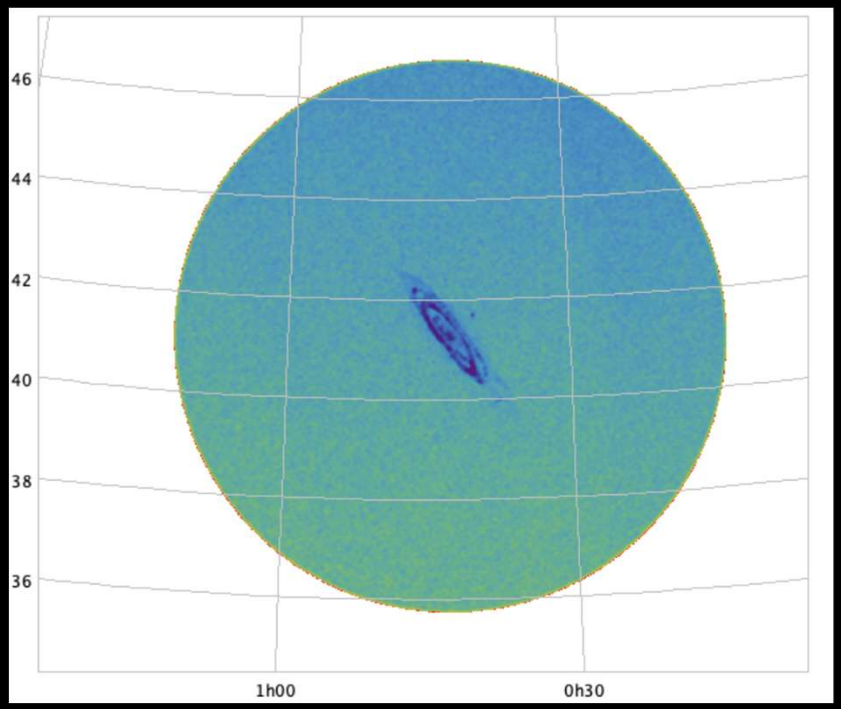
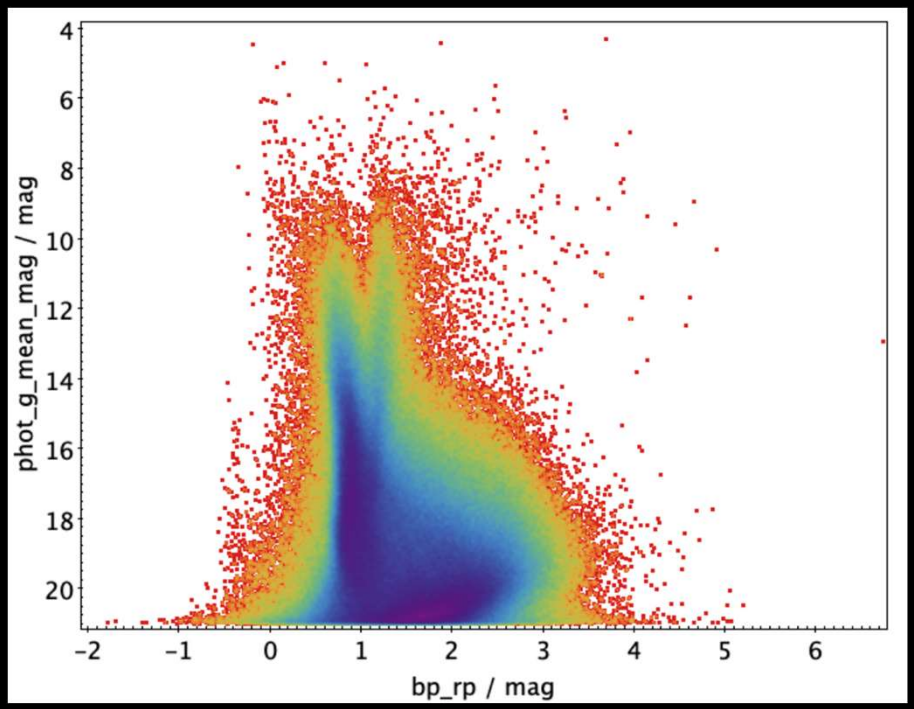
Gaia Andromeda Photometric Survey

Content: photometric time series for **all** sources located in a 5.5°-radius field centred on the Andromeda galaxy.





GDR3 pages

- Overview: https://www.cosmos.esa.int/web/gaia/data-release-3
- Content description: https://www.cosmos.esa.int/web/gaia/dr3
- Papers (titles): https://www.cosmos.esa.int/web/gaia/dr3-papers
- Known Issues: https://www.cosmos.esa.int/web/gaia/edr3-known-issues
- Previews: https://www.cosmos.esa.int/web/gaia/dr3-previews

DR3 papers

Performance verification papers

- Gaia Data Release 3: Mapping the asymmetric disc of the Milky Way
  Gaia Collaboration, Drimmel, R., et al.
- Gaia Data Release 3: Pulsations in main-sequence OBAF stars
  Gaia Collaboration, De Ridder, J., et al.
- Gaia Data Release 3: Reflectance spectra of solar system small bodies
  Gaia Collaboration, Galluccio, L., et al.
- Gaia Data Release 3: The Galaxy in your preferred colours. Synthetic photometry from Gaia low-resolution spectra
  Gaia Collaboration, Montegriffo, P., et al.
- Gaia Data Release 3: Stellar multiplicity, a teaser for the hidden treasure
  Gaia Collaboration, Arenou, F., et al.
- Gaia Data Release 3: The extragalactic content
  Gaia Collaboration, Bailer-Jones, C.A.L., et al.
- Gaia Data Release 3: Chemical cartography of the Milky Way
  Gaia Collaboration, Recio-Blanco, A., et al.
- Gaia Data Release 3: Golden Sample of Astrophysical Parameters
  Gaia Collaboration, Creevey, O.L., et al.
- Gaia Data Release 3: Exploring and mapping the diffuse interstellar bands
  Gaia Collaboration, Schultheis, M., et al.

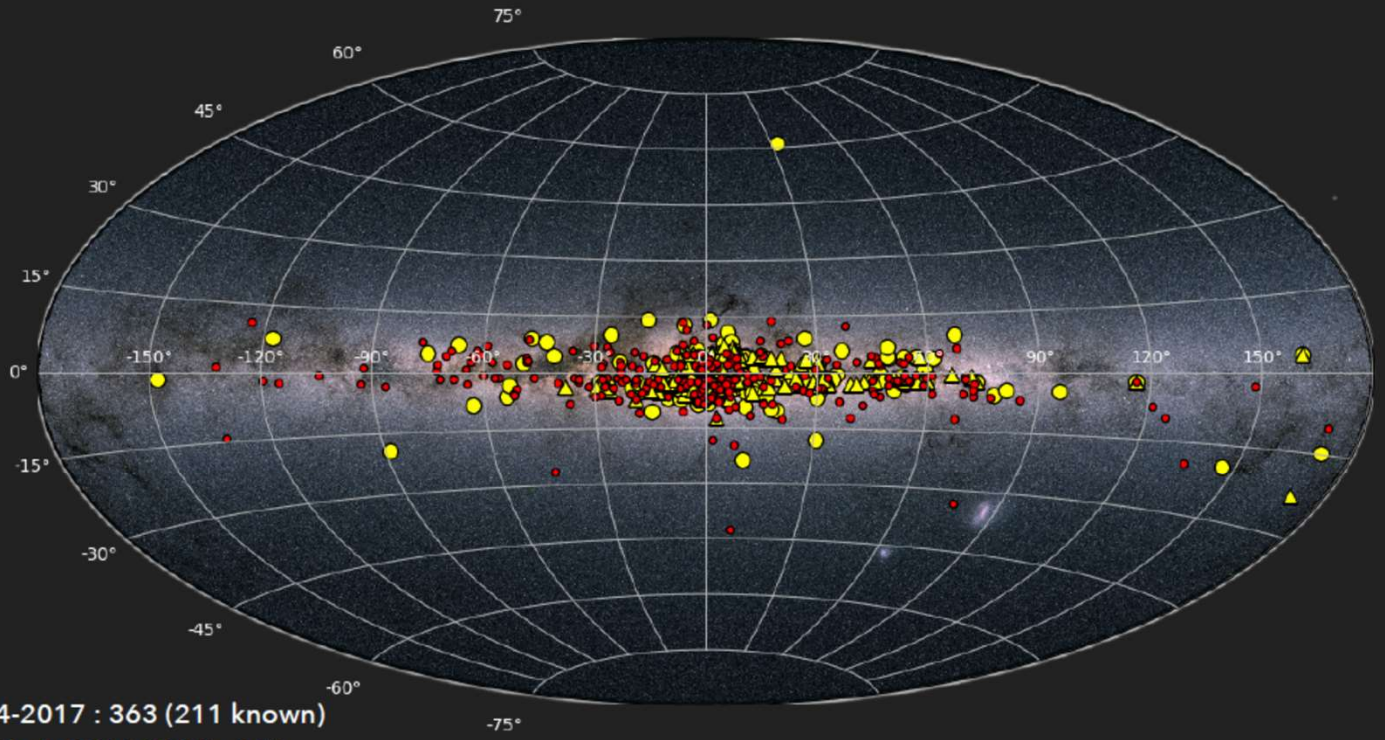
The Future

DR4:

- Baseline: 66 months of observations
- Gain: factor 1.4 for parallaxes, factor 2.8 for proper motions
- When: not before end 2025
- What:
  - More and better astrometry, photometry and spectroscopy
  - binaries and exoplanets
  - Epoch astrometry, photometry, and BP/RP/RVS spectra

DR5: 10yrs of observations, > 2030

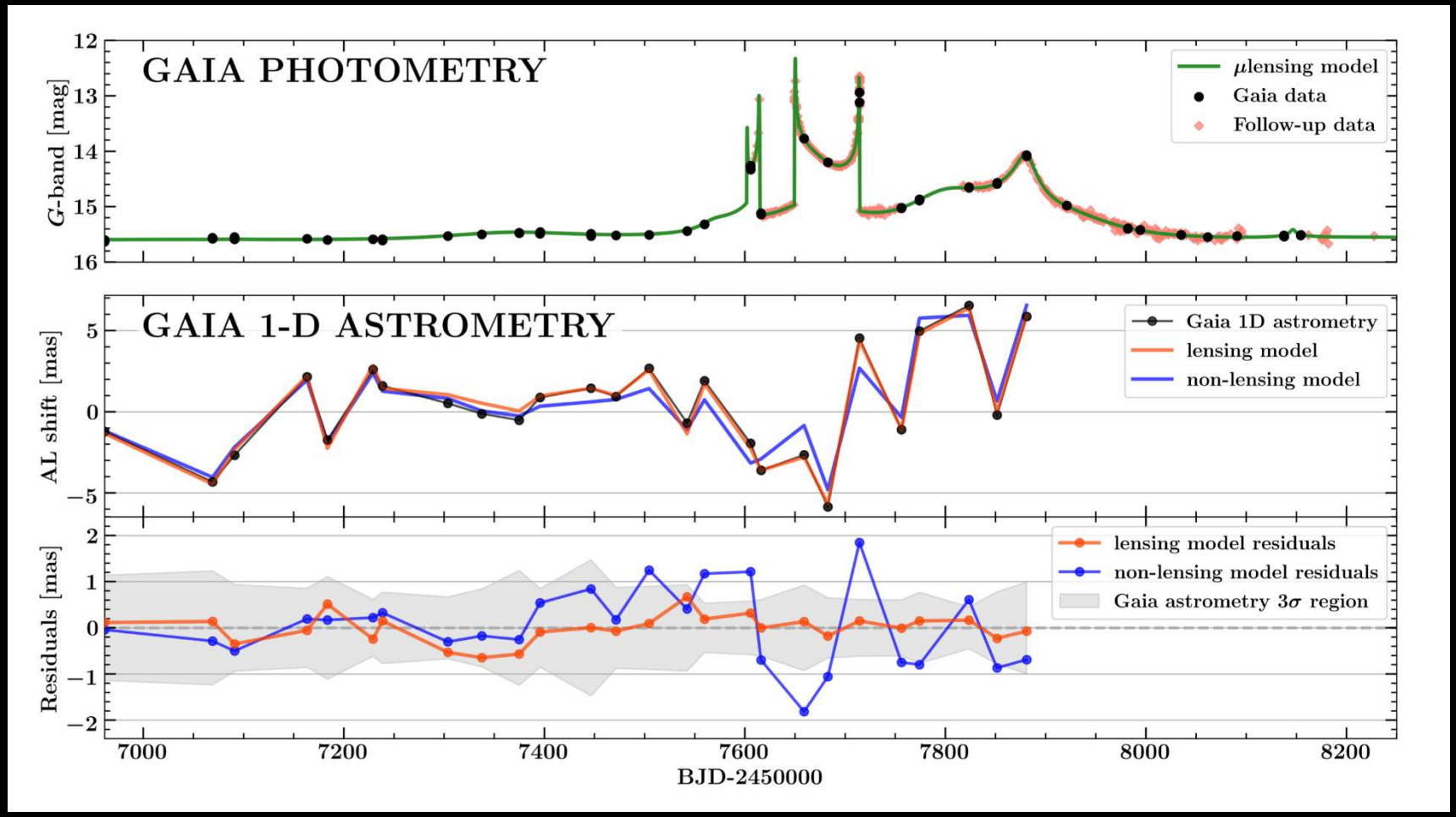
MICROLENSING EVENTS IN GAIA DR3 AND GAIA SCIENCE ALERTS



Gaia DR3 2014-2017 : 363 (211 known)

Gaia Science Alerts 2016-2020 : 244

Gaia16aye



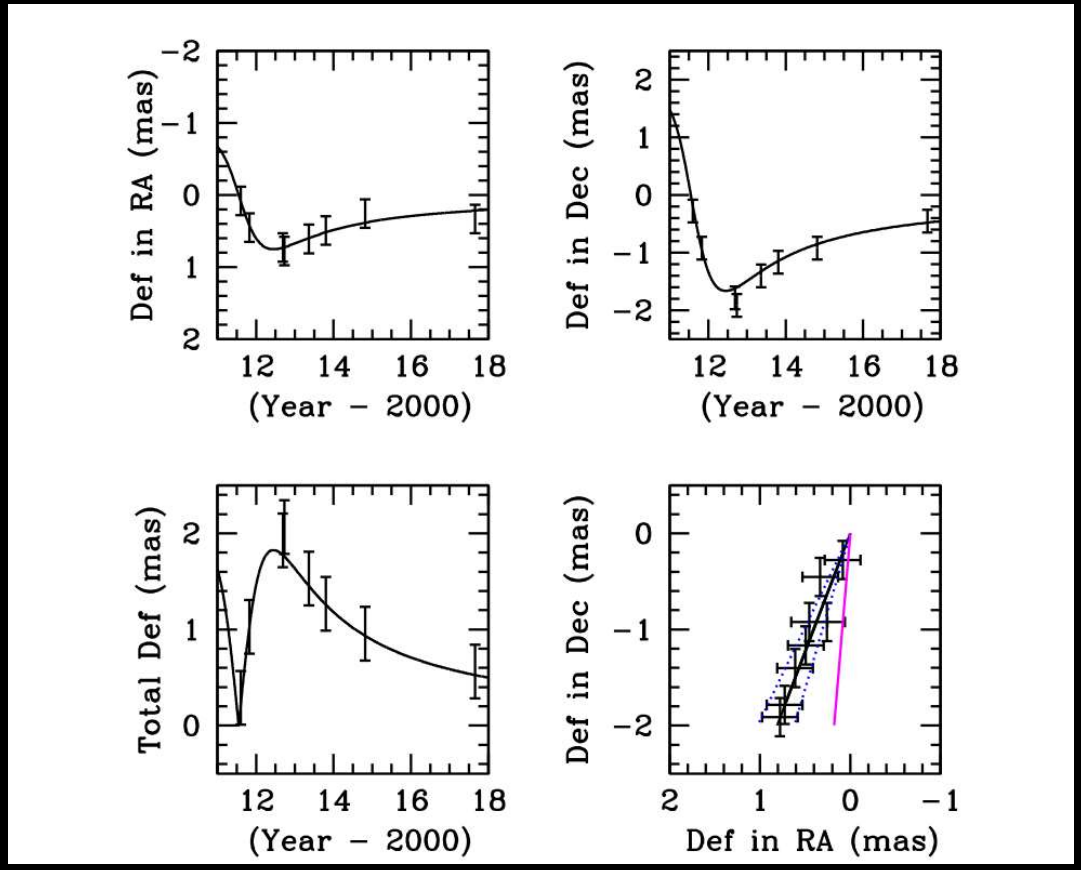
https://www.cosmos.esa.int/web/gaia/iow_20210924

Isolated Black Hole?

7.1 +/- 1.3 M_Sun
at 1.58 +/- 0.18 kpc

OR

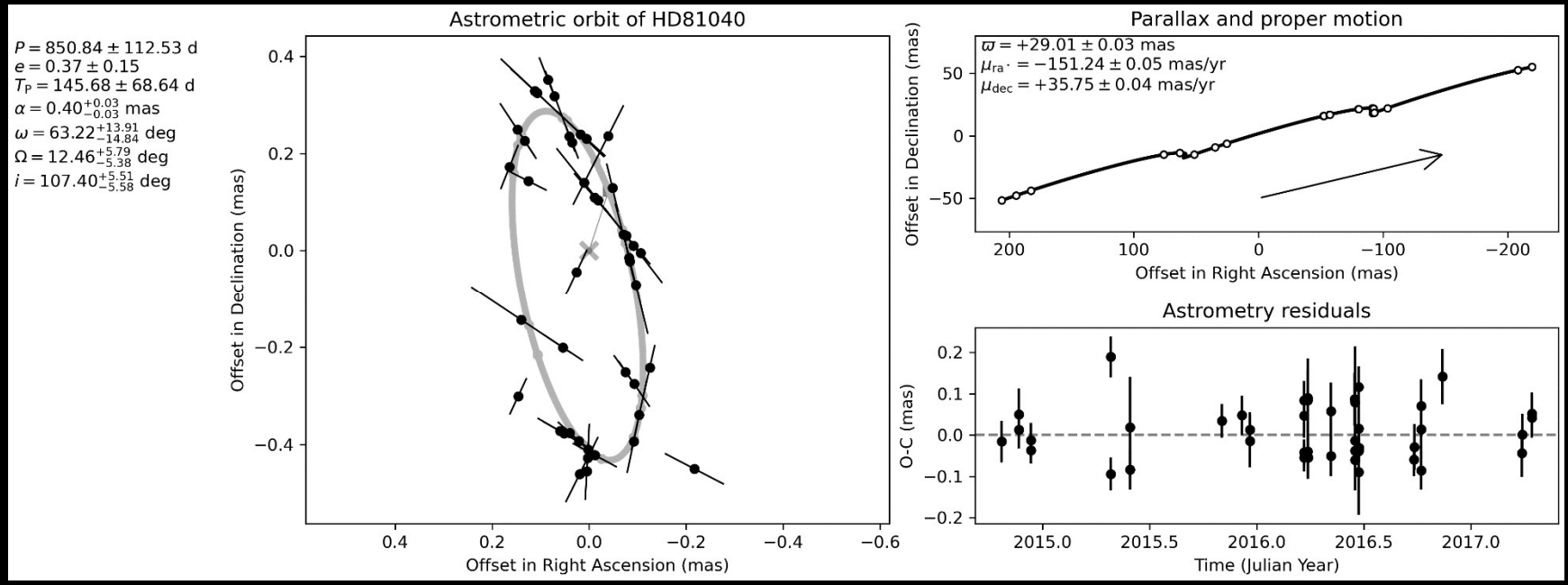
1.6 - 4.2 M_sun
at 690 - 1370 pc



Paper 1: https://ui.adsabs.harvard.edu/abs/2022arXiv220113296S/abstract

Paper 2: https://ui.adsabs.harvard.edu/abs/2022arXiv220201903L/abstract

Gaia Exoplanets



https://www.cosmos.esa.int/web/gaia/iow_20220131

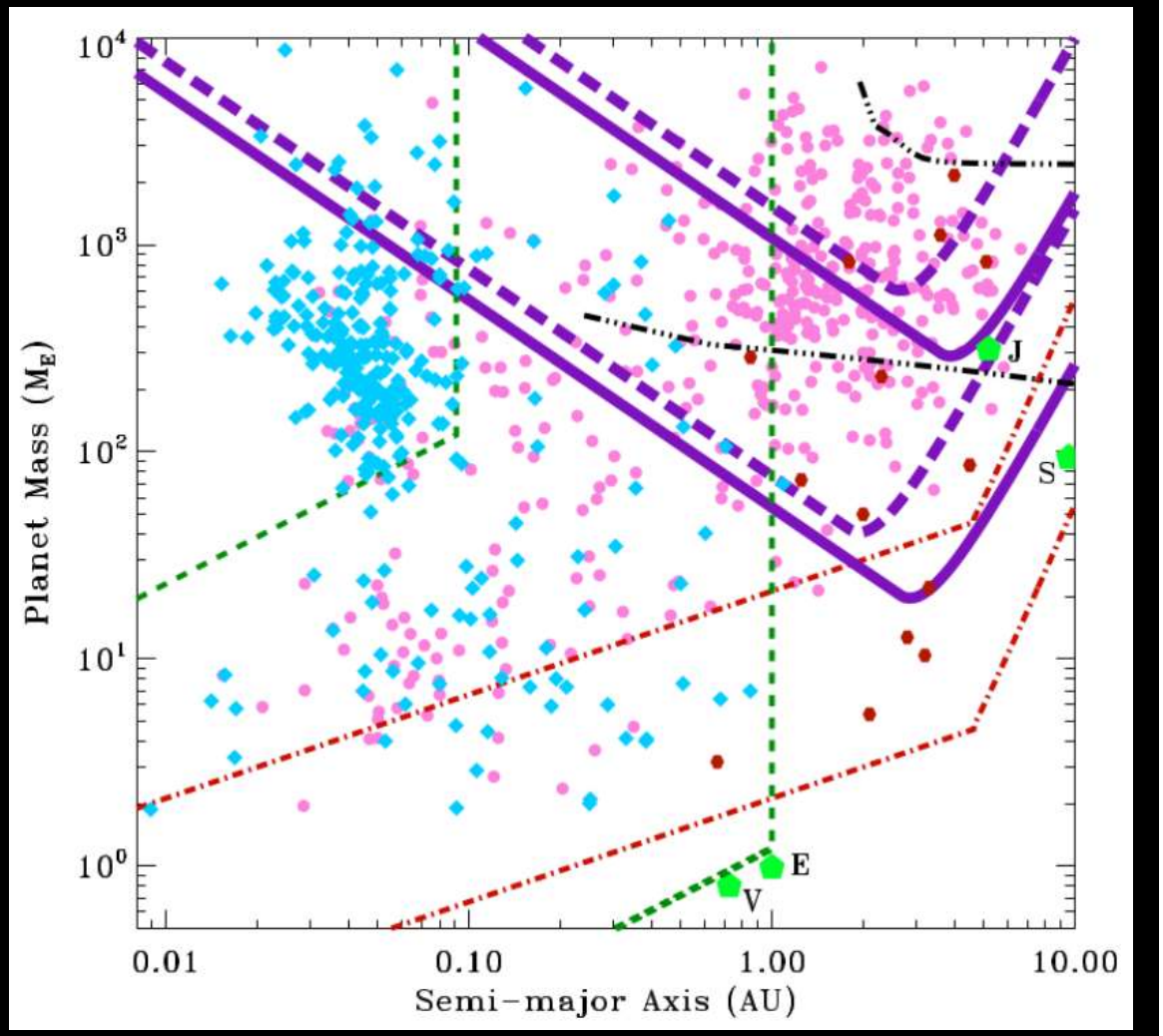
Gaia exoplanet discovery space

Unbiased, magnitude-limited planet census of maybe 10^6-10^7 stars

>10^4 NEW gas giants (< 15 M_{JUP}) around A through M dwarfs

<u>Numbers might as much as triple for a 10-yr mission</u>

Measured M_P / M_*



The End