De Gaia DR2 à EDR3

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(Using the DPAC slideshow)

3 décembre 2020 • Publication du 3ème catalogue Gaia, première partie (EDR3)

Gaia mission

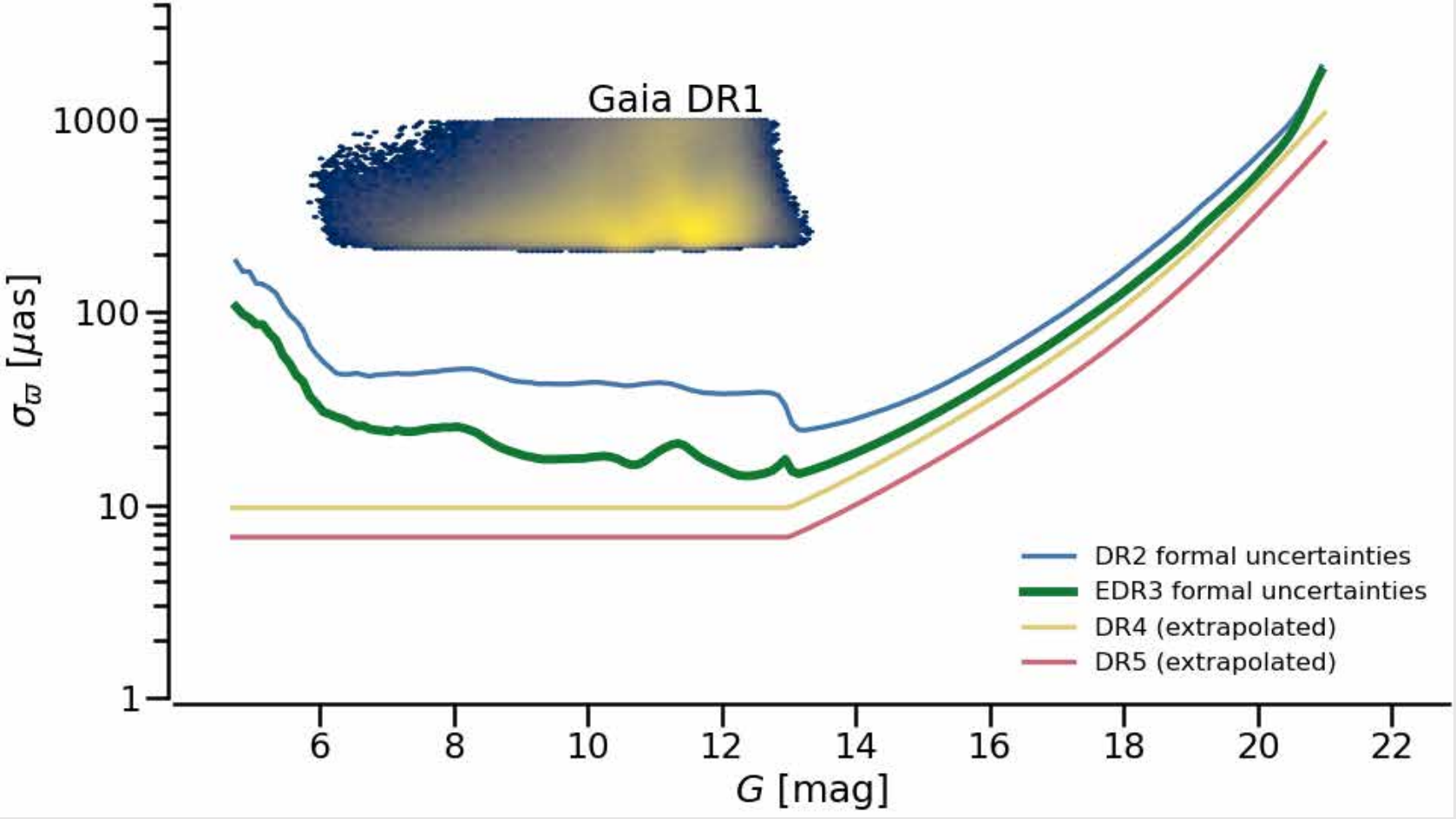
- Mission status
  - Operations continue with minimal impact on science
  - Up to now, more than 160 billion object detections :
    - More than 1,600 billion astrometric CCD measurements
    - More than 320 billion spectrophotometric CCD measurements
    - More than 31 billion CCD spectra for radial velocities

- Mission extension
  - Gaia nominal 5 year mission was completed summer 2019
  - Gaia expected to continue observing until early 2025
    - End of mission due to end of consumables for micropropulsion
    - Would represent 10 years of Gaia data
  - Gaia extension funding formally approved until the end of 2022
    - indicatively until the end of the satellite operations in 2025

Gaia EDR3

- In April 2018, Gaia DR2 has represented a major breakthrough
  - More than 3 800 papers quote Gaia results
- The DR3 release will publish for the first time most of Gaia “products”
  - Which represents a serious challenge, planned for 2022
  - With astrometry and photometry yet ready early 2020
    - For the community, publishing this data was deemed useful
- EDR3 represents an observing time of 34 months vs 22 for DR2, 14 for DR1
  - Astrometric precision scales as $t^{-0.5}$ for parallaxes and $t^{-1.5}$ for p.m.
  - Time also allows better instrument calibrations

Parallax precision



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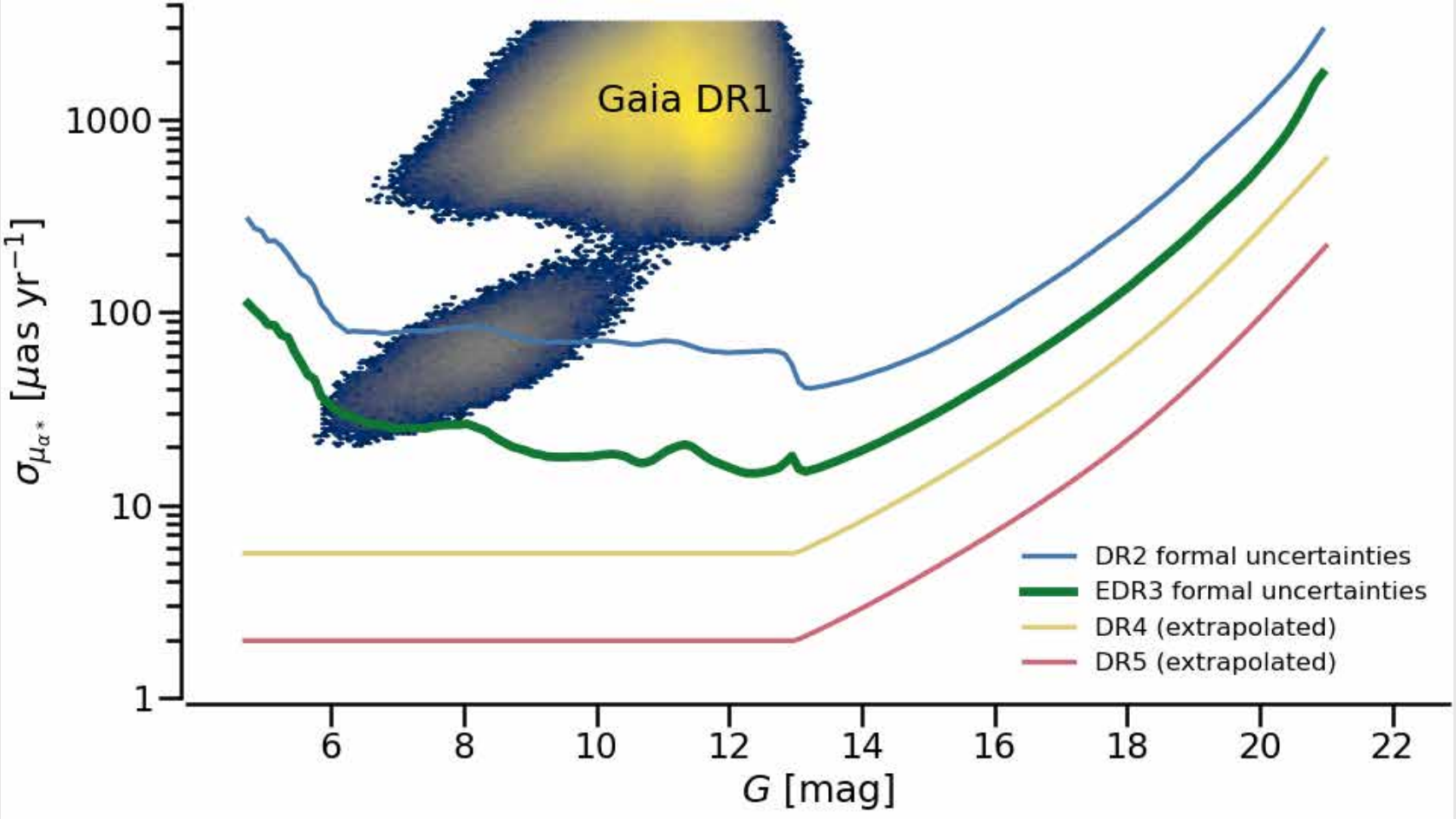
Proper motion precision



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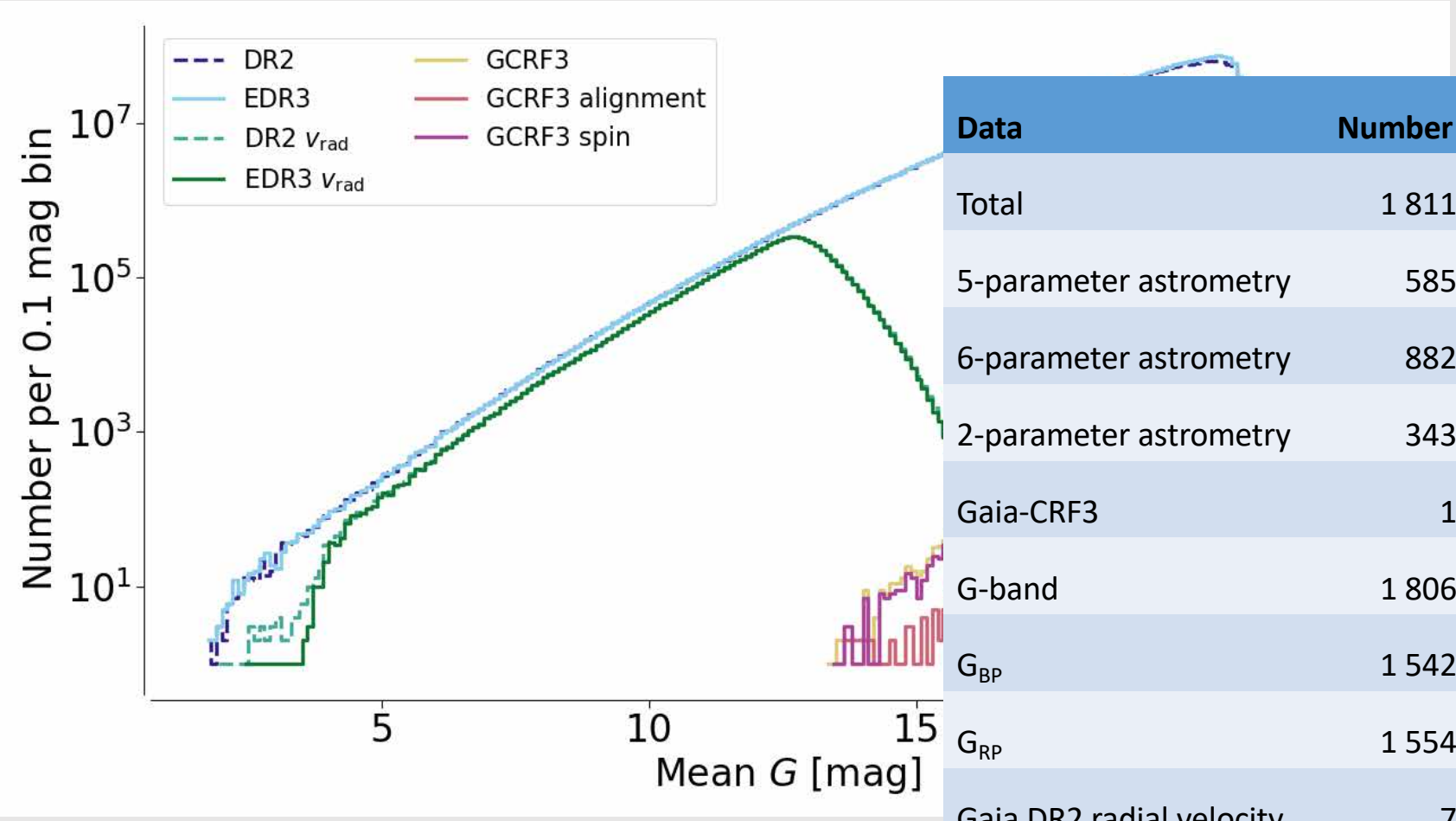
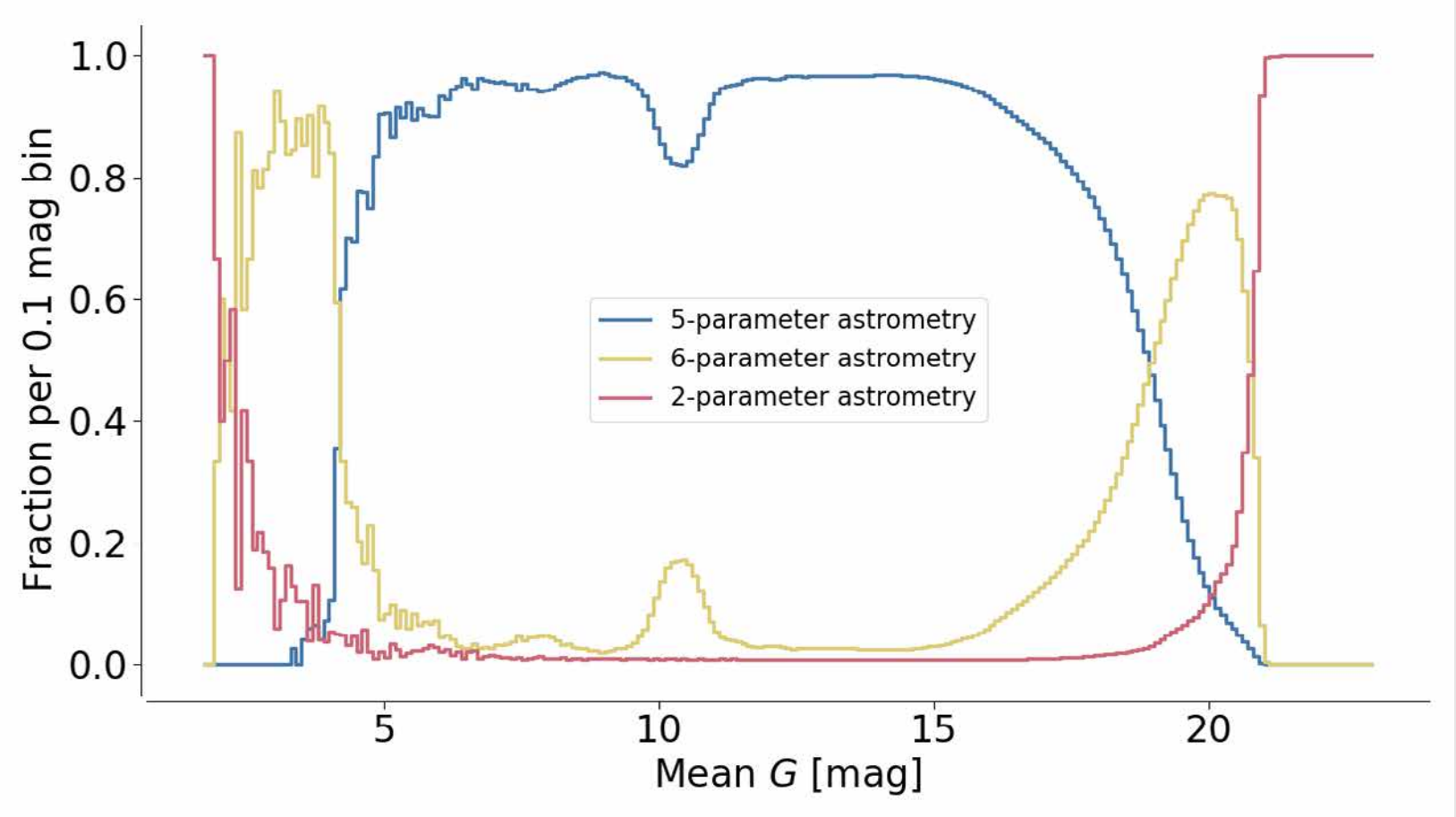
Completeness in magnitude

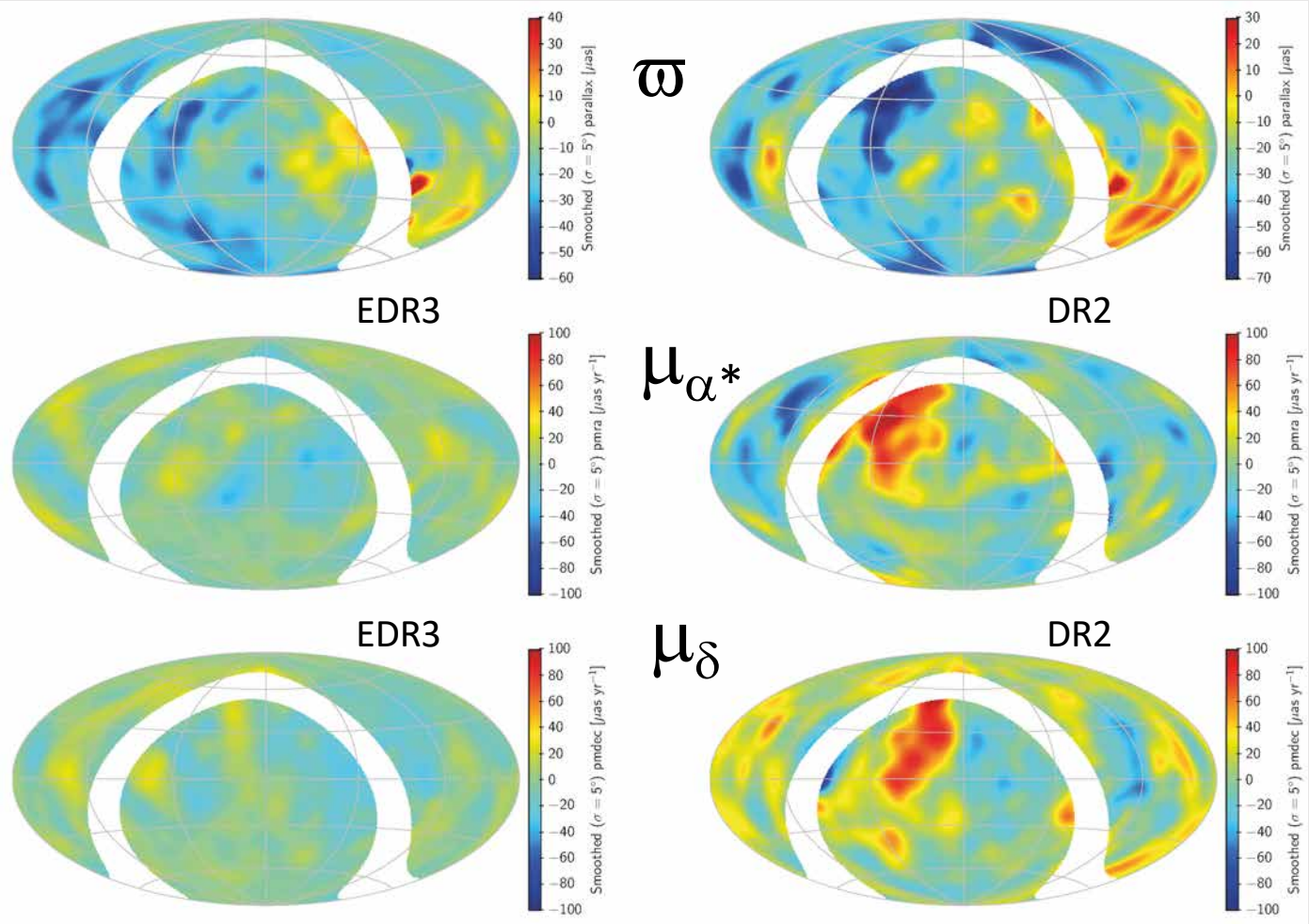


Data	Number
Total	1 811 709 711
5-parameter astrometry	585 416 709
6-parameter astrometry	882 328 109
2-parameter astrometry	343 964 953
Gaia-CRF3	1 614 173
G-band	1 806 254 432
G_{BP}	1 542 033 472
G_{RP}	1 554 997 939
Gaia DR2 radial velocity	7 209 831

Fraction of solution types



Large scale systematics



ϖ

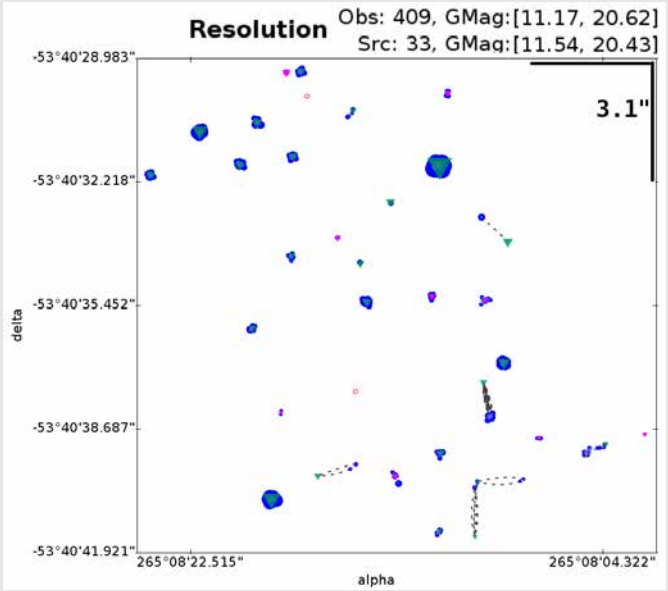
$\mu_{\alpha*}$

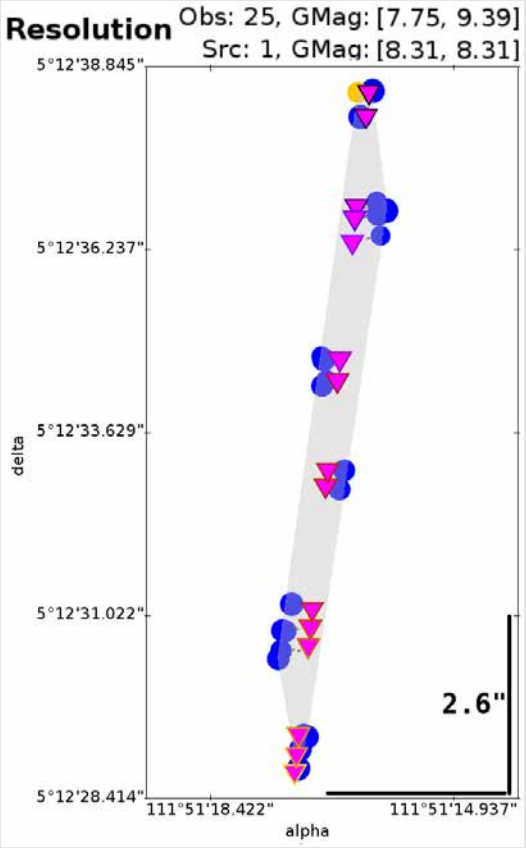
μ_{δ}

Systematics as mapped through quasar parallaxes and proper motions

- Global parallax zero point: -17 μas
- RMS angular variations: 26 μas and 33 μas/yr

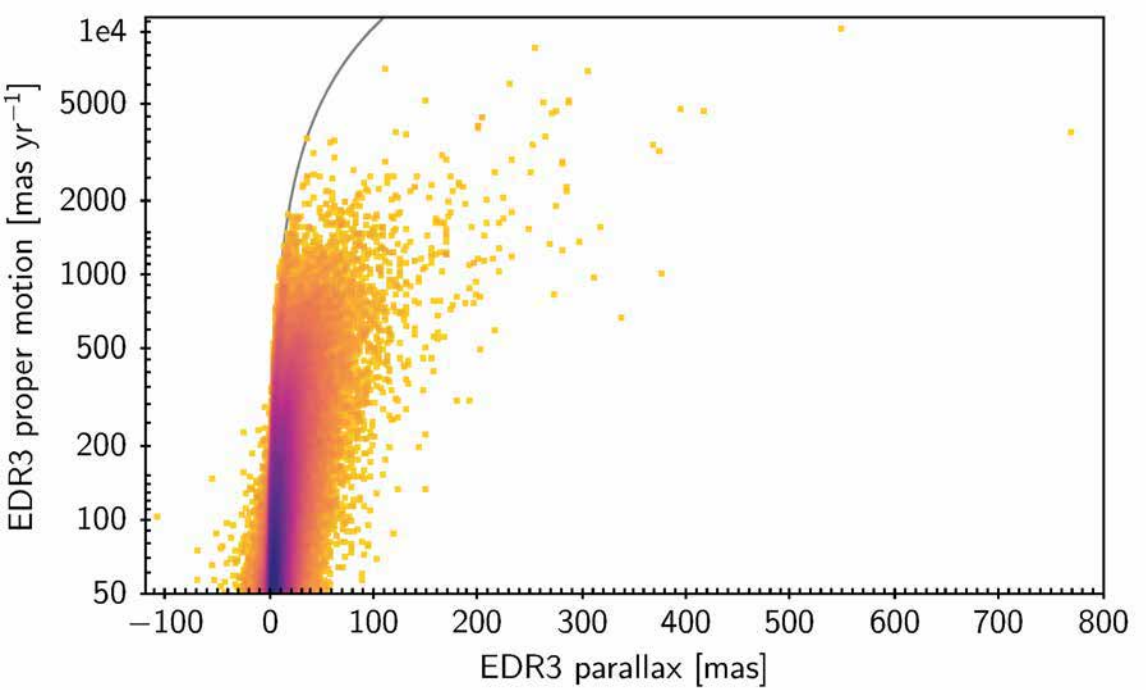
Other notable changes DR2 to EDR3





- Photometric system changed
  - Passbands
  - Zero points
- Completeness in crowded regions improved
- Lower limit on source separations is now 0.18 arcsec
- Source list improved
  - 4% of source_id changed
  - Improved large p.m.

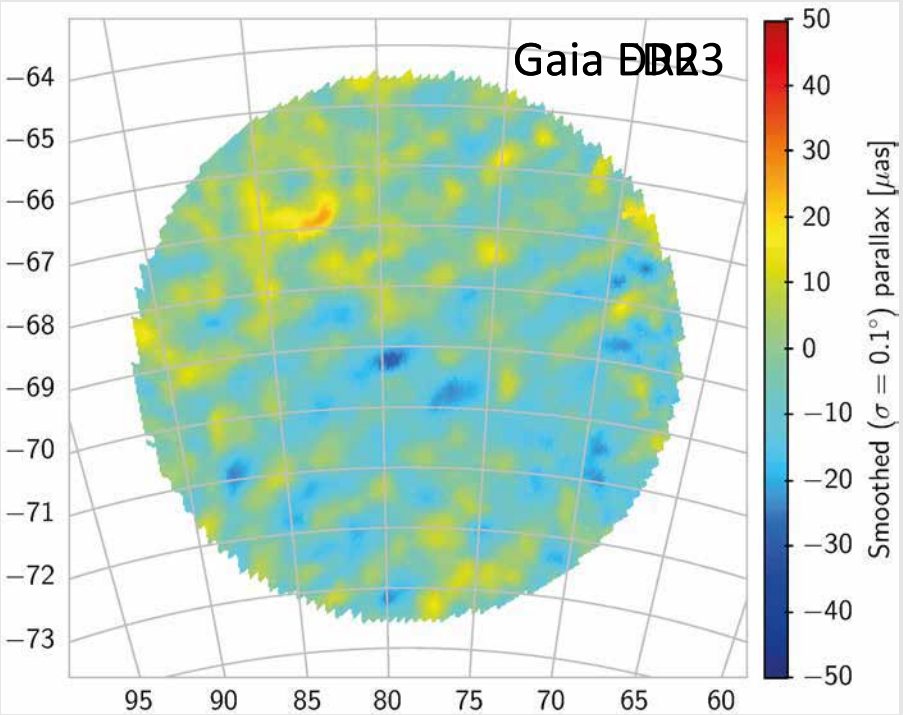
Astrometry: spurious solutions

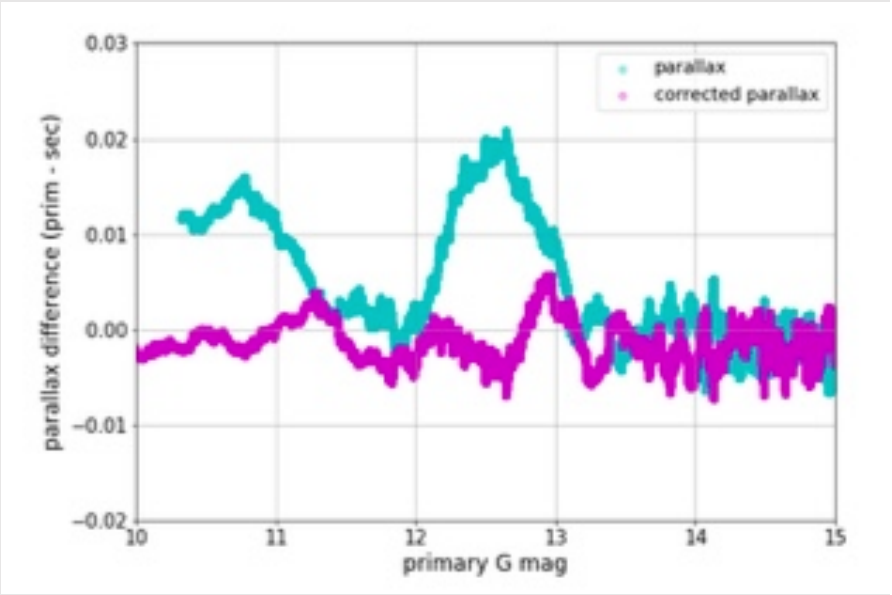


Spurious parallaxes and proper motions still present

- Due to half-resolved sources not (yet) handled
- Much less frequent than in Gaia DR2
- Spurious solutions produce smaller errors on astrometry
- For solutions with S/N>5 :~1.6% → 10% at G=20 for 6p

Astrometry: zero-point systematics



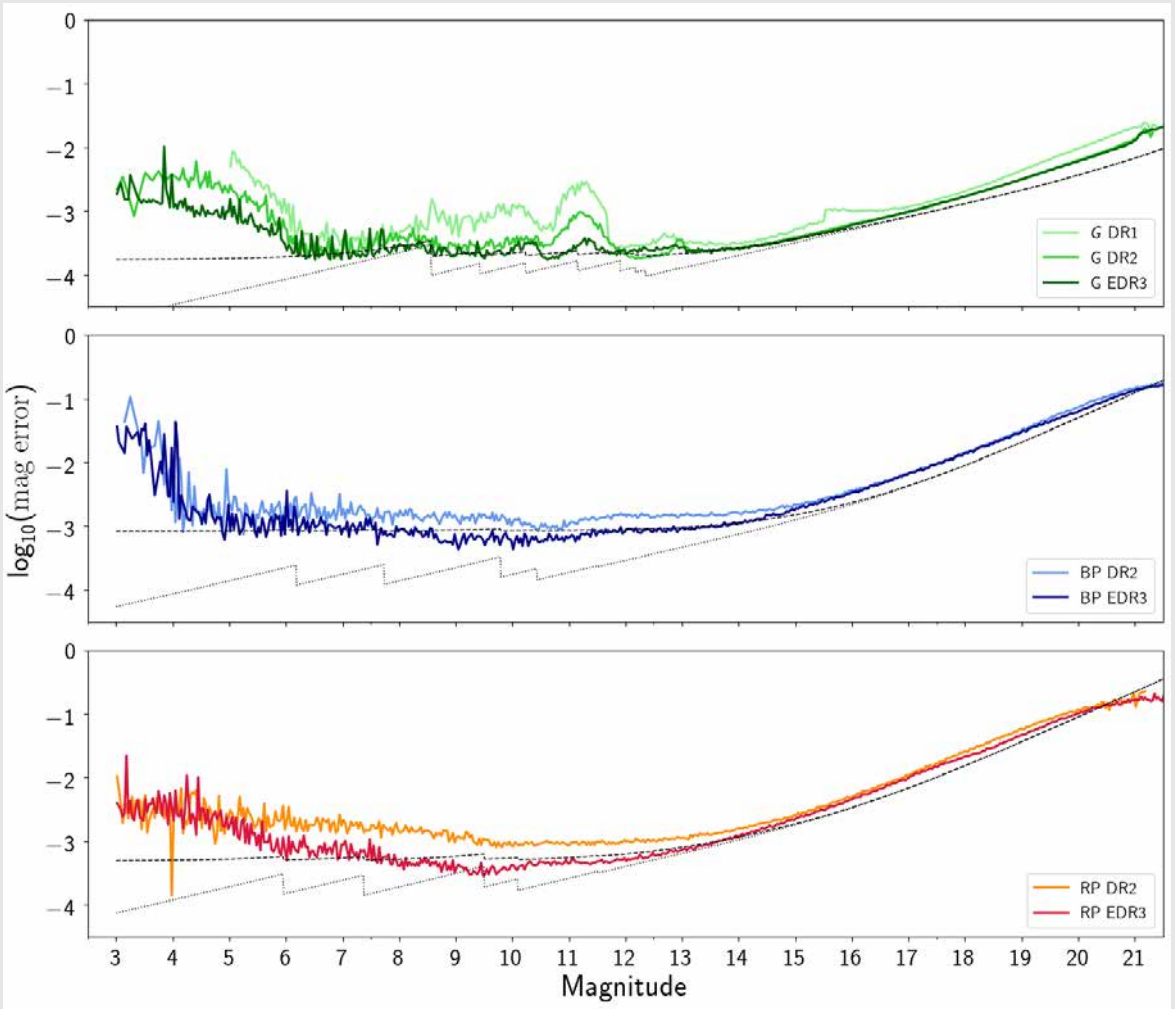


Parallax zero-point variations still present (significantly supressed)

- Tentative ad-hoc recipe is proposed to correct for the variations
- Python code at https://gitlab.com/icc-ub/public/gaiadr3_zeropoint
- Proper motions also show systematics and angular correlations

Photometric precision

Uncertainty



G

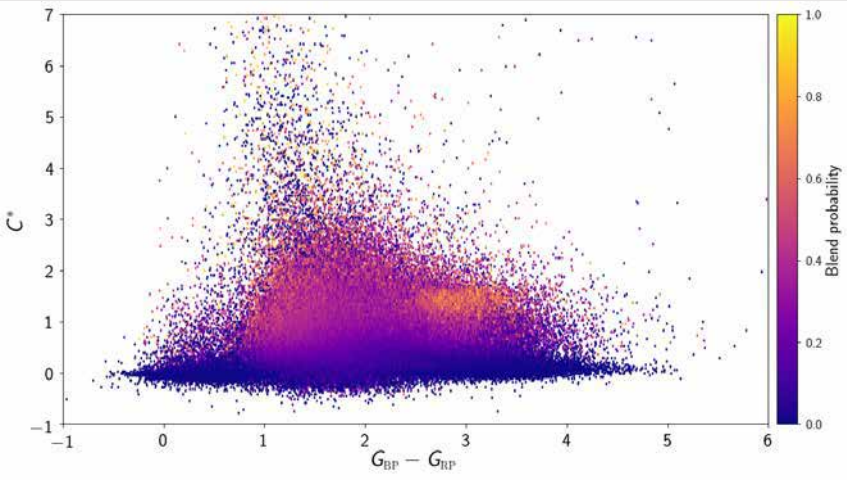
G_{BP}

G_{RP}

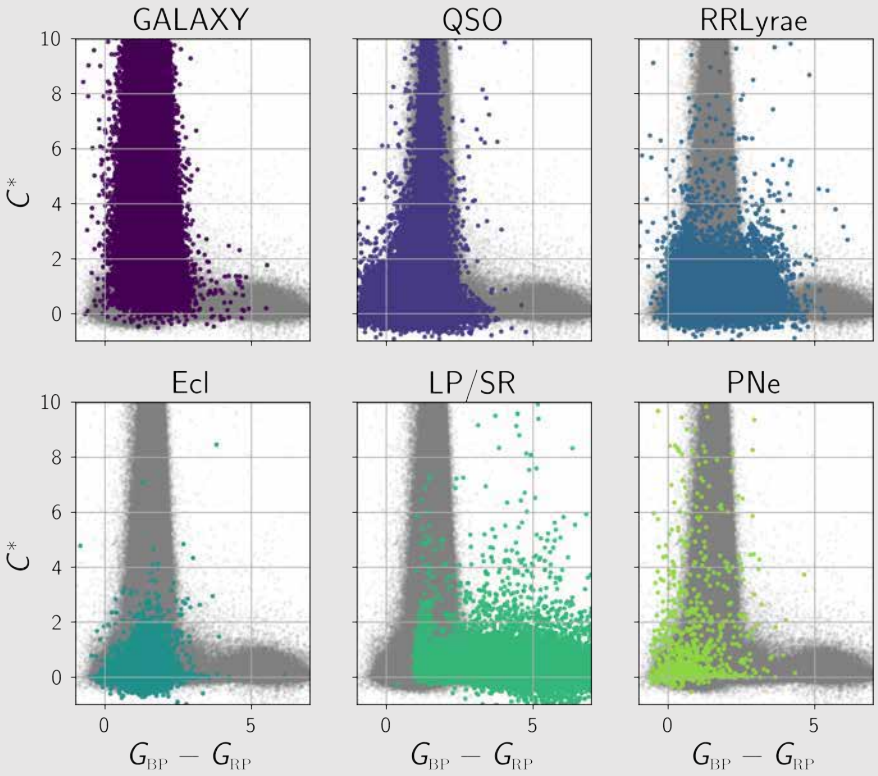
Compared to DR1,2

- Less systematics for bright stars
- No jumps around G=13, 16
- Systematics below 0.01 mag

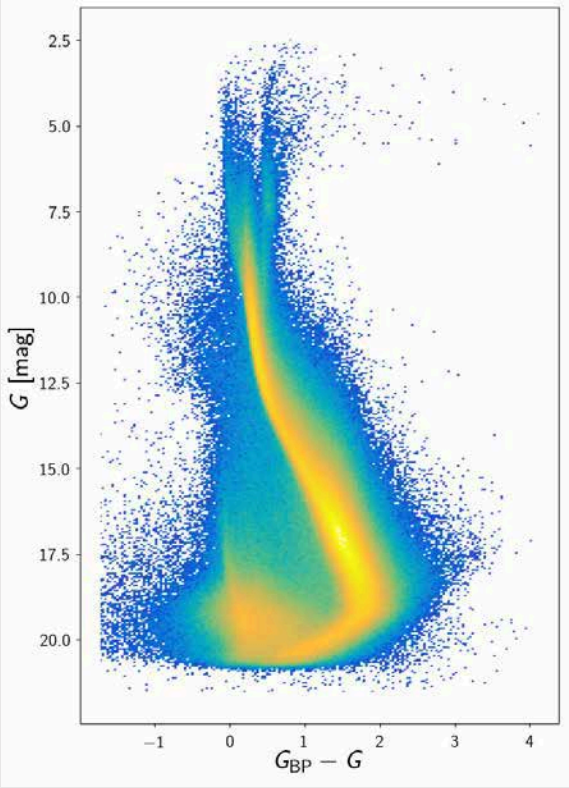
Photometry: flux excess factor



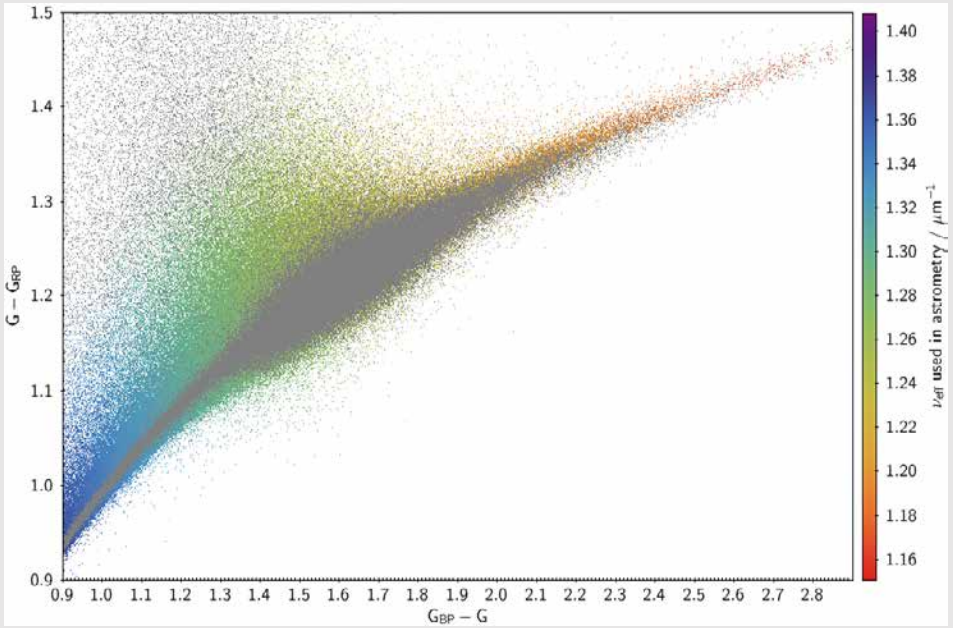
- A colour-independent form of flux excess factor
  - Formulae and ADQL/Python recipes available
- Flux excess can indicate issues with crowding or background subtraction
  - *but also contains astrophysical information*



Photometry: limitations



- At faint end BP flux overestimated
  - Sources appear too blue
- Use ($G-G_{RP}$) instead to study faint red sources



G-band photometry for sources with 6-parameter astrometry should be corrected

- Formulae and ADQL/Python recipes available

Useful tips

Question	Tip
Find a DR2 source	Use dedicated neighbourhood table
Isolated source?	Check image parameter statistics, in particular RUWE < 1.4
Parallax zero point	Consider applying the correction by Lindegren et al.
Spurious solutions	If selecting only positive parallaxes, make a similar selection with negative parallaxes for comparison + use ipd flags
Missing G mag	Alternative G photometry is available
G magnitude	A small correction should be added for 6p solutions
G_{BP} or G_{RP} mag.	Strong bias for $G_{BP} > 20.5$, strong bias for $G_{RP} > 20$
Colour	Use $G-G_{RP}$ instead of $G_{BP}-G_{RP}$ when faint red sources are included
Calibration issues ?	RUWE < 1.4 + significant excess noise

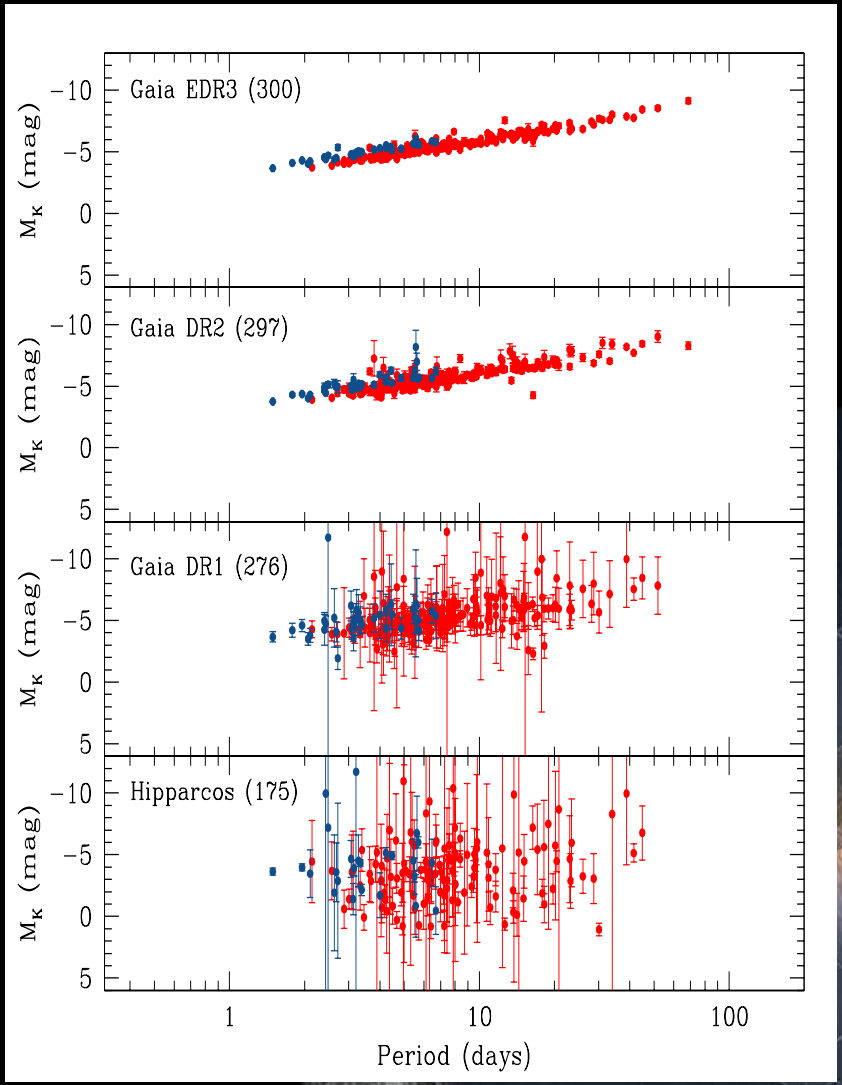
- In case of trouble, don't hesitate to ask…

Useful resources

- Several documentation papers and 4 science demonstration papers
- Several X-match available with main catalogues
  - Hipparcos-2, Tycho-2 + TDSC, 2MASS) PSC , SDSS DR13, Pan-STARRS1 DR1, SkyMapper DR1, GSC 2.3, APASS DR9, RAVE DR5, allWISE, and URAT-1
  - a Gaia DR2 to Gaia EDR3 match table : `dr2_neighbourhood`
- Useful links
  - Main ESA link: https://www.cosmos.esa.int/web/gaia/earlydr3
  - Table descriptions: https://www.cosmos.esa.int/documents/29201/1645651/DraftDataModel-EDR3.pdf
  - Photometric passbands: https://www.cosmos.esa.int/web/gaia/edr3-passbands
  - Transformation between main photometric systems in Riello et al.
  - Transit times https://www.cosmos.esa.int/web/gaia/scanning-law-pointings
  - Various Python codes : https://www.cosmos.esa.int/web/gaia/edr3-code
  - ESA Database access : https://gea.esac.esa.int/archive/
  - Database access from within ObsPM soon : https://gaia.obspm.fr/tap-server/tap

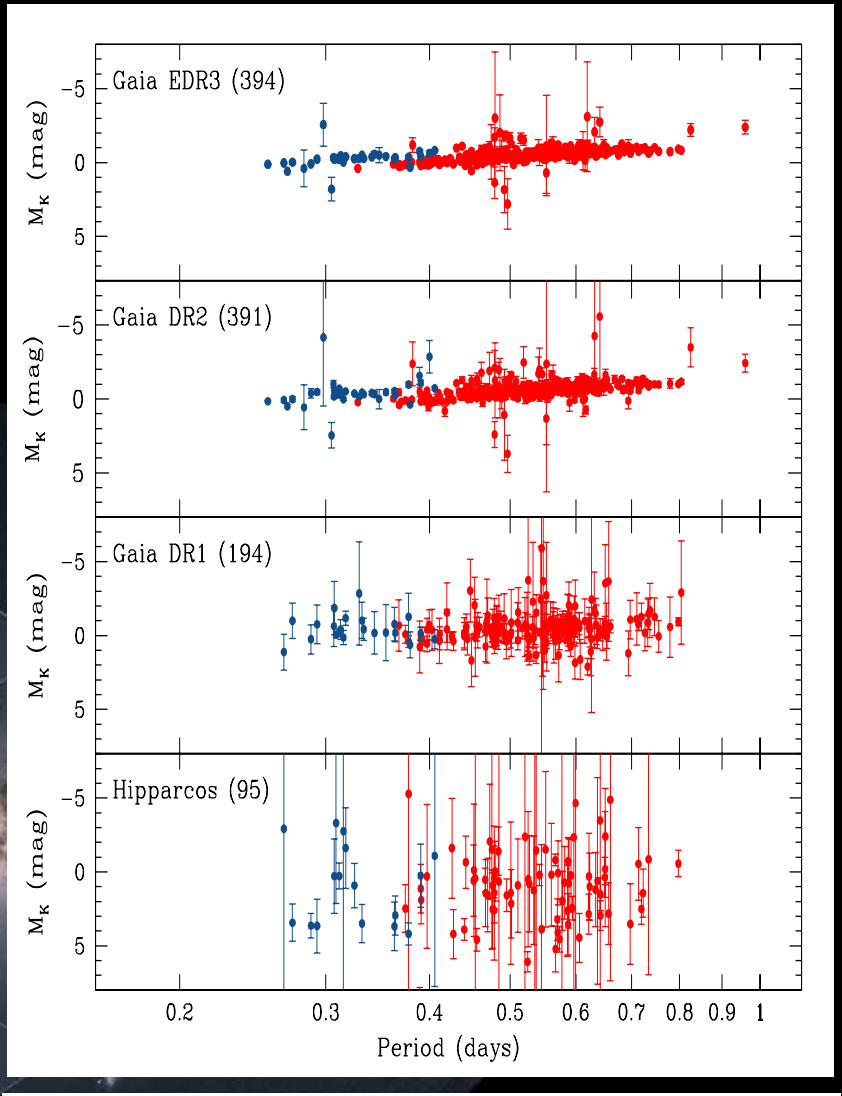
Cepheids and RR Lyrae as Standard Candles
From Hipparcos to DR1 to DR2 To Gaia EDR3

Cepheids

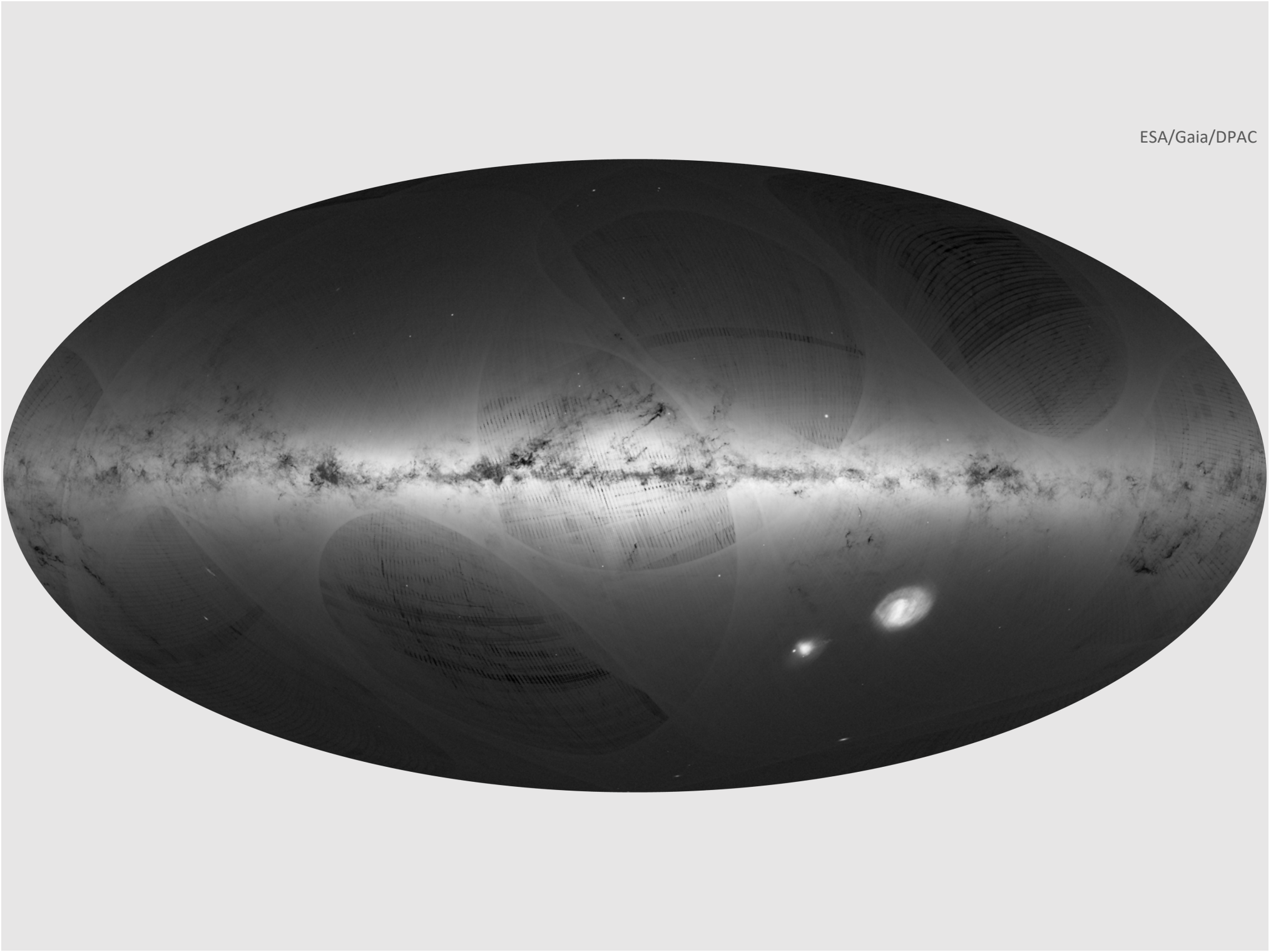


Credit: ESA/Gaia/DPAC, created by: V. Ripepi

RR Lyrae



Credit: ESA/Gaia/DPAC, created by: T. Muraveva & A. Garofalo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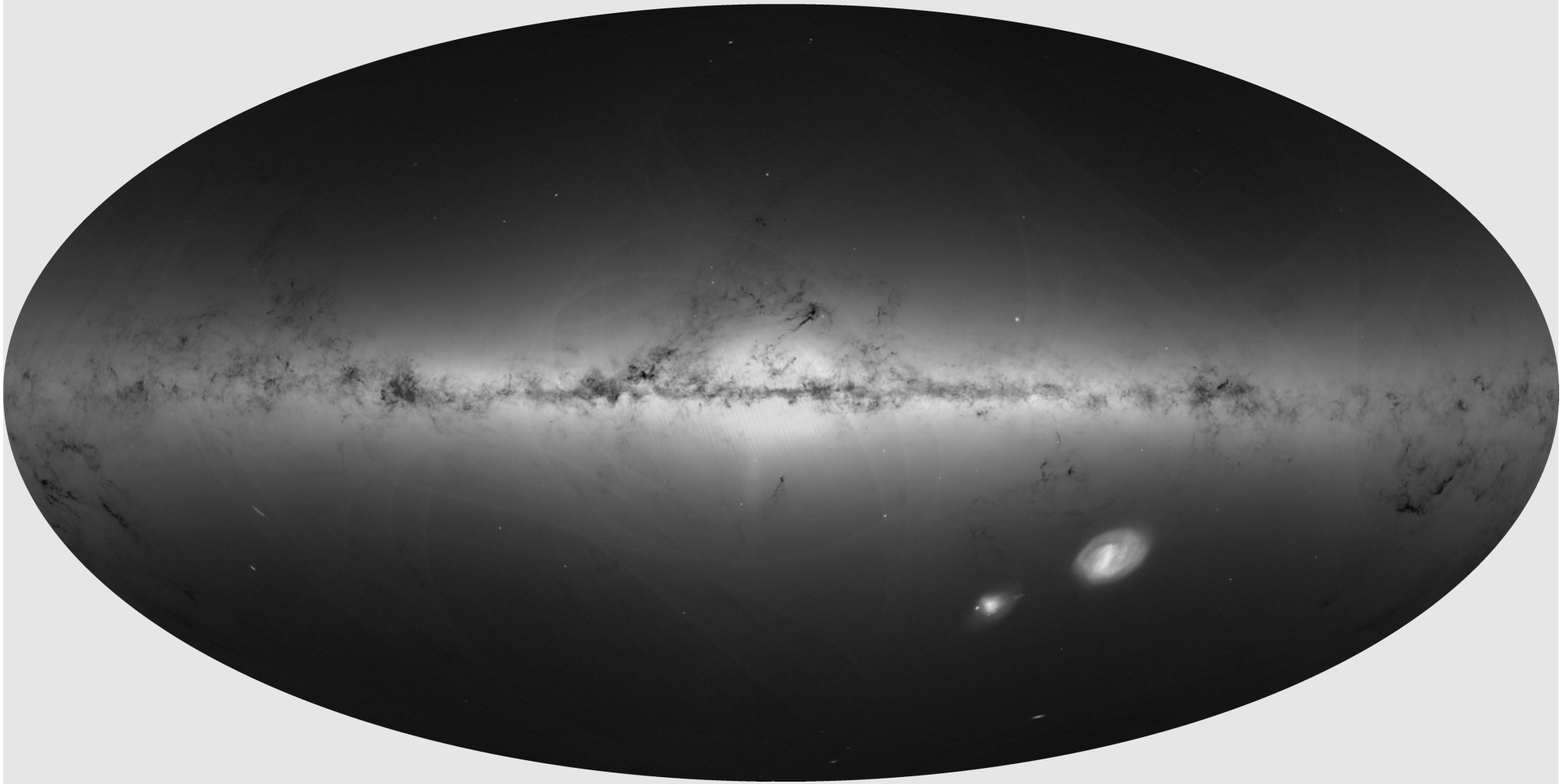

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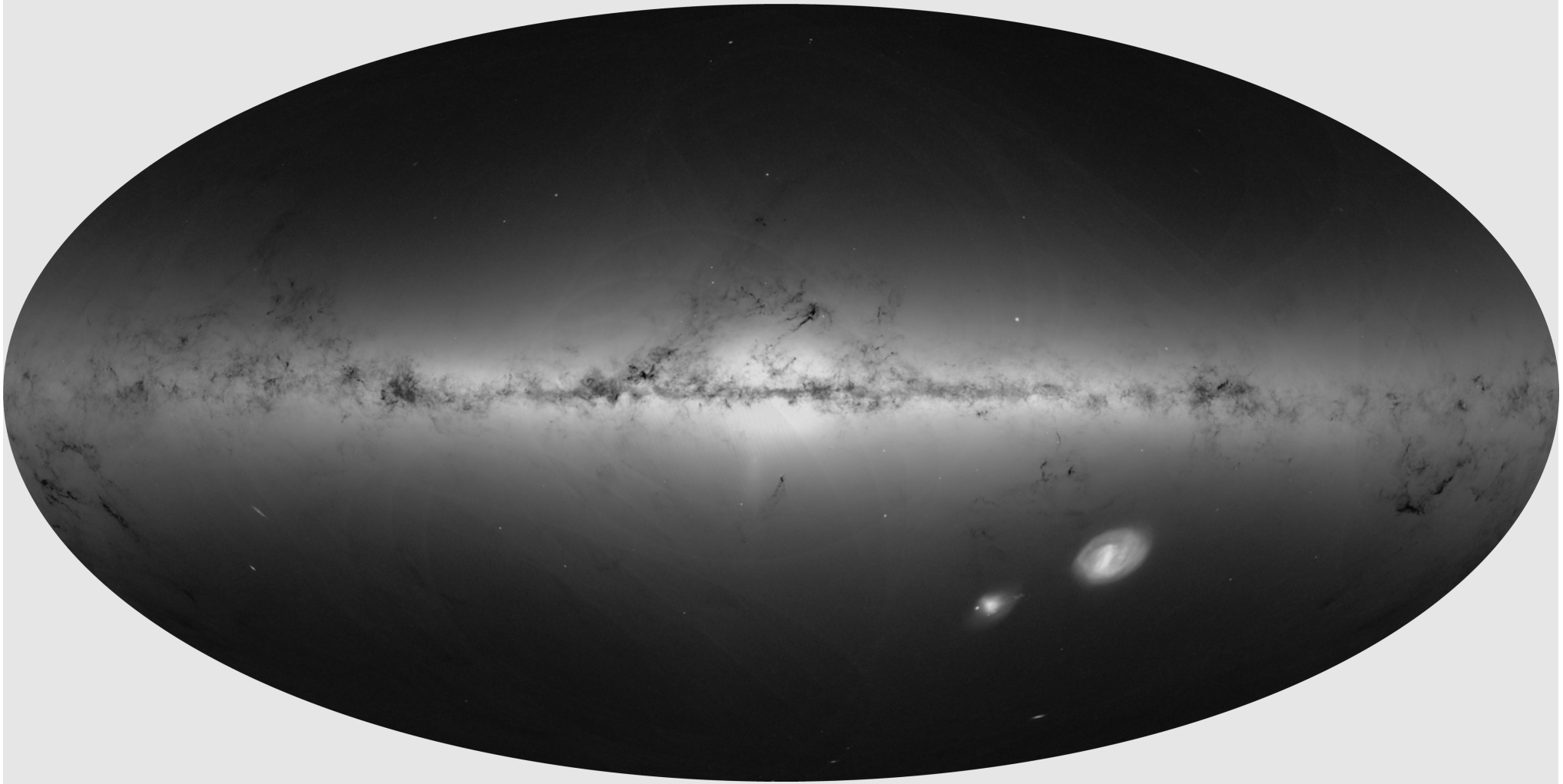

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