Gaia DR1 overview and future releases

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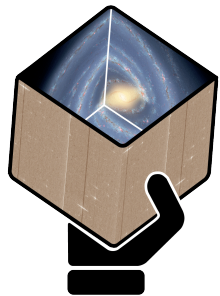
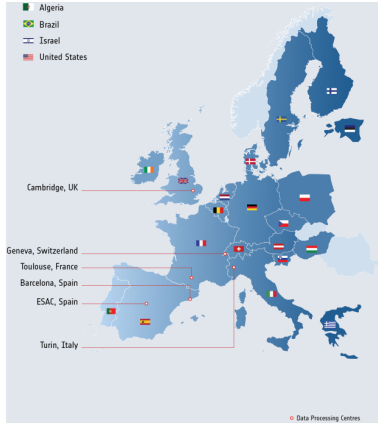
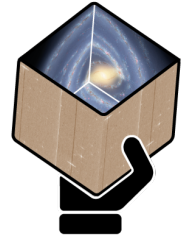


Teamwork to deliver the promise of Gaia

- 10+ years of effort
- 450 scientists and engineers
- 160 institutes
- 24 countries and ESA
- Six data processing centres





gaia

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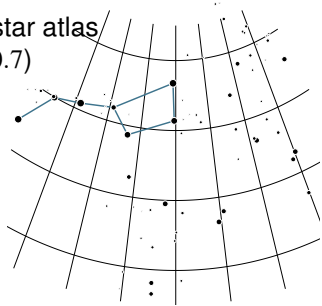
Gaia DPAC Data Processing & Analysis Consortium

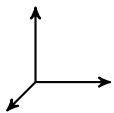
α δ ϖ $\mu_{\alpha*}$ μ_δ G ...

What's in the Gaia DR1 delivery

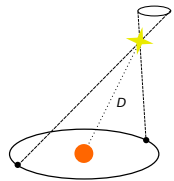
Billion star atlas
($G \lesssim 20.7$)

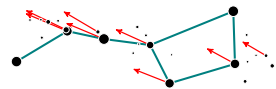


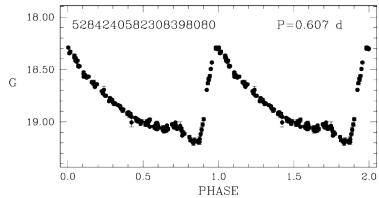
Positions and magnitudes
for ~ 2000 ICRF quasars



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

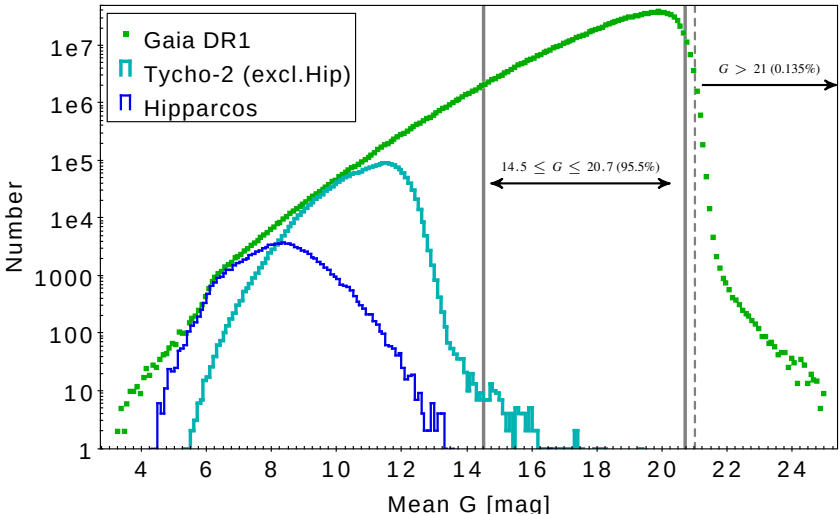






Variable stars near
south ecliptic pole
(~ 600 Cepheids,
~ 2600 RR Lyrae)

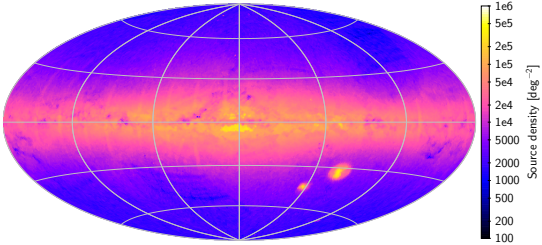
Gaia DR1 magnitude distribution



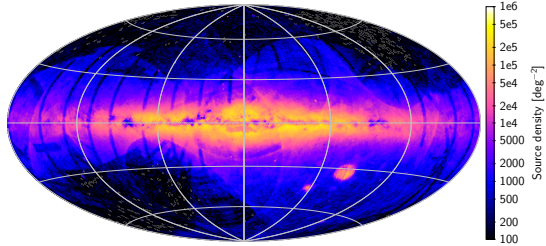
Gaia Collaboration, 2016, A&A

Highly precise positions, new sources

685 million sources matched to IGSL

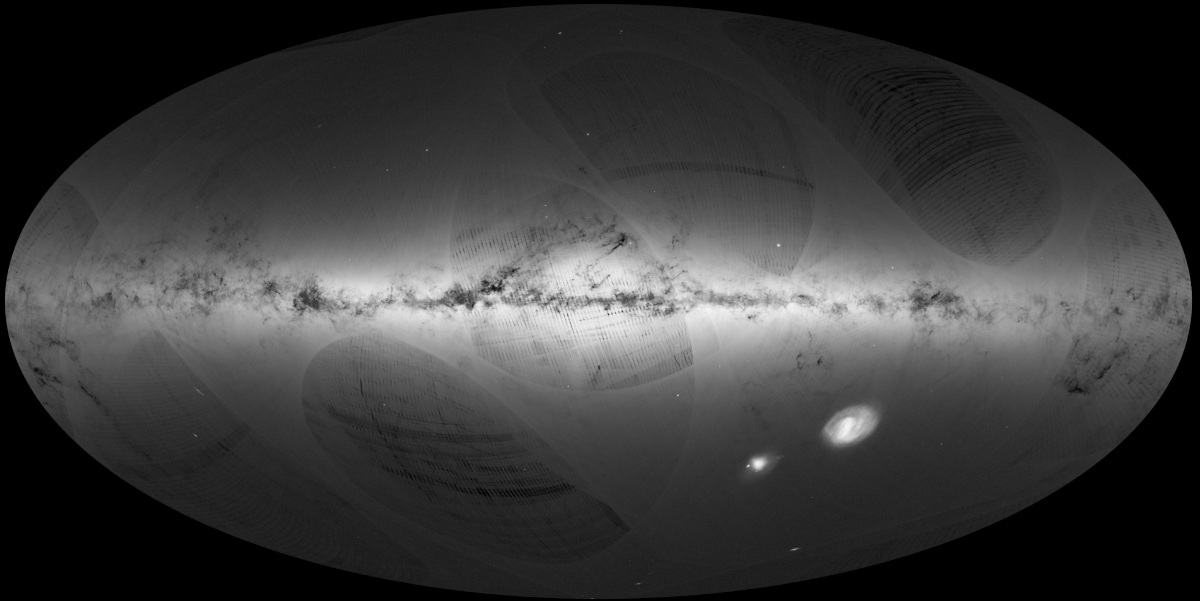


456 million new sources in Gaia DR1



DPAC/CU3/Lindegren et al., 2016, A&A

- (α, δ) for ~ 1.1 billion sources to $G = 20.7$
- Epoch J2015.0, alignment to ICRF < 0.1 mas, rotation < 0.03 mas yr^{-1}
- Typical position uncertainty ~ 10 mas
- Positions of 2191 ICRF sources from special astrometric solution (Mignard et al., 2016, A&A)
  - 90% with $\sigma_{\rm pos} < 3.35$ mas
  - no systematic differences with radio positions of more than few tenths of mas



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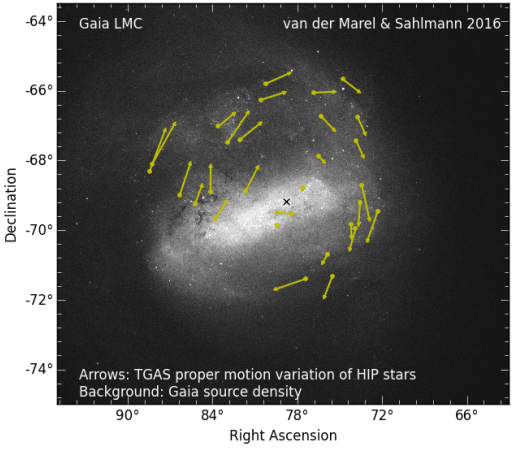
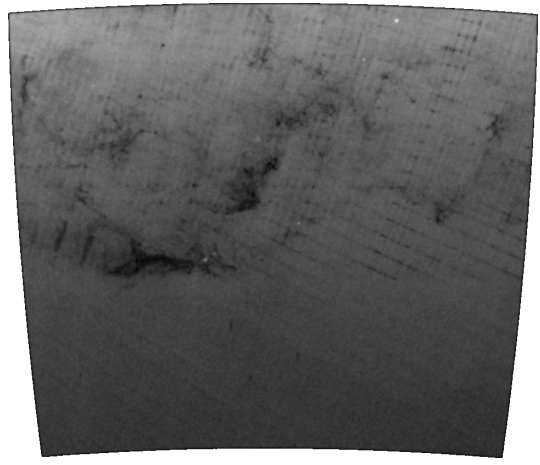
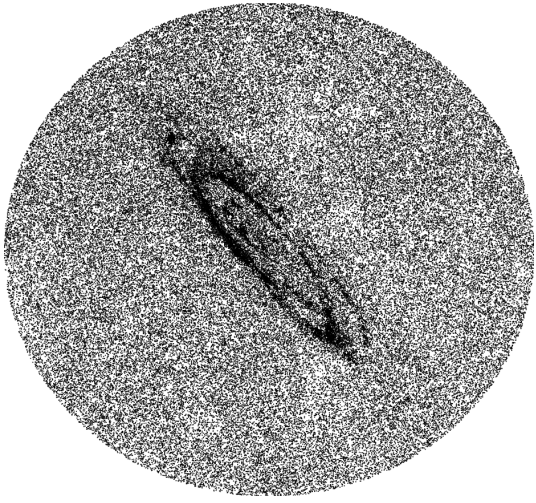
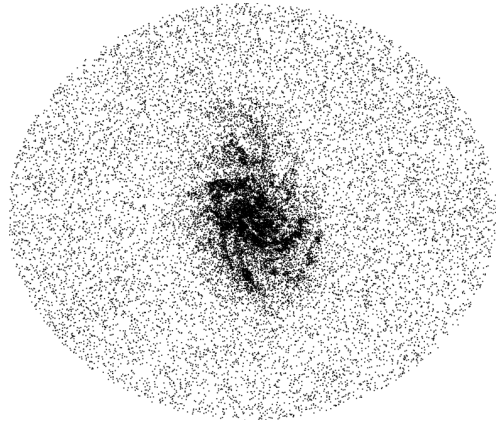
The Gaia Sky


Gaia LMC
van der Marel & Sahlmann 2016
Arrows: TGAS proper motion variation of HIP stars
Background: Gaia source density
-64°
-66°
-68°
-70°
-72°
-74°
Declination
90°
84°
78°
72°
66°
Right Ascension



The Gaia Sky

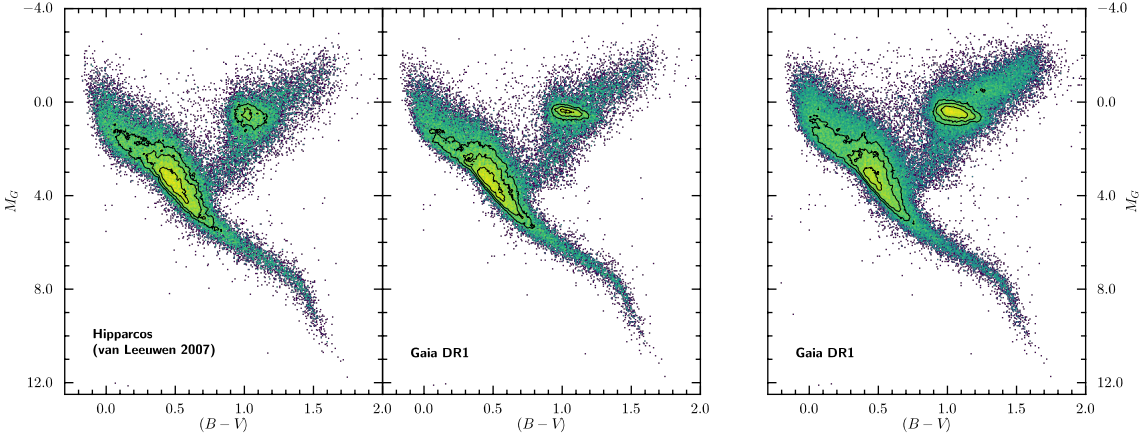




HR diagrams with TGAS

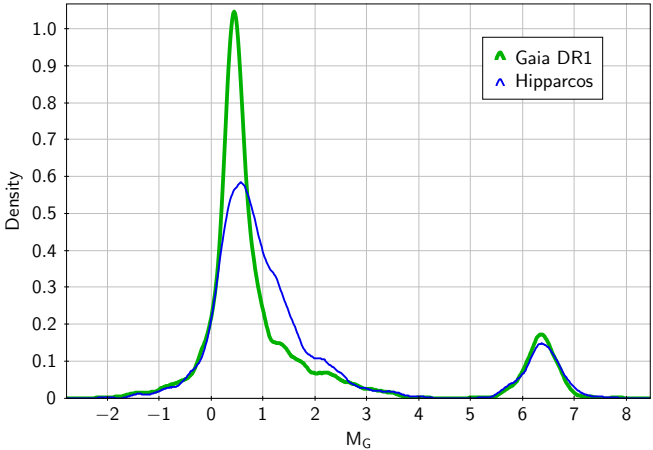
Hipparcos *and* Gaia DR1 parallaxes precise to $\leq 20\%$
43 546 stars, 90% stars inside 280 pc

Gaia DR1 parallaxes precise to $\leq 20\%$
77 771 stars, 90% inside 450 pc



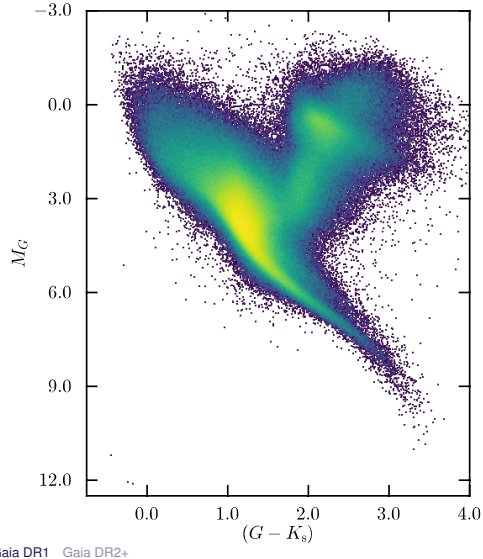
All stars from Hipparcos Catalogue

HR diagrams with TGAS



- Distribution of M_G for stars with $1.0 \leq (B-V) \leq 1.1$ and $\varpi/\sigma_{\varpi} \geq 5$
- Comparison robust scatter estimate for M_G:
  - Red clump: Hipparcos 0.5, Gaia DR1 0.3
  - Dwarfs: Hipparcos 0.4, Gaia DR1 0.3

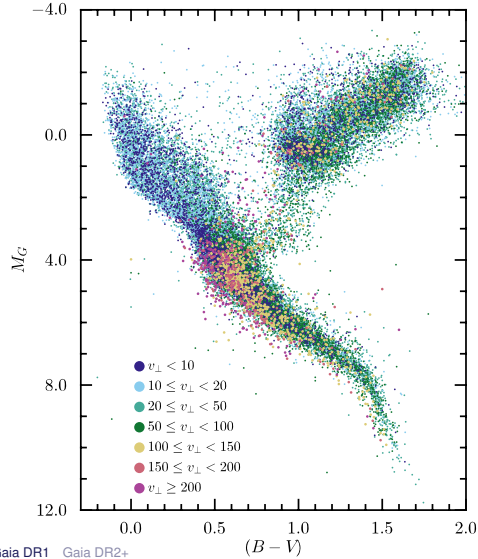
HR diagrams with TGAS



Full Gaia DR1 data set

- 1 million stars with parallaxes precise to $\leq 20\%$
- 90% inside 590 pc
- Future
  - $\sim$ 10 million parallaxes precise to 1%
  - $\sim$ 150 million precise to 10%
  - $\sim$ 280 million precise to 20%

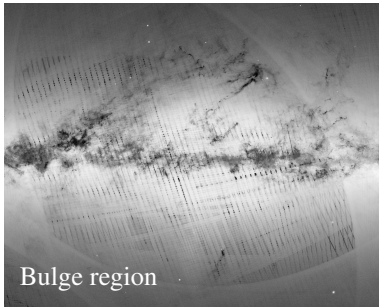
HR diagrams with TGAS

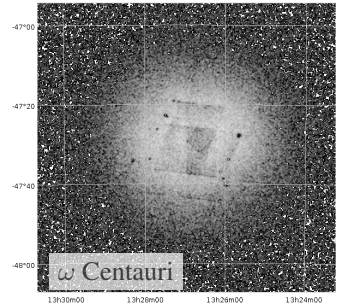


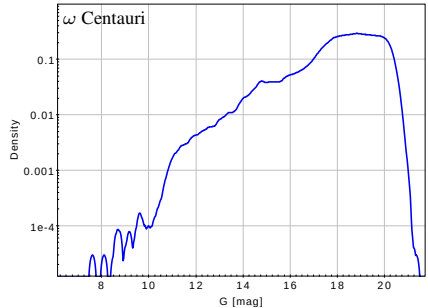
HR diagram colour coded by tangential velocity

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

Remarks on Gaia DR1 completeness

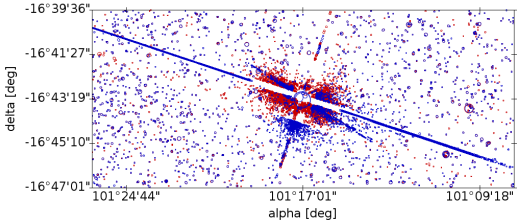


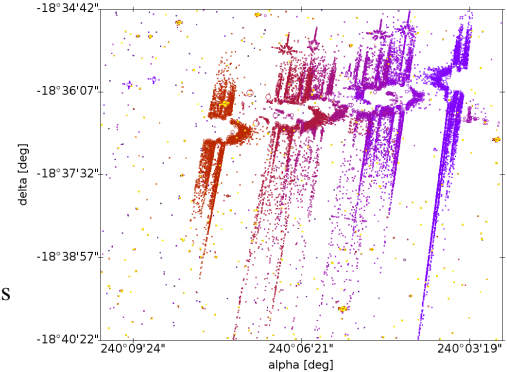




- Ill-defined and celestial position dependent faint limit
- Scanning law + filtering on data quality $\longrightarrow$ source density artifacts
- High density regions (few 100 000 stars/deg^2) affected by several factors
- Below 4 arcsec separation many secondary components of binaries missing
- Many bright stars missing at $G \lesssim 7$
- High proper motion stars ($\mu > 3.5$) arcsec yr^{-1} missing
- See section 6.2 of Gaia DR1 paper for details (arXiv:1609.04172)

Spurious sources and Gaia cross-match





- Bright objects cause spurious on-board detections
- Vast majority removed during data processing
- Small fraction of Gaia DR1 sources may have photometry affected by inclusion of a spurious transit
- Details: Fabricius et al., A&A, 2016

Gaia DR2

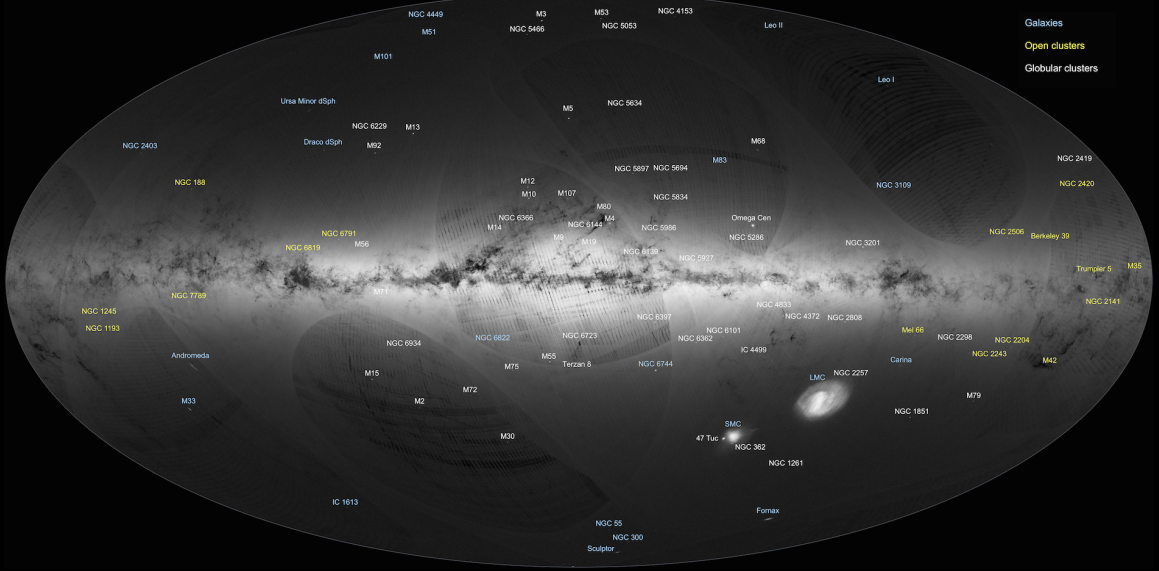
- Targeted for Q4 2017
- Astrometry and photometry based on roughly 22 months of data
  - Gaia stand-alone astrometric solution (unlike TGAS, no priors needed)
  - 5-parameter astrometry for all sources
- Broad band photometry, G, $G_{\rm BP}$, $G_{\rm RP}$ (broad band colours)
  - improved photometric calibrations
  - proper pass-band calibrations
- Median radial velocities for bright ($G_{\rm RVS} < 12$), constant RV, stars

Gaia DR2

- More variable star results
  - Cepheids, RR Lyrae all sky, LPV, short time scale variables, exercise exo-planet transit algorithms, QSO variability
- Solar system object results
- Astrophysical parameters (*details very much TBD*)
  - attempt determination $T_{\rm eff}$ and A_0 from $(G_{\rm BP} - G_{\rm RP})$ or publish relation between $T_{\rm eff}$ and $(G_{\rm BP} - G_{\rm RP})$(conditioned on A_0)

Some remarks on future releases

- Each release is a step in: precision, accuracy, number of sources, types of sources, richness of the data set (i.e., more tables, more columns)
- Expect changes to the source identifiers
  - relfects improved linking of observations to sources
  - intend to provide access to previous releases
  - DPAC looking into tracking mechanisms across data releases
- Epoch data from Gaia DR4 onward
  - already available for selected variable sets from Gaia DR1 onward
  - epoch and transit data for all sources as part of Gaia DR5 (based on 5 years of mission data)
- Supporting file downloads of full contents will not be possible for future releases
  - selected subsets may be available for download



ESA/Gaia/DPAC/André Moitinho & Márcia Barros (CENTRA - University of Lisbon) Annotations: Francois Mignard (OCA Nice)