

The Gaia Catalogue of Nearby Stars

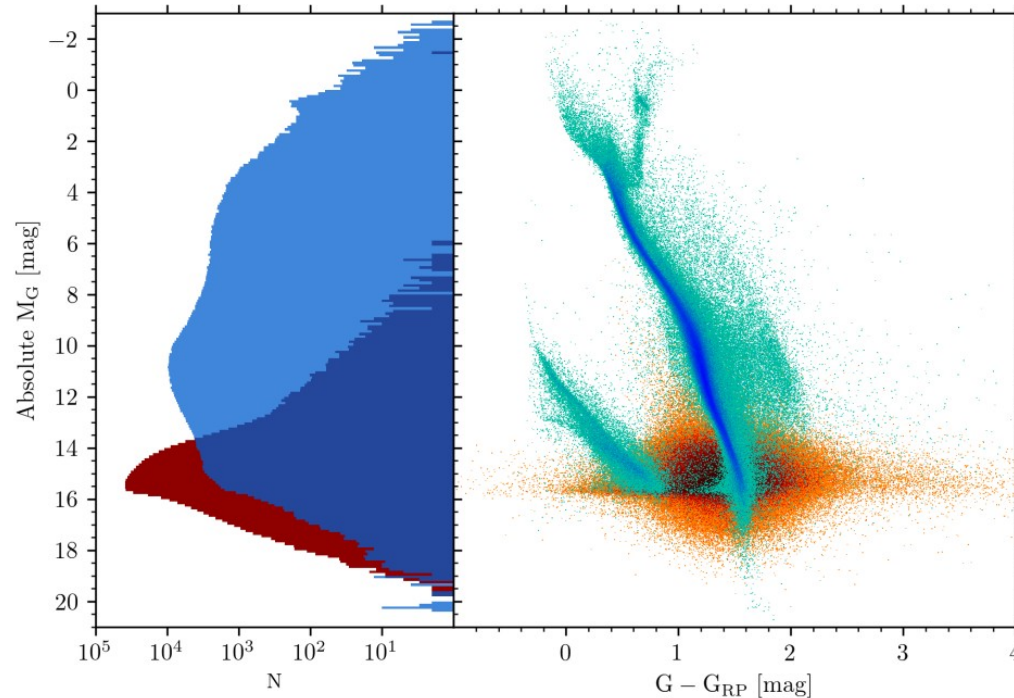
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GCNS definition I: Select good astrometric solutions.



1. Select EDR3 entries with parallaxes > 8 mas (1211740 sources).
2. Clean this set from spurious entries due to the inclusion of outliers in positions (mostly in regions of high density).
3. Favour completeness over contamination



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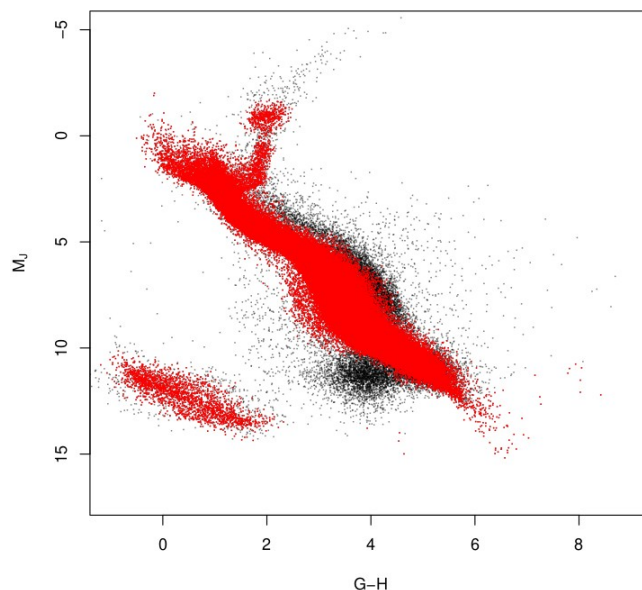
GCNS definition I: Train classifier based on astrometry.

Definition of training set.

GOOD: Cross-match to external photometry and select loci in CAMD

POOR: Selection of sources with $\text{parallax} < -8$ mas.

Assumption: the properties of spurious large parallaxes are the same for positive and negative ranges.



Feature name	Mean Decrease Gini index
parallax_error	33821
parallax_over_error	27713
astrometric_sigma5d_max	24035
pmra_error	20226
pmdec_error	14866
astrometric_excess_noise	12737
astrometric_params_solved	7677
ipd_gof_harmonic_amplitude	5628
ruwe	3383
visibility_periods_used	2371
pmdec	2263
pmra	2039
ipd_frac_odd_win	1566
ipd_frac_multi_peak	1006
astrometric_gof_all	801
scan_direction_strength_k2	694
parallax_pmdec_corr	522
astrometric_excess_noise_sig	413



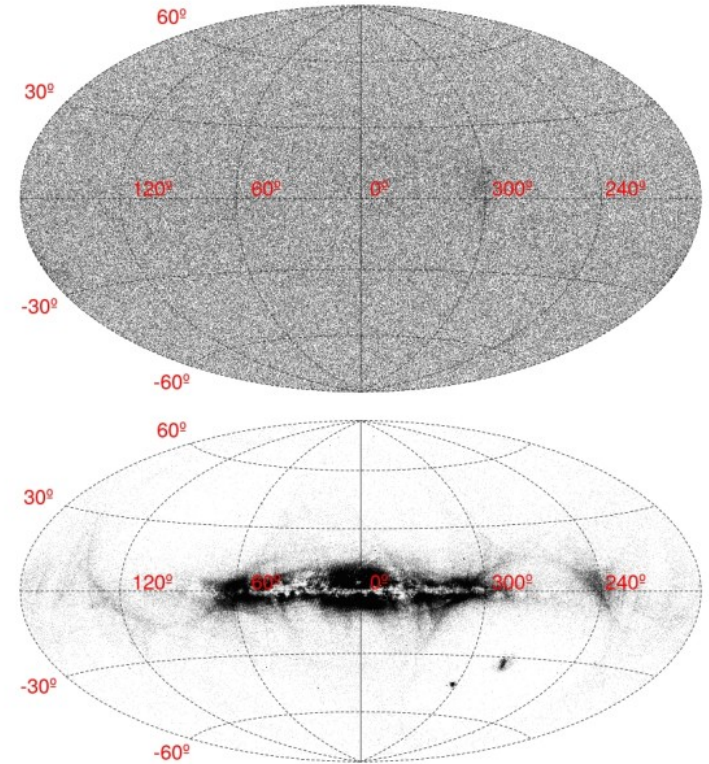
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GCNS definition I: Sky distribution

GOOD: We detect overdensities at the Hyades and Lower Centaurus Crux subgroup of the Sco OB2 association at 115 pc

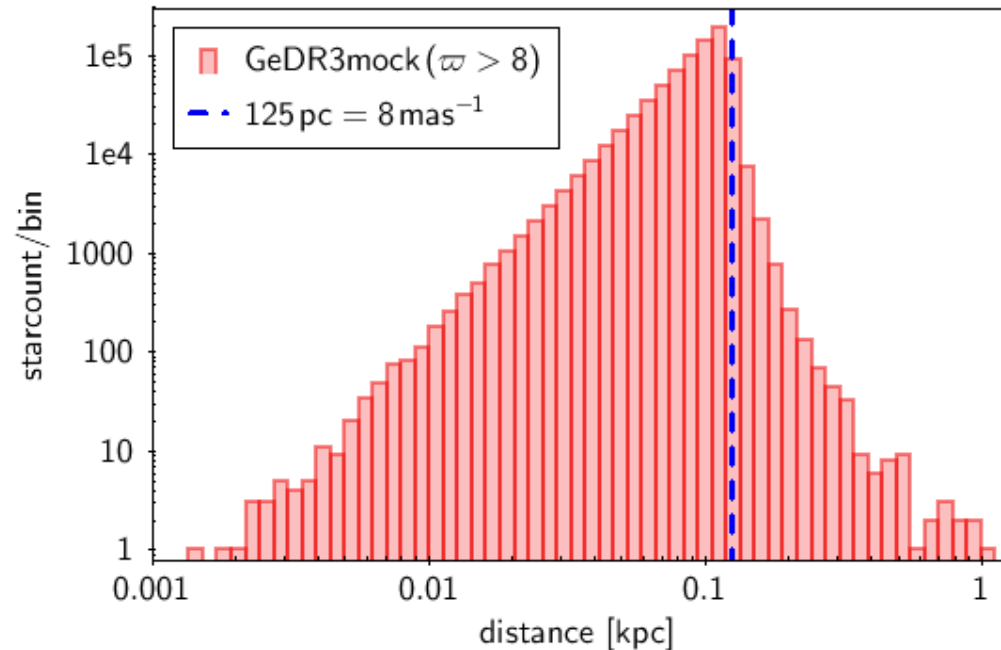
BAD: As expected, the poor astrometric solutions identified by the classifier concentrate in regions of high source density.



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GCNS definition II: From parallaxes to distances.



We infer posterior distributions for the distance using a prior from GeDR3mock (mock catalogue).

In the GCNS catalogue we provide 99 quantiles of the posterior distribution.

Our selection favours completeness over contamination (we include all sources with more than 0.01 probability, 1%, of being closer than 100 pc)



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Gaia

Nearby stars with trigonometric parallaxes

10 pc
382 stars

25 pc
5 423 stars

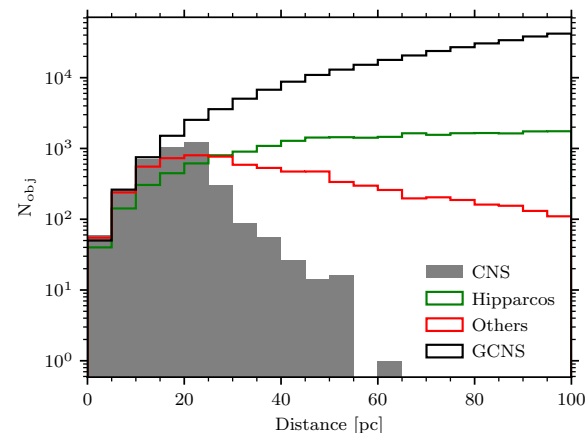
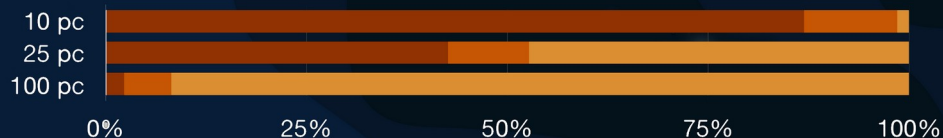
100 pc
303 446 stars

Gaia Catalogue of Nearby stars

Hipparcos

Ground Based

Number of stars within 10 pc, 25 pc, and 100 pc, with parallaxes in the Gaia Catalogue of Nearby Stars, Hipparcos, and other programs (mainly ground-based). The surface of the circles is proportional to the number of stars. The circles overlap when stars are common in several programs. The histogram represents the percentage of cataloged stars; first from ground-based programs, then Hipparcos, and finally Gaia.



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GCNS Completeness & Contamination

Completeness

- 331312 GCNS entries
- eDR3 missing 26 sources from 348 expected
 - ~ 8% incompleteness
 - Extrapolation 1-2% incomplete
- PS1 Comparison 98% complete at 20.4
 - 50% completeness M9 @ 100pc
- Mock => 50 lost to $\varpi > 8\text{mas}$
 - Very minor contribution
- Lost due to *classifier*
 - 0.1% lost positives
- Binary resolution losses, 0.6" & 15%
 - but 15% of 5% stellar binaries

Dominated by 8%

Contamination

- Included incorrectly, p large
 - 0.1% false positives (but evident)
- Outside 100pc but $\text{dist}_1 > 0.1$
 - 9% probability outside 100pc

Should tailor use of catalog to goal.
If a clean sample is needed use dist_{50} , if completeness important use dist_1 but with distance PDF.
If object selection needed, add external photometry not used in this selection.



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GCNS demonstrations I: vertical stratification

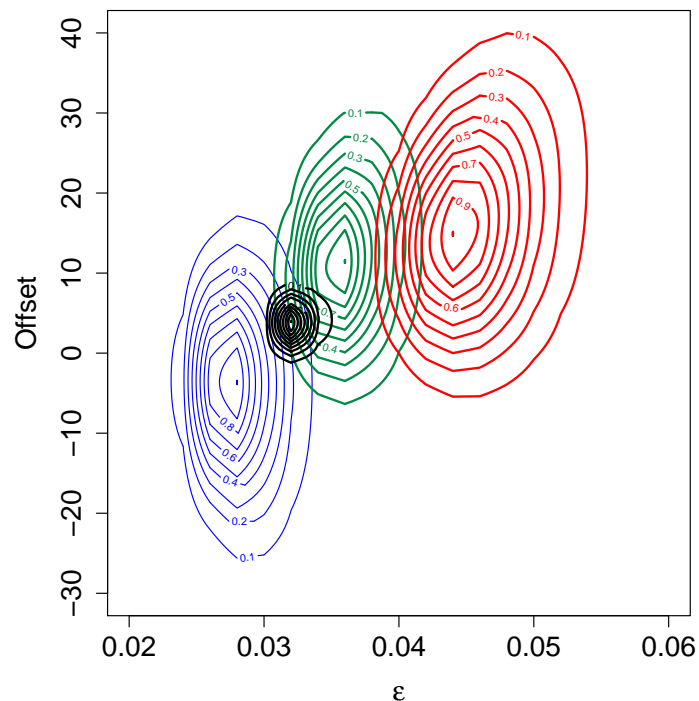
Hierarchical bayesian model to infer the *local* parameters of the vertical stratification.

Uses only b and ϖ and includes truncation in parallaxes

Einasto stratification law

Finds ϵ consistent but small solar z coordinate above plane, Z .

Difference of ϵ and Z seen as function of age: early spectral types before the turn-off point (blue), spectral types G and early K (green) and M-type stars (red). All objects black.



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GCNS demonstrations II: Luminosity Functions

Uses `dist_50` and `G` for main sequence and RGB stars

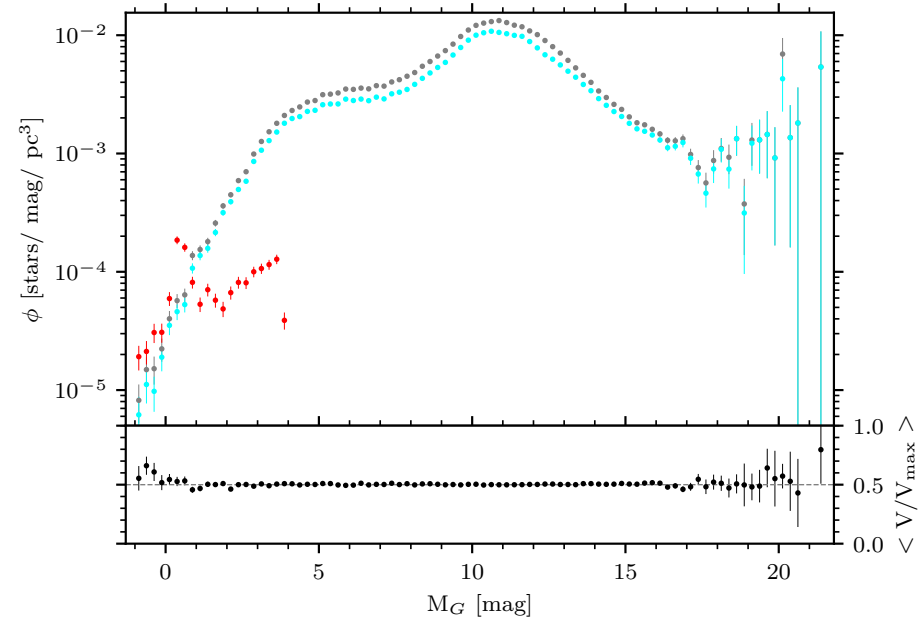
GCNS Luminosity function, 0.25 bin, log scale.

Grey: main sequence stars.

Cyan: main sequence stars with `ipd_frac_multi_peak=0`.

Red: giants stars.

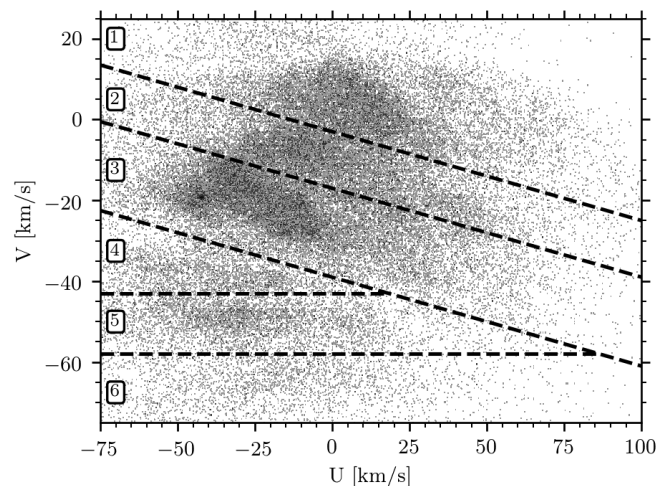
- ρ is 0.081 ± 0.003 */pc³
- Stellar/substellar boundary
- Jao gap



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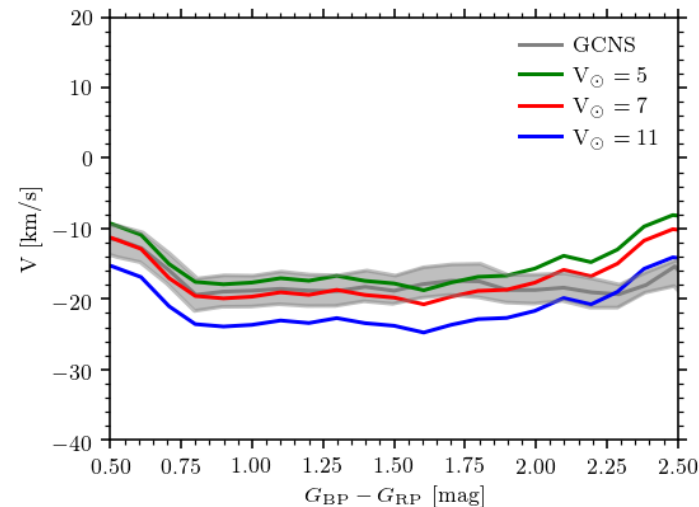


GCNS demonstrations III: Local kinematics



Uses parallax, μ , G , G_{BP} , G_{RP} (and bayesian UVW)

- Structure in the U , V , W plane. Sirius branch, Hercules stream, bar resonances...
- Halo and thick disk stars, Gaia-Enceladus members, visitors from Galactic centre
- Solar Motion relative to the LSR



Median velocity vs $G_{BP} - G_{RP}$ for stars with $G < 13$, quantiles 0.45, 0.50 and 0.55 in grey. Simulations with V of 5 (green), 7 (red), and 12 km/s (blue).

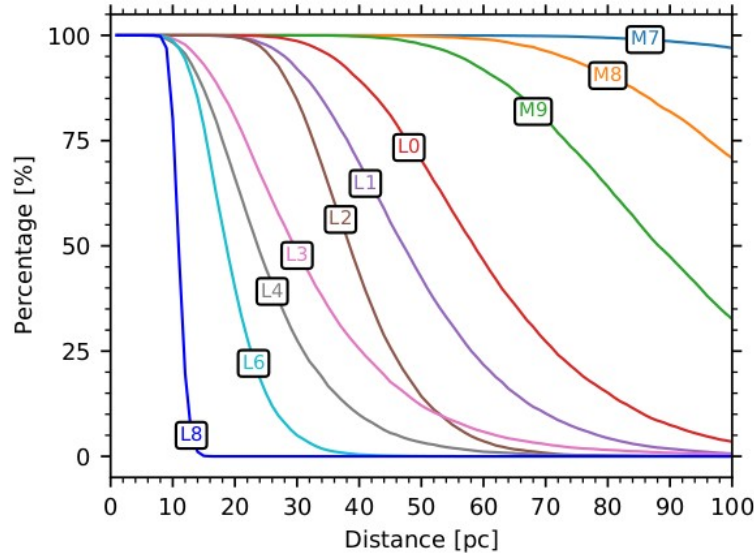


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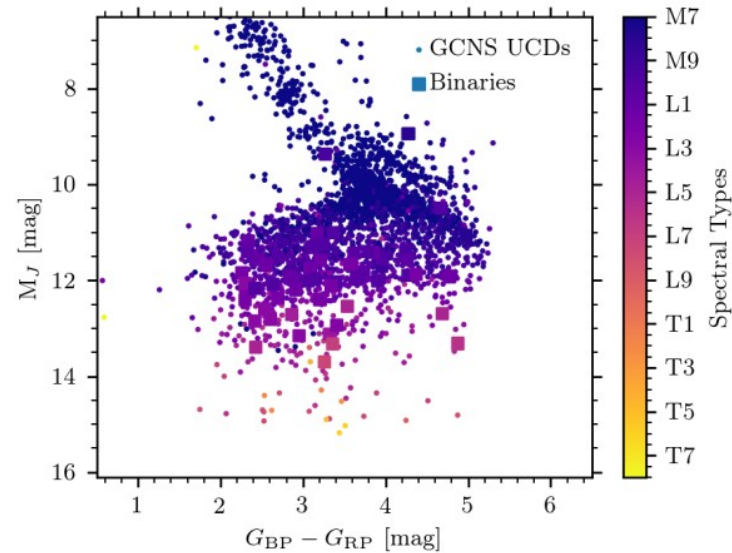


GCNS demonstrations IV: UltraCool Dwarfs

Estimated completeness



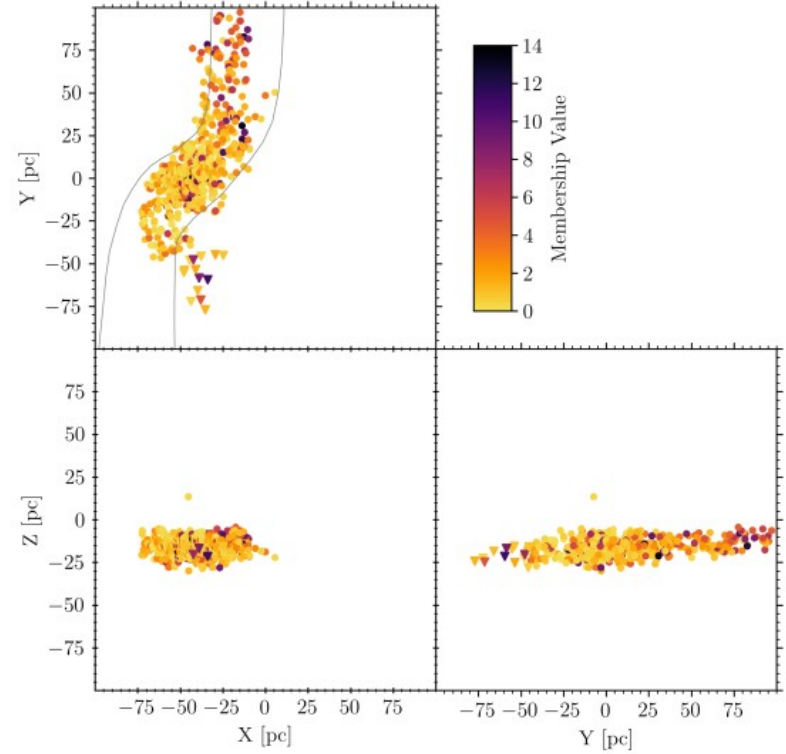
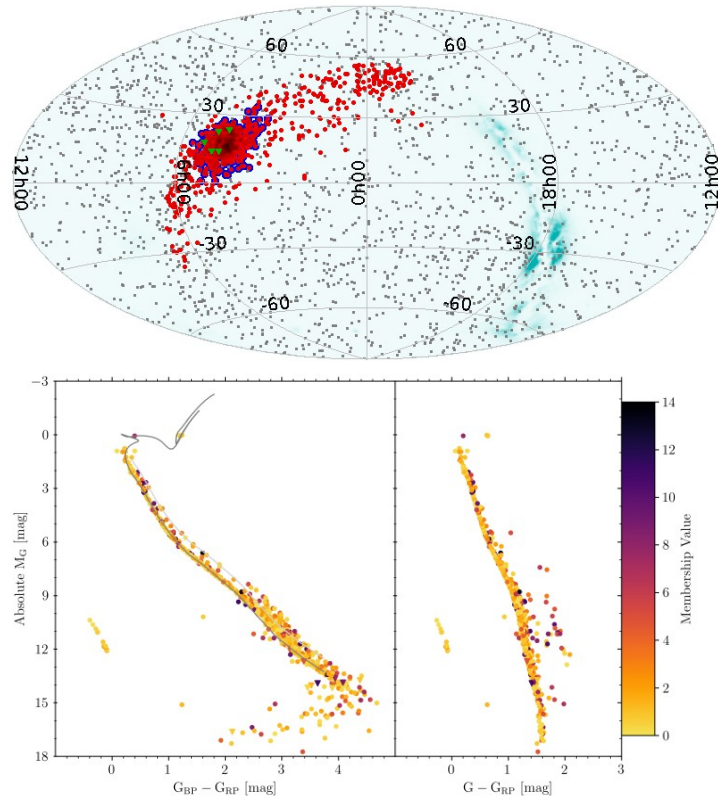
Limitations of G_{BP}



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GCNS demonstrations V: Hyades and Coma Berenices clusters



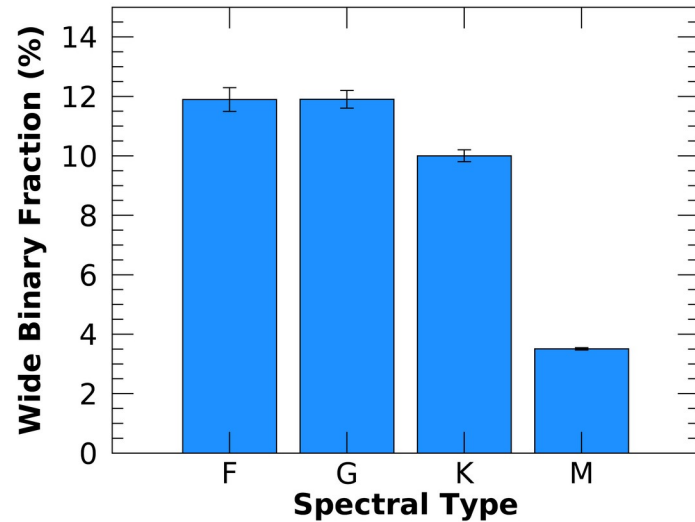
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GCNS demonstrations VII: binaries

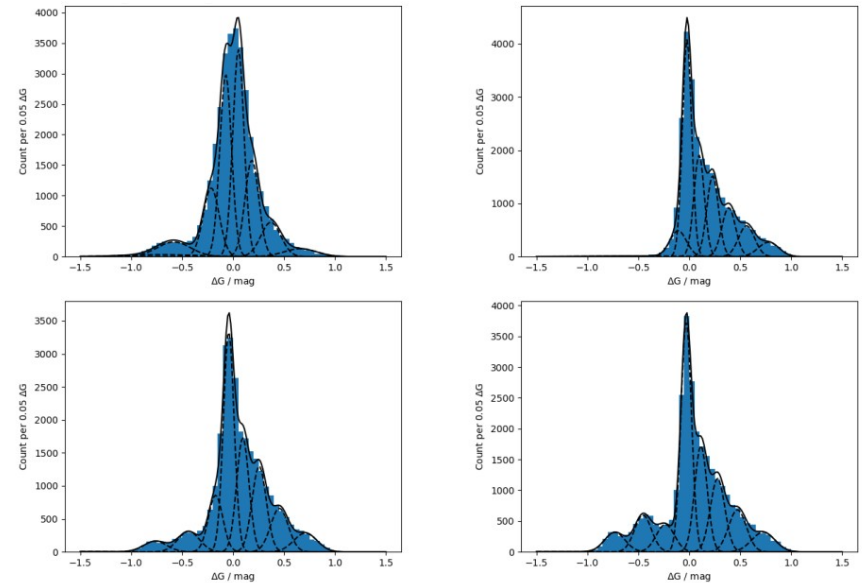
(Wide) Binarity fraction:

- 16556 wide binary systems
- No separation bimodality



Unresolved binarity:

Good agreement with prescriptions by Arenou (2011)



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GCNS outreach materials

There are various materials that showcase aspects of the GCNS, links to which can be found in the EDR3 stories page.

A video of a fly through the GCNS catalog highlighting the motions, colors and variety of the contents as well as clusters and binary systems.

A video of the orbits of objects in the GCNS over 500 Myr, roughly twice the orbital period of the Sun around the Galaxy.

A web based interactive tool for exploring the GCNS with the ability to select special classes of objects and to see how they move.

A poster of the brighter stars within 100pc and the high density regions found from the GCNS.

A poster showing the improvement Gaia has made to our knowledge of the Solar Neighbourhood compared to historical efforts.



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