Gaia News:Counting down to launch

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on behalf of DPACE

Outline

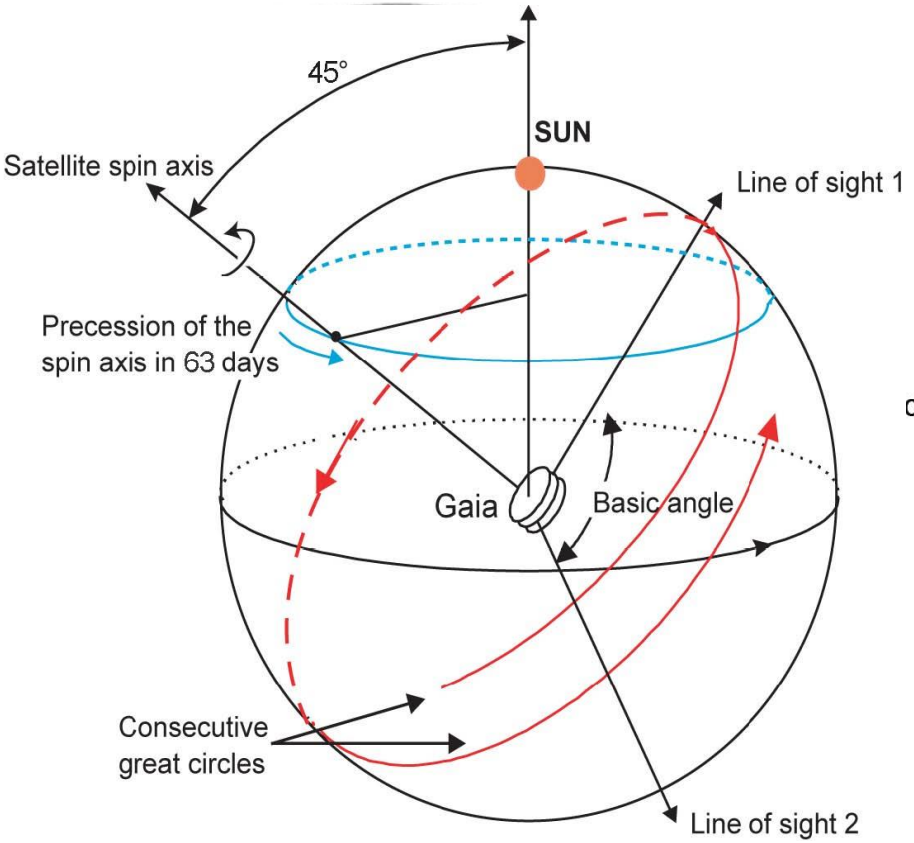
- Gaia Spacecraft status
- The Gaia sky
- Gaia open and globular clusters
- From data to science: data releases

Counting down to launch

- Gaia in Kourou on 23-26 August
- Launch campaign underway
- Payload Module is under electrical testing
- Sun Shield Deployment test 10-11 October
- S/C fuelling 2-5 Nov
- Launch 20 Nov 2013 08:57:30 UTC
- OR#4 successful
- Science performances

Scanning the Galaxy

- Scanning Mission
- Complete down to to G=20.
- Bright limit G=5.7
- Five-year scanning survey mission: sky-coverage non-uniformity
- Each source is observed ~ 75 times in astrometry & photom. 50 in spectroscopy
- Varies over the sky between
- ~50 and ~130 (~20% dead time)
- Angular resolution comparable to HST



Astronomer's shopping list

- High precision astrometry →
- High-precision broad-band photometry
- Multi-band photometry
- Spectra IR Ca II triplet
- Spectral classification (log g, T_eff,[Fe/H] (Bailer-Jones+2013)
  - Radial velocities →
  - Metallicities →
  - Rotation velocities

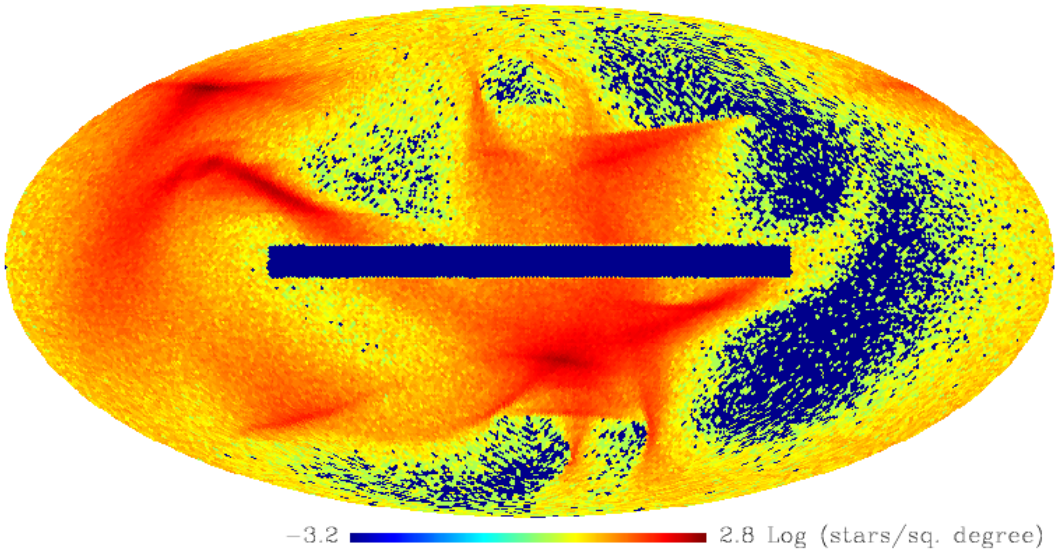
1 billion stars
- 10 µas @ V < 13 mag
- 25 µas @ V = 15 mag

300millions of stars

a few millions

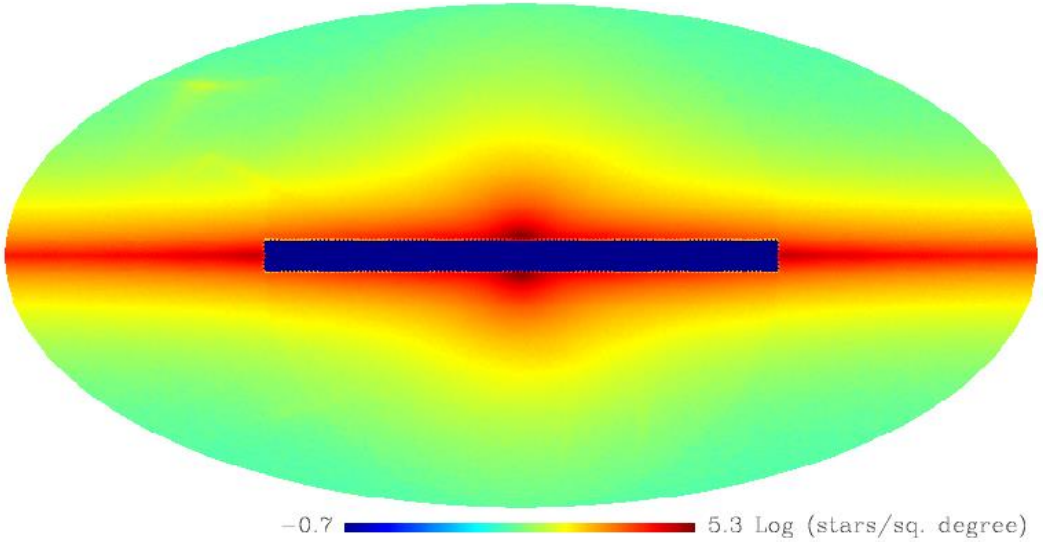
- Single Stars, but not only: SSO (Mignard+2012), binaries, galaxies(Bellas-Velidis2013), QSOs,exoplanets (Sozzetti+ 2008)

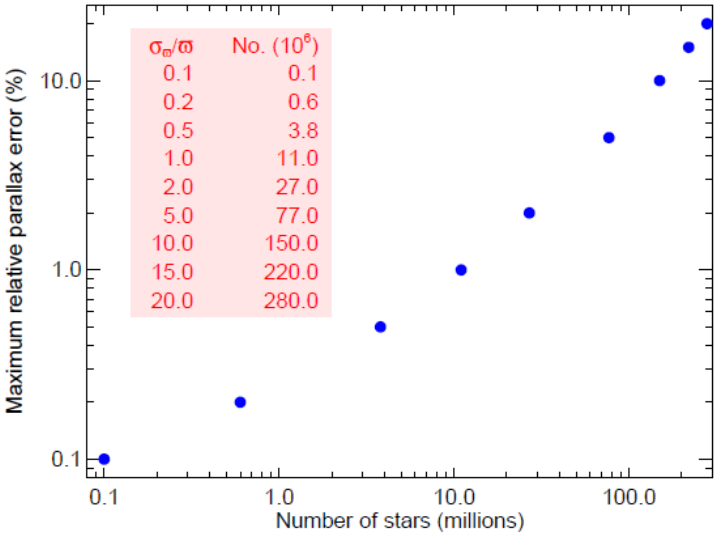
Gaia sky



9E8 Thin Disk,
4.3E8 Thick Disk stars,
2.1E7 Halo stars
1.7E8 Bulge stars

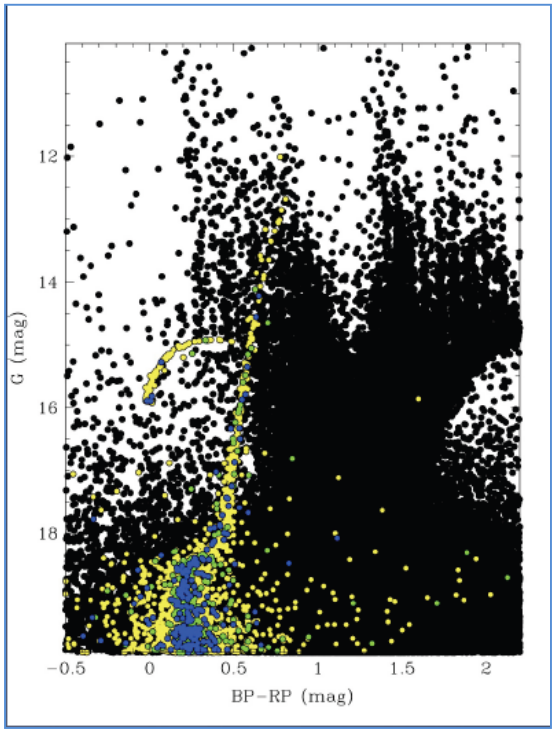
Colors: stellar density
(X. Luri 2010)



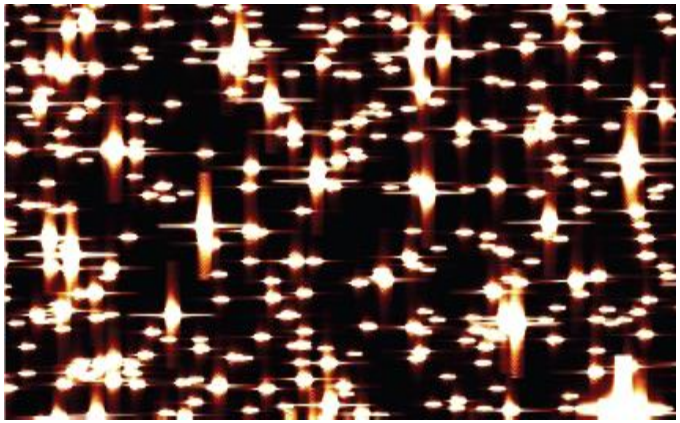


Globular clusters View - I

d=10 Kpc, c=2.5, bulge

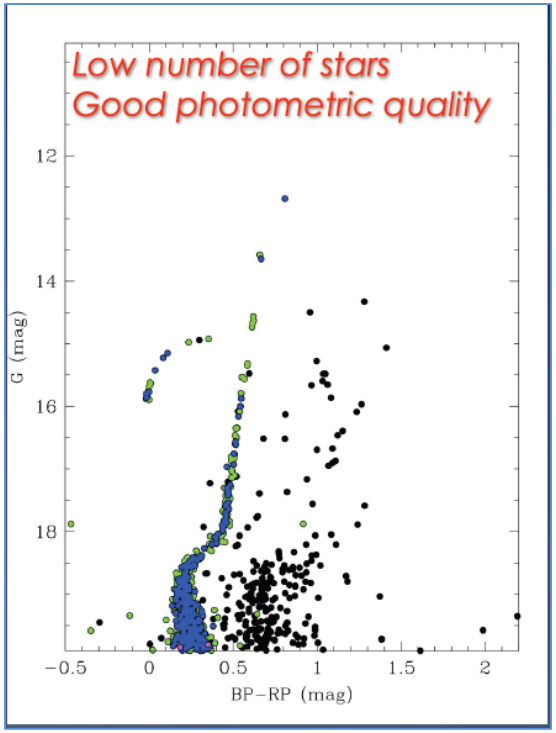


Gaia GIBIS FoV



Pancino+2013

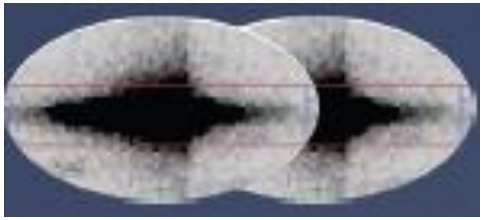
p.m selection



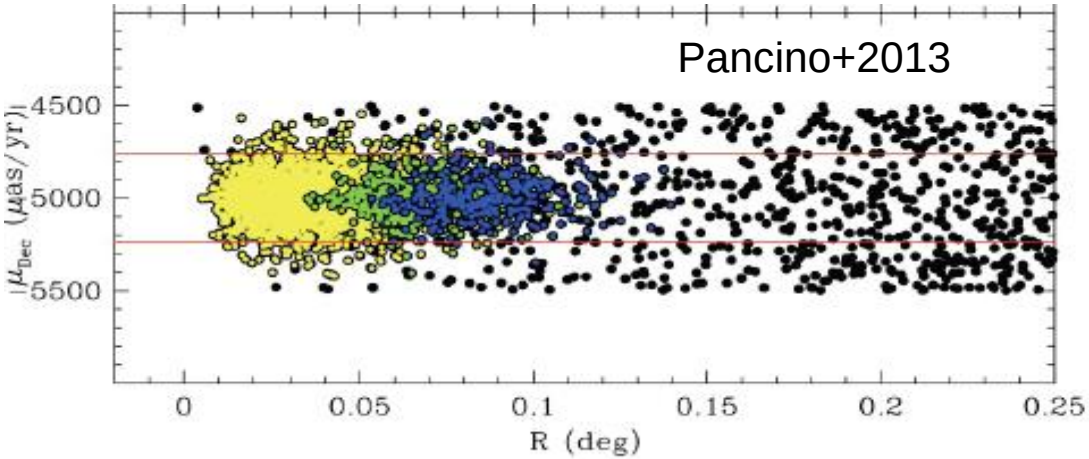
Non rotating 3D cluster (Kupper + 2011) +field stars

Generating Gaia images

crowding (partial superposition)



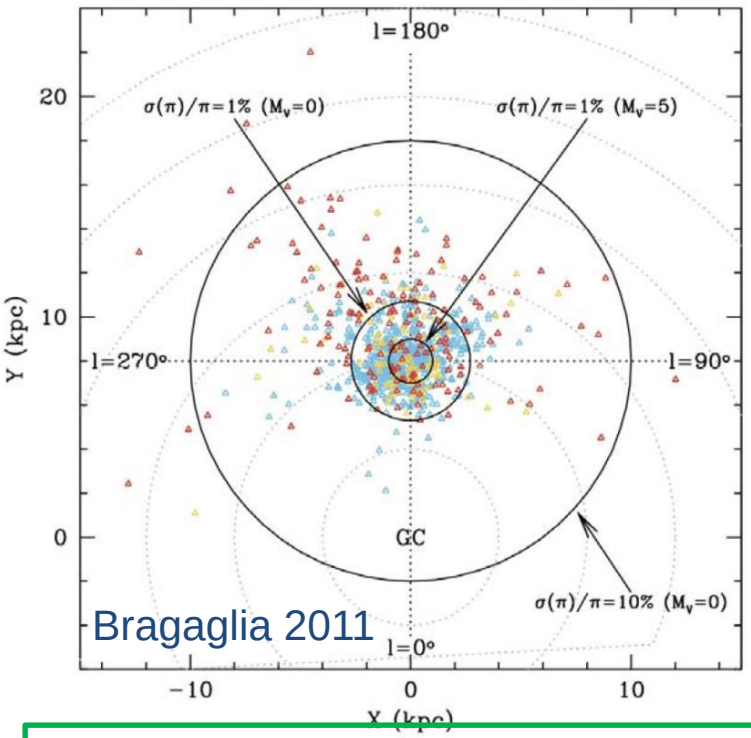
Globular cluster View - II



- 80 of 150 GCs

  d < 10 Kpc
- Proper motions – orbits – maybe tidal tails → halo potential
- Membership determination of 100/10000 stars(outside the half light radius, 3-5 µarcsec/yr at 10 Kpc)
- More than 5000 stars for half of the clusters
- Mean distances to < 1 % for about 80 clusters
- Mean distances to < 5 % for all clusters
- Spectra of stars above G=17 for Rv

Gaia Open Clusters-I



Bragaglia 2011

Present situation: 2095 known OCs
1193 with distance
100 with a [Fe/H] estimate(Dias+2010)

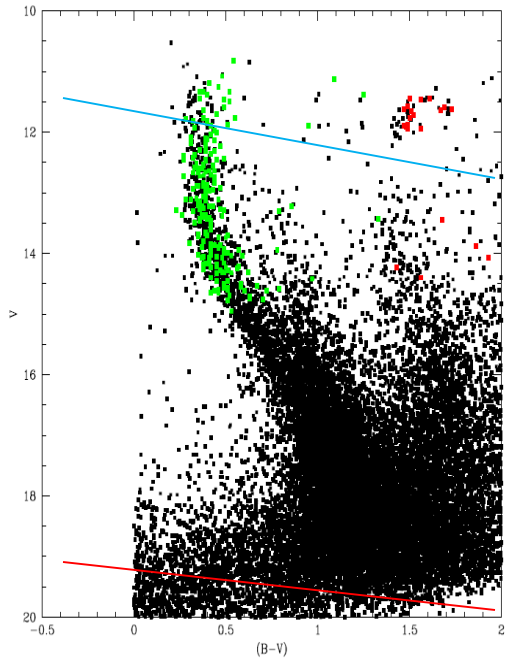
Gaia: Derive distances + pm of individual stars in Ocs
- at 1% for Mv=5 d < 1.5kpc
- at 1% for M=0 d < 4kpc
-at 10% for almost all known cluster
→ accurate membership-- orbits

Small velocity dispersion in OCs (1 - 2 km/sec) → <u>studies of the internal dynamics require ~ 0.2 km/sec</u>

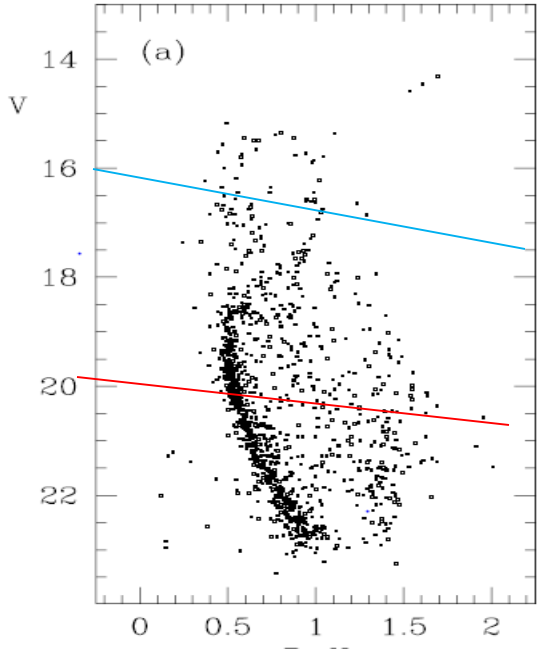
– Gaia: accuracy better than 1% for transverse velocity
G0 stars brighter than V~13 (d<500pc), K1 III (red clump in old OCs) V<14 :d < 5 kpc.

<u>Missing: Detailed chemical abundances for G>11-12</u>

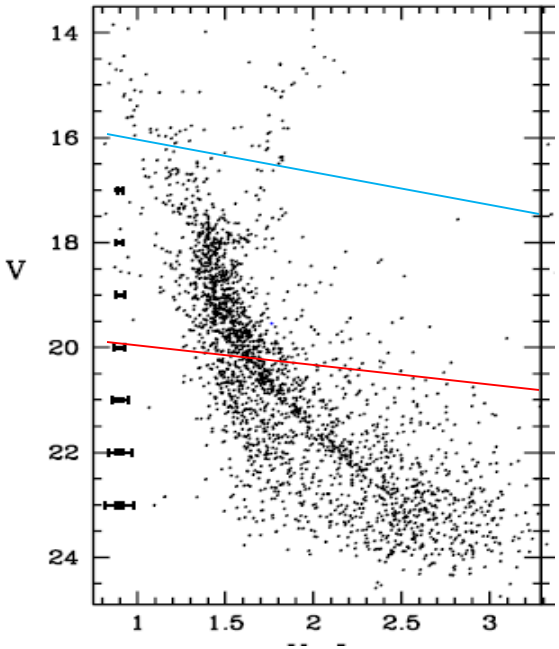
Gaia Open Clusters-II



B-V



V-I



B-V

NGC 6705
(Vallenari+2013)
D=1800 pc,
Age=250-300 Myr

Be 17
(Vallenari+1999,
Bragaglia+ 2006)
D=2600 pc,
Age=10 Gyr

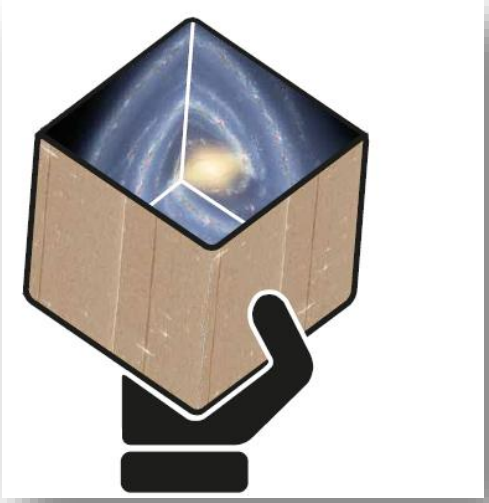
Be 29 (Tosi,
Bragaglia 2006)
D=13.05 Kpc,
Age=3.7 Gyr

From data to science: Gaia Catalog

- Complex catalog dealing with more than 2 billions of objects, having information about:

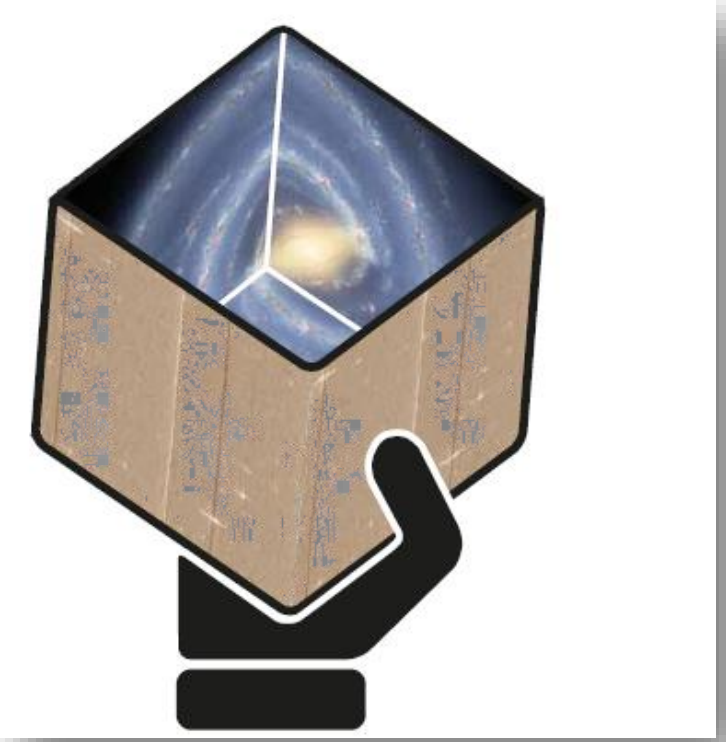
  positions, proper motions, parallaxes, radial velocities, Aps, binarity, variability

- What will you get:
  - Validated Gaia data
  - Documentation
  - Advanced tool for data manipulation, data mining, and visualization
  - cross.-match with existing Catalogs and survey data



Catalog Validation

- Internal consistency checks
  - proper motion vs. distance
  - photometry vs. Spectroscopy
- Comparing to models and external data
  - detecting artifacts from the data processing
  - systematics in Gaia data
- Apply data mining techniques
  - identify outliers and unexpected correlations
  - identify and document expected correlations
- Special objects: clusters
- Cross method variability analysis
  - variability correlated with binary component separation
  - periodicities correlated with scanning law



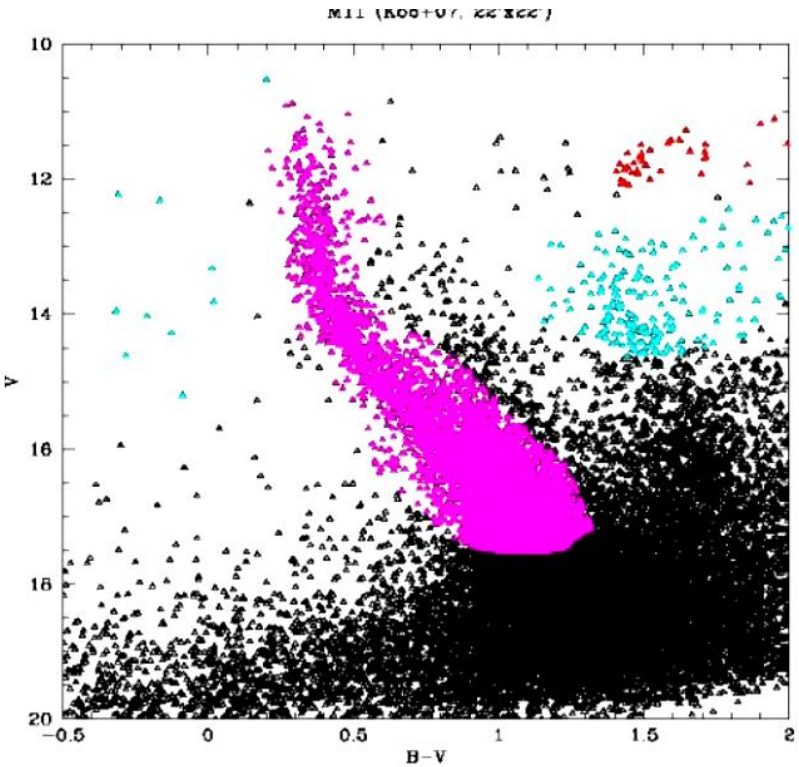
Using Ocs for Catalog Validation

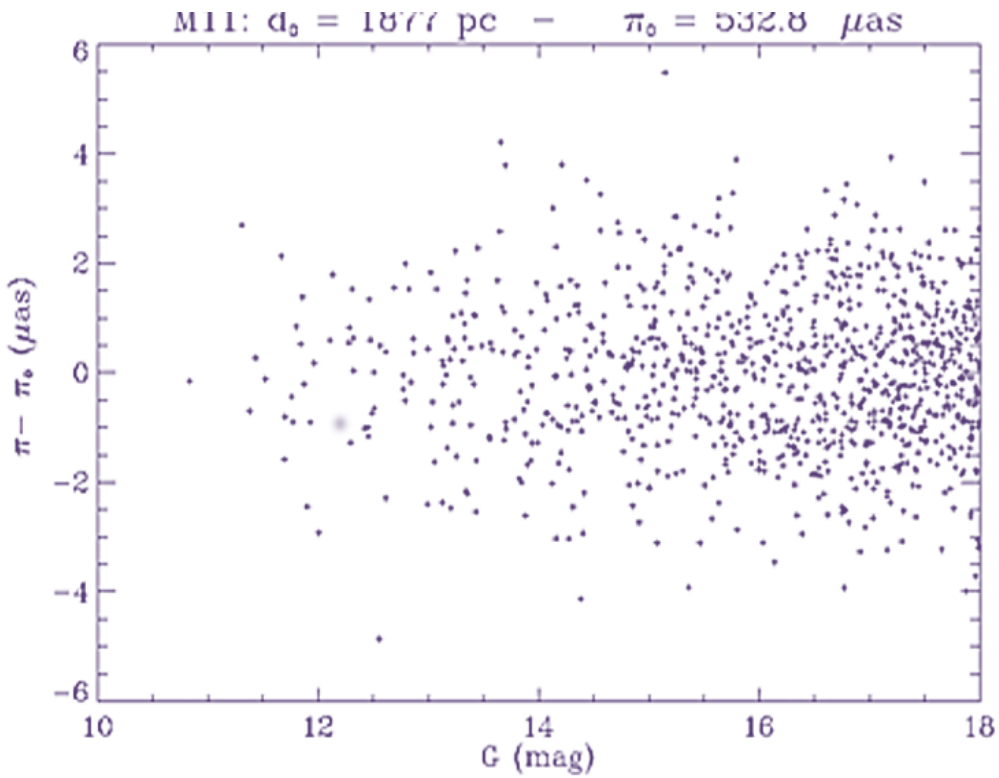
- Ocs are single stellar population: same age and metallicity
- large samples (10E2 -10E3) of stars having a 3D spatial spread of about **10 pc** and a 3D velocity dispersion **<1 km/s**.
- Ideal tests of Gaia astrometry, stellar parameters
- Cross match with external Catalogs+comparison with stellar models → ground based surveys
- Pleiades MS problem and 10% distance discrepancy: sistematics over 1 deg in Hipparcos data? (van Leewen 2009)

Table 1. Pleiades parallaxes (updated from Soderblom *et al.* 2005)

Method	π_{abs} (mas)	D (pc)	m−M	Ref.
Hipparcos all-sky	8.45±0.25	118.3±3.5	5.37±0.06	2
Hipparcos new reduction	8.18±0.13	122.2±1.9	5.44±0.03	7
Main-sequence fitting	7.58±0.14	131.9±2.4	5.60±0.04	1
Allegheny Observatory parallaxes	7.64±0.43	130.9±7.4	5.59±0.11	3
Interferometric orbit	7.41±0.11	135.0±2.0	5.65±0.03	4
Dynamical parallax	7.58±0.11	131.9±3.0	5.60±0.05	5
HST FGS parallax of 3 Pleiads	7.43±0.17	134.6±3.1	5.65±0.05	6

Clusters for Validation: M11





NGC 6705 (Vallenari+2013)
D=1800 pc,
Age=250 -300Myr
Radius=6.2 pc
Conservative Intrinsic d dispersion= 5 pc

Intrinsic σπ=1.4μas
<< expected Gaia uncertainty at G>11
To be used up to 2-3 Kpc
(Spagna 2013)

Gaia Data: Why do you have to wait so long

- Gaia is self-calibrating
  - iterative process to derive astrometric parameters, attitude and stellar parameters
- Gaia principles involve global astrometry: no immediate scientific data from single observations
  - Total commissioning phase: 4-6 months
  - at least one full sky coverage needed for an astrometric solution (positions)→ at least 6 months of data
  - at least 18 months of data for a full astrometric solution but sampling might be not sufficient in many cases
- Colors must be known to achieve good accuracy→ calibrated photometry
- Each data release requires time to go from DPAC internal database to public archive (3 Months)

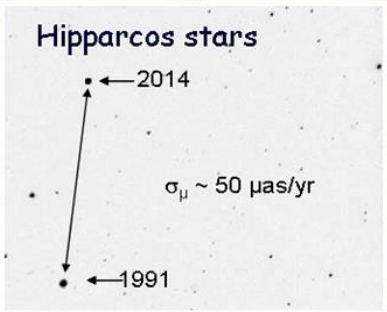
Data release scenario

Science alert: ASAP

Release

L + 22m

α deg 8	δ deg 9
4.18700521	41.06905721
57.84982093	−25.93298679
87.24506095	63.69702032
[illegible]	[illegible]50422

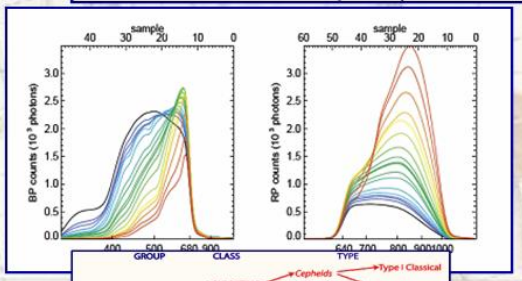


L + 28m

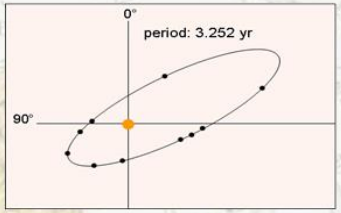
α deg 8	δ deg 9	π mas 11	μ_α mas/yr 12	μ_δ mas/yr 13
4.18700521	41.06905721	18.92	190.14	27.75
57.84982093	−25.93298679	21.42	273.72	167.93
87.24506095	63.69702032	4.12	5.07	−98.19
97.98452970	−27.72950422	17.95	21.31	217.87
106.43757563	26.14031575	21.74	18.58	−10.54
109.41026120	−29.01434479	7.92	−4.53	−7.01

G G_{BP} G_{RP} Vr

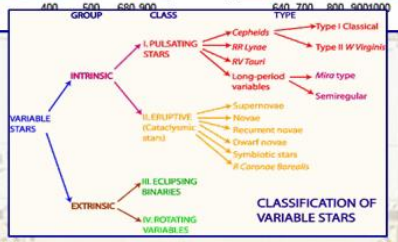
L + 40m

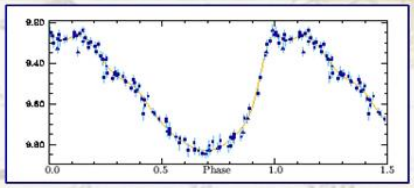


⟨Vr⟩



L + 65m





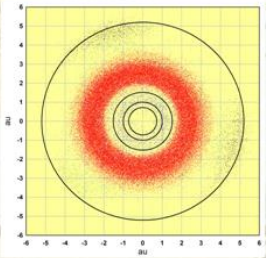


Figure by Franc¸ois Mignard

Clusters in H T P M catalog

- accuracy on pm (best case) : 30 to 250 µas/yr, depending on the magnitude, with an average of 50 µas/yr (20 times better than the average 1000 µas/yr of the Hipparcos values)

- All OCs closer than 300 pc + the richest OCs up to 500 pc (19 objects, vanLeewen 2009)
- 150 stars in Hyades to 40-10 stars in distant OCs (V=12)
- 80 more candidates from Francis +2012
- Full sample of clusters in the second release+

Conclusions

- Gaia is approaching launch
- Final tests are going on
- DPAC is ready to deliver the promises of Gaia
- A paper will be published after commissioning to update Perryman 2001