



Gaia ESA's mission status Unraveling de Milky Way The Galaxy in 3-D

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- 1. Mission overview
- 2. Science performances
- 3. Current status
- 4. Science exploitation





<u>Gaia main goal</u>: unravel the formation, composition, and evolution of the Galaxy

<u>Key:</u>

stars, through their motions, contain a fossil record of the Galaxy's past

May 2012



What's needed ?

A survey of a significant and representative volume of the Galaxy

- To reach large distances \rightarrow faint stars
- High precision in measurements
- Full sky coverage
- Positions, motions and <u>distances</u>
- Properties of stars (ages, chemical composition)

<u>Astrometry</u>: positions, proper motions and parallaxes <u>Spectrophotometry</u>: astrophysical diagnostics, chromaticity correction <u>Spectroscopy</u>: radial velocity, perspective acceleration, (chemical composition, binarity, stellar rotation, ...)

1. Mission overview



Gaia principle

Two telescopes continuously scanning the sky Lissajous orbit, Lagrangian point L2 Sun-Earth





The scanning law provides full sky coverage



5 years: average of 70 observations

- Full sky coverage until magnitude limit of detectors
- Unpercedented angular resolution

The metallicity distribution in the Milk





Gaia Universe Model Snapshot

Robin et al (2012) arXiv:1202.0132v2

Stars	G < 20 mag	Grvs < 17 mag	Grvs < 12 mag
Single stars	31.59%	25.82%	12.91%
Stars in multiple systems	68.41%	74.18%	87.09%
\Rightarrow In binary systems	52.25%	51.55%	40.24%
\Rightarrow Others (ternary, etc.)	16.16%	22.63%	46.85%
Total stars	1,600,000,000	600,000,000	28,000,000
Individually observable	1,100,000,000	390,000,000	13,000,000
\Rightarrow Variable	1.78%	3.06%	8.37%
\Rightarrow With planets	1.75%	1.44%	0.66%

The catalogue is available at CDS: VI/137





Sky distribution







Luminosity class	G < 20 mag	Grvs < 17 mag	Grvs < 12 mag
supergiant	0.00%	0.01%	0.07%
Bright giant	0.81%	2.18%	11.01%
Giant	14.47%	28.38%	62.71%
Sub-giant	15.08%	14.38%	10.32%
Main sequence	69.40%	54.82%	15.76%
Pre-main sequence	0.18%	0.20%	0.08%
White dwarf	0.05%	0.01%	0.03%
Others	0.01%	0.02%	0.02%
Total	1,100,000,000	390,000,000	13,000,000



The metallicity distribution

http://www.rssd.esa.int/gaia (click "Science Performance")



- 1. 6 < G < 12: bright-star regime (calibration errors, CCD saturation)
- 2. 12 < G < 20: photon-noise regime, with sky-background noise and electronic noise setting in around G ~ 20 mag

Courtesy of J.deBruijne





The metallicity distribution in the Milky Way discs, 29-31 May 2012



1 Photometric standard error per FoV transit [mag] G BP for V-I = 0 mag 0.1 RP for V-I = 0 mag 0.01 0.001 0.0001 6 7 8 11 12 13 14 15 16 17 18 19 20 9 10 G [mag]

Transit-level integrated-photometry

Courtesy of J.deBruijne

Sky-average end-of-mission number of transits ~ 70



1 Photometric standard error per FoV transit [mag] -G BP for V-I = 4 mag 0.1 RP for V-I = 4 mag 0.01 0.001 0.0001 7 12 13 15 17 6 8 9 10 11 14 16 18 19 20 G [mag]

Transit-level integrated-photometry

Courtesy of J.deBruijne

Sky-average end-of-mission number of transits ~ 70



Stellar parameters



50% and 90% bounds shown

Courtesy of C. Bailer-Jones

More in http://www.mpia.de/Gaia



SNR per single CCD



Courtesy of J.deBruijne



End-of-life atmospheric parameters from LR Kordopatis et al (2011)



3. Current status Industrial development



Launcher: Soyuz–Fregat from Kourou



20th Oct first launch: Liftoff of Soyuz flight VS01

Confirmation that the launch site and launcher configuration for Gaia are ready

New tests during next launch of PleiadesII

Ground segment is progressing nominally

Gaia launch in 2013



Sunshield deployment test successfully completed



the test demonstrated correctness of alignment, confirmed the deployment functionality and verified the flatness

delivered to Astrium; now in storage



All 10 mirrors integrated on the optical bench



Alignment of the two telescopes in progress, tolerance 3 mm

This is in the critical path !!!!



Focal Plane Assembly





General status

The progress is overall good. There are no major unresolved technical issues Almost all flight elements delivered

Major milestones recently passed:

- 1. Completion of the FPA mechanical tests and thermal tests
- 2. BAM device delivered
- 3. Phase Array antenna delivered
- 4. Sunshield tested and delivered

Major milestones ahead:

- 1. Completion of telescopes alignment
- 2. Radial Velocity Spectrometer qualification
- 3. Integration of BAM + RVS + FPA on PLM
- 4. Mechanical and thermal tests scheduled for Aug 2012



<u>The schedule is not stable yet</u>. A stabilization is expected after the delivery of the Focal Plane Assembly and the completion of the alignment of the two telescopes on the PLM (expected end of May)

4. Science exploitation

4. Science exploitation



Data release scenario (I)

Gaia Science Team and DPAC have proposed an scenario for early releases that accounts for:

Wishes:

- to release data as early as possible
- followed by incremental releases in terms of new data and relevant improvement of precision

Constrains:

- launch+6 months: cruise to L2, commissioning, DPAC systems initialization
- 6 months of nominal scanning for (nearly) full-sky coverage
- disentangling parallaxes and proper motions needs 18 months of data
- processing, calibration, validation
- each data release needs 3 months from production to the public archives

This scenario has been submitted to the AWG and will be the basis for the AO of CU9

(in addition early releases of transient sources and Near Earth Objects)



Data release scenario (II)

First release: launch + 22 Months Sep-2013 →Jul-2015	 Positions (α,δ) and G-mag for single-like stars (90% of the sky) the Hundred Thousand Proper Motions (HTPM) catalogue based on the Hipparcos stars
Second release: launch + 28 Months Jan-2016	 Updates of above + Mean radial velocities for stars with non-variable radial velocity (90% of the sky)
Third release: launch + 40 Months	 Positions (α,δ), proper motions, and parallaxes and G-mag for single stars (90% of the sky) Orbital solution for period between 2 months and 75% of the observation duration Integrated photometry RP/BP Spectrophotometry from RP/BP for sources for which astrophysical parameters are simultaneously released
Jan-2017	 Source classification based on BP/RP and astrometry for stars with sufficiently high quality data Mean RVS spectra for sources where single epoch spectra are usable and APs are simultaneously released

4. Science exploitation



Data release scenario (III)

Fourth release:	Updates of all above +
launch + 65 Months	 Source classification plus multiple stellar astrophysical parameters derived from BP/RP, RVS and astrometry for the majority of stars
	 Variable star classifications and parameters as available, and the epoch photometry
Feb-2019	 Solar system results with preliminary orbital solutions and individual epoch observations
	Non-single star catalogue
Final release:	Full astrometric, photometric, radial velocity catalogue
End Mission + 3	 All available variables and non-single stars solutions
years (36 months)	 Source classifications (probabilities) plus multiple astrophysical parameters derived from BP/RP, RVS and astrometry for stars, unresolved binaries, galaxies and guasars.
	Precision improved with respect to 4th release. Some parameters may not be available for fainter stars.
	 Non Single Stars solutions and exo-planet list
Sep-2021/2022	 All epoch and transit data for all sources
-	 All Ground Based Observations made for data processing purposes (or links to it)

4. Science exploitation



Gaia science networks

GREAT-ESF has a very good health:

- 7 workshops scheduled in 2012
- 6th open call for proposals issued *deadline 15th June*
- *5th Great Plenary Meeting*, 4 6 Jul 2012, Rome, in the framework of the European Week of Astronomy and Space Science, EWASS
- GUMS Gaia Universe Model Snapshot available for training scientific exploitation

GREAT-ITN: all ESR in place and PhD projects initiated

• 3 schools in 2012

Coordination for acquisition of on-ground data complementary to Gaia

- Gaia-ESO spectroscopic survey
- WEAVE@WHT in the North under study



Summary

Industrial & technical development is progressing (almost) nominally Data processing preparation is progressing nominally Launch in 2013

Scientific community is well organized: GREAT network

Good flow of information between DPAC-community and scientific community at large
Tools have been provided: ESA's pages, papers, GUMS, ...
Surveys for complementary data are ongoing

Good health Keeping GREAT expectations for Gaia data !

Thanks !









Transit-level integrated-photometry



Courtesy of J.deBruijne

Sky-average end-of-mission number of transits ~ 70



Proper motion and parallax





Proper motion and parallax





Spectroscopy







End-of-life rotational-velocity errors

The metallicity distribution in the Milky Way discs, 29-31 May 2012

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3. Current status: DPAC





GAP: Gaia Archive Preparation WG

has been set up to formulate the DPAC approach to the archive (CU9)

Rough idea of current schedule for AO

- * March 2011 : issued call for Lol- new people included in GAP
- * Feb 2012 Agree release scenario
- * Sept 2012 Commence response writing
- * Nov 2012 First complete draft of response
- * Nov 2012 Announcement of opportunity (short)
- * Jan 2013 Hopefully successful negotiations and acceptance
- * Feb 2013 Preliminary set up work
- * Aug 2013 (Launch) Start regular CU9 work

Meanwhile:

- GENIUS "Gaia European Network for Improved data User Services": proposal submitted to EU-FP7 2012
- Close cooperation with DPAC and GREAT

1. Mission overview









ESA Cornerstone mission within Horizon 2000+ programme

astrometry, spectrophotometry and spectroscopy

Global astrometry concept successfully demonstrated by former Hipparcos mission

3. Current status Data processing (DPAC)

3. Current status: DPAC



3. Current status: DPAC





Oct-Des: <u>Gaia Science Implementation Review.</u> Conclusions are:

The panel judges the situation of the DPAC to be firmly under control from a scientific view-point.

The Review documentation and presentations give confidence that the scientific foundation which underpins the DPAC system is sound

<u>Operations plan</u> in matured state DPAC activities for commissioning in planning phase

End-to-end tests are on-going. Rehearsal campaign Jun-Jul 2012 All CUs are involved in different phase

<u>CU9 for archive preparation</u>: AO foreseen by Nov-2012 Meanwhile GAP: Gaia Archive Preparation WG





End-of-life radial-velocity errors

The metallicity distribution in the Milky Way discs, 29-31 May 2012



Limiting magnitude



Courtesy of J.deBruijne



