Gaia Status & Early Releases Plan

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Gaia launch: 20 November 2013

@ 08:57:30 UTC
Gaia: a many-sided mission

Driven by Astrometry, designed for astrophysics
The Gaia Sky

- All-sky survey to 20 mag
- 70 observations per source, 5 years

- 1 billion stars
- 600,000 quasars
- 350,000 asteroids
- 1-10 million galaxies
- >10,000 exoplanets

from Robin et al., 2012
Observation principles

• **Gaia is a scanning mission**
  - no pointing, no change in the schedule

• **Gaia gathers astrometric, photometric and spectroscopic data**
  - each source is observed ~ 75 times in astrometry & photom., 50 in spectroscopy

• **Gaia has an internal system of detection**
  - sensitivity limited detection at $G \sim R = 20$

• **Objects are reasonably regularly measured during the mission**
  - orbit reconstruction
  - light curves
Final Activities on the S/C in 2012-13

- Service Module finalised
- Thermal/vacuum tests during summer 2012
- Deployable Sunshield qualified
- Put into storage
Main Activities on the P/L

- Assembly, Integration and Testing of the payload
- Telescope alignment completed with final checks
- Focal Plane Assembly completed
- Payload and Service modules mated
Astrometric accuracy: single observation

- Small field accuracy with final attitude
- Single observation accuracy ➔ orbit, solar system
  - one field transit, final attitude
  - point source

![Graph showing astrometric accuracy](image)
Gaia Accuracy at mean epoch

- Five year mission, sky-averaged
  - reference value: $\sigma_\omega = 25 \mu\text{as} @ G = 15$
  - based on data from J. De Bruijne (ESA)
Sky distribution – Parallaxes

- Plot for $G = 15$, but scalable to other magnitudes

$\sigma_\varpi - \mu\text{as}$

$<\sigma_\varpi> = 25\ \mu\text{as}$
Transverse velocity estimate with Gaia

![Accuracy in Transverse Velocity](chart)

- **σ (Vr) (km/s)**
- **Distance in pc**

Key:
- G
- 15.5
- 16.6
- K5V
- K6V
- G0V
- F5V
- F0V
- A5V
- A0V

- 1 km/s
- 10 km/s
Gaia Accuracy in the past and future

- Covariance matrix fully propagated at \( t = 1890 \)–\( 2090 \) step 1 yr
  - sky averaged accuracy
  - mean accuracy between \( \alpha \) and \( \delta \)
Photometric accuracy

- Epoch photometry: 1 transit over Astro CCDs or BP/RP
  - performances for photometric stability

![Graph showing photometric accuracy](image-url)
The Mission
Gaia: Mission Components

Industry/ESA CSG/ESOC/ESAC

One consortium for the Processing: the DPAC

(2013)
Operations Schedule I

- Sun Shield Deployment test 10-11 October
- S/C fuelling 2-5 November
- L = Launch 20 November 2013
  - Cruise and insertion to L2 takes about one month
  - Followed by outgassing and return to thermal equilibrium
- First Telemetry data ➔ L + 2.0 months
- Instrument Commissioning Phase ➔ + 4 to 6 weeks
  - In-orbit spacecraft verification and early calibration
  - Evaluation of the scientific performance
  - Test of the different operation modes, adjusting AOCS, spin rate ...
Early Operations Schedule II

• Processing initialisation phase ➔ + ~ 2 months
  - use a specific scanning mode with repeated observations
  - Initialise DPAC processing subsystems
  - More in-depth instrument calibration

Start of Routine Operations: Launch + 5-6 months

  - first full sky coverage ➔ L + 12 months
  - 1st non-degenerate solution for parallaxes & PM ➔ L +24 m
What Gaia will deliver

Data processing

- Photometry
- Astrometry
- Spectroscopy

- 3D positions
- 3D motions
- Stellar types, ages, compositions

cartoon: A. Brown
Data Releases: some issues I

• **Gaia principles involve global astrometry**
  - no immediate scientific data from single observations
  - At least one full sky coverage needed for an astrometric solution
    • this takes at least 6 months with the Gaia scanning law
  - no valuable parallaxes without at least 12 months of data
    • but sampling might be not sufficient in many cases

• **Gaia is self-calibrating**
  - instrument parameters, attitude and stellar parameters are determined in an iterative loop
  - colors must be known to achieve good accuracy
Data Releases: some issues II

- Mission with no instrument PI
- No observation calls
- Mission with no data right for participants
- No proprietary period for DPAC members
  - specific and coordinated publications during the processing
- Global astrometry is the core of the mission
  - full processing needed to get the best results
  - every stars, every observations are considered equally
  - no mean to isolate subsets in this processing
  - binary or planetary orbits must wait until the mission end
The Data Consortium Analysis (DPAC) needs time to initialise and certify its processing system.

- The processing itself is organised into:
  - daily operations for initial data management
  - cycles of about 6 months for global processing

- There is a time dependency between systems
  - eg: attitude must be known to process solar system objects

Any data release must be carefully checked and documented

- This must be agreed between ESA and the DPAC
Gaia Releases

Release
L + 22m
L + 28m
L + 40m
L + 65m

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Hipparcos stars
σp ~ 50 μas/yr

G  G  G_BP  G  R_P

< Vr >
Gaia Data Access

- Effective and efficient access to the Billion source catalogue and related data
  - no boundaries: seamless interfaces to related missions and survey data
- Science enabling and visualisation applications
- Long term access - data preservation and data re-use
- Gaia data access relevant and arranged for access to all users
  - from research scientists to the wider public

Building the archive and access system is now underway with requirements from the community driving its shape and scope

New DPAC CU selected by ESA SPC in 2013
Launch Campaign
Gaia P/L wrapped before shipment
PLM and SVM Mating

PFM#2 configuration

Final configuration
Gaia: last days in Toulouse

Gaia packed in Toulouse

pictures: Astrium/ESA

Take-off from Toulouse to Kourou

on a truck to reach the airport
Gaia first day in Kourou

Gaia arrival in Kourou

Container in the clean room, Kourou

unloaded in Kourou

pictures : CNES

Crate open, Gaia is in!