Gaia overview and status

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ESA
Gaia Summary

- Gaia: science with 1 billion objects in three dimensions
- ESA cornerstone mission building on the Hipparcos heritage
- Astrometry, Photometry and Spectroscopy
- Satellite, including the payload, by industry, management and operations by ESA and data processing by scientists (DPAC)
- Launch 19 December 2013 with Soyuz from Kourou
- Commissioning formally completed 18 July 2014
- 5 years of operations in L2
- First intermediate data release summer 2016, but Science Alerts start earlier

[cosmos.esa.int/gaia](cosmos.esa.int/gaia)
Payload and Telescope
Total field:
- active area: 0.75 deg$^2$
- CCDs: 14 + 62 + 14 + 12 (+ 4)
- 4500 x 1966 pixels (TDI)
- pixel size = 10 \(\mu\)m x 30 \(\mu\)m
  = 59 mas x 177 mas

Sky mapper:
- detects all objects to 20 mag
- rejects cosmic-ray events
- field-of-view discrimination

Astrometry:
- total detection noise \(\sim 6\ e^-\)

Photometry:
- spectro-photometer
- blue and red CCDs

Spectroscopy:
- high-resolution spectra
  - red CCDs

Figure courtesy Alex Short
Science Topics

• Structure and dynamics of the Galaxy
• The star formation history of the Galaxy
• Stellar astrophysics
• Binaries and multiple stars
• Brown dwarfs and planetary systems
• Solar system
• Galaxies, Quasars and the Reference Frame
• Fundamental physics: General relativity
Gaia integration on the launcher adaptor
Gaia integration on Fregat
Gaia inside the fairing
Soyuz three stages roll out
Gaia on 20 December 2013
Thüringer Landessternwarte, Tautenburg, Germany
LEOP

- After launcher separation automatic sequence:
  - transmitter, gyroscopes, Payload module bipod release, CPS priming, thermal control configuration

- Acquisition of Sun pointing attitude
- Sunshield deployment
- Start of Payload decontamination
- Star tracker switch-on and preparation for day-2 manoeuvre
- Day-2 trajectory correction
Commissioning

- Focal-plane switch-on on 3 January 2014
- L2-orbit-insertion burns on 7 + 14 January
- Launch and all manoeuvres very accurate leaving good propellant margins
- Ecliptic-pole scanning + 6-h spin started on 8 January
“First” light

- Before telescope alignment and focusing an image captured of Sadalmelik
- By now telescopes are optimally aligned and focused over the whole focal plane
Spin rate

- Spin rate matched to TDI clocking of CCDs
“First” focused light

- NGC1818 in LMC
- 212 by 212 arcsec
- about 1% of astrometric field of view
- 2.85s of integration time
“First” focused light

OGLE image courtesy of Łukasz Wyrzykowski
M94
More “first” light

- M51 with optimum focus
- 2.8s integration time
Commissioning results

- Micro propulsion system working well
- Attitude and Orbit Control System working well
- Phased Array Antenna operating with healthy link budget
- Clock working at required accuracy
- 106 CCDs, electronics, data acquisition and storage all functioning

Micro-meteoroid hit example. Figure by F. van Leeuwen
Photometry
Spectroscopy

Figure courtesy D. Katz, O. Marchal, C. Soubiran
Unwanted surprises

- Stray light both from astronomical sources and the Sun
  - Sun stray light paths not yet identified
  - Impacts faint sources especially in spectroscopy
- Transmission loss due to continuing contamination of mirrors by frost
  - Water source not yet exhausted and at the moment 0.3 mag lost of the best transmission
- Degradation of focus
- Basic Angle variation larger than expected
  - However, Basic Angle Monitor providing very precise measurements of the changes
Next steps

- Stray light
  - New man power in investigations of the stray light origin
  - On-board s/w modification under development for spectroscopy

- Contamination
  - A new decontamination procedure will be executed in some weeks involving a short heating of mirrors
  - Focus tuning planned around decontamination

- Basic Angle variation larger than expected
  - Analysis of dedicated measurements have verified Basic Angle variation being true
  - Working group established to chase the root cause of the variations
Scientific performance

For unreddened Solar type (G2V) star

<table>
<thead>
<tr>
<th>V-magnitude</th>
<th>Astrometry (parallax)</th>
<th>Photometry (BP/RP integrated)</th>
<th>Spectroscopy (radial velocity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 to 12</td>
<td>5-14 µas</td>
<td>4 mmag</td>
<td>1 km/s</td>
</tr>
<tr>
<td>15</td>
<td>25 µas</td>
<td>5 mmag</td>
<td>13 km/s</td>
</tr>
<tr>
<td>20</td>
<td>540 µas</td>
<td>60 (RP) – 80 (BP) mmag</td>
<td></td>
</tr>
</tbody>
</table>

Calculations by: Airbus DS, D. Katz, C. Jordi, L. Lindegren, J. de Bruijne
Scientific performance

For unreddened Solar type (G2V) star

- Single epoch precisions for BP integrated photometry
  - 0.01 mag reached at G=15.0 mag
  - 0.1 mag reached at G=17.8 mag

- Single epoch precisions for RP integrated photometry
  - 0.01 mag reached at G=16.0 mag
  - 0.1 mag reached at G=18.8 mag

Calculations by: Airbus DS, D. Katz, C. Jordi, L. Lindegren, J. de Bruijne
Time Line

- Routine phase started with 28 days of Ecliptic Pole Scanning

- Now operating in Nominal Scanning Law

- Activities to be finished:
  - Magnitude limits for astrometry and photometry
  - Magnitude limit for spectroscopy
  - Decontamination by heating of mirrors
  - Focus check and tuning, if needed

- 25 September spin axis adjustment for the Nominal Scanning Law for the Jupiter quadrupole experiment