The Gaia mission
&
1-meter class telescopes

Laurent Eyer
Geneva Observatory, Switzerland
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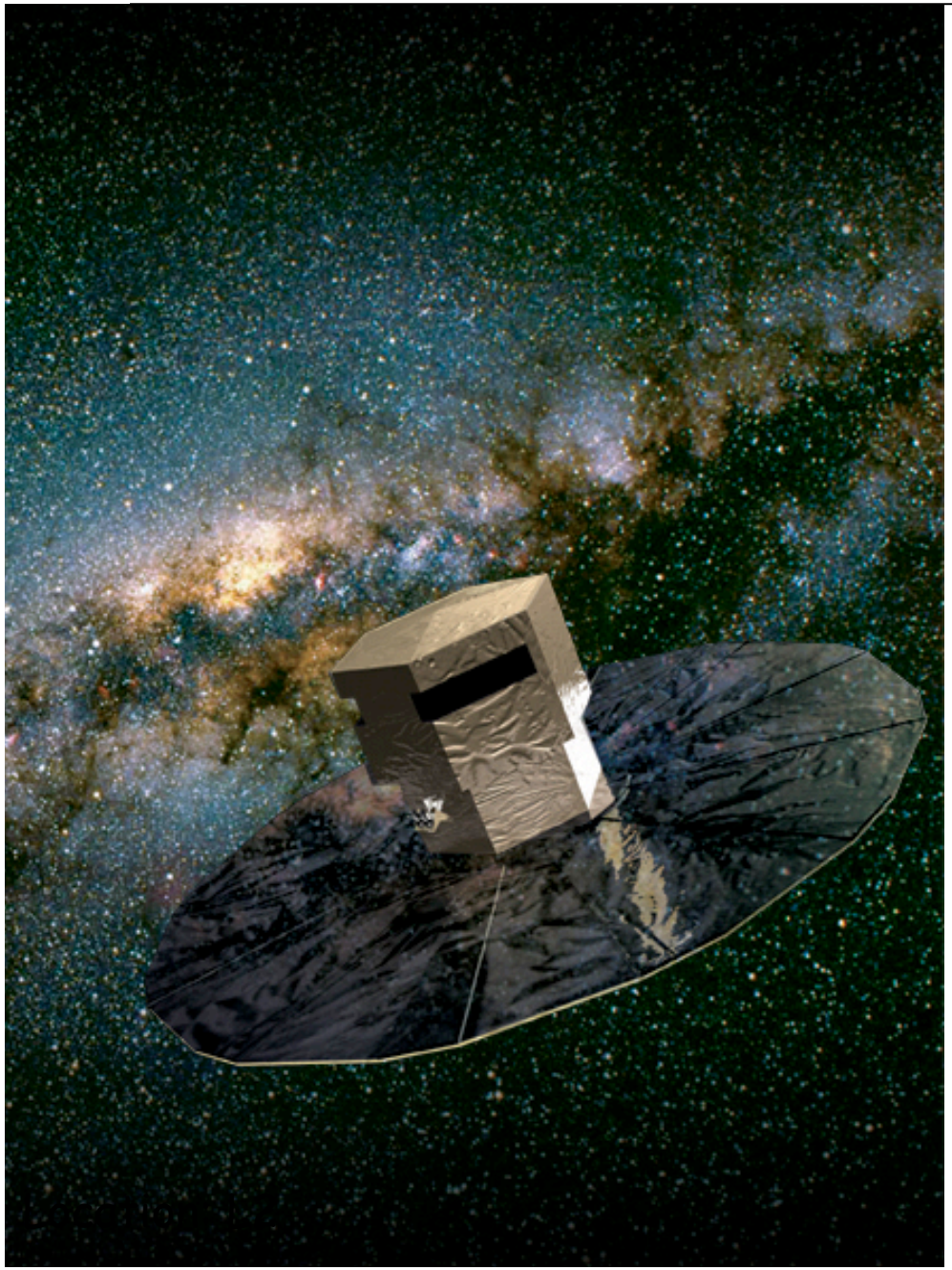
The Gaia mission



- Satellite of the European Space Agency
- Observations of all the objects between than **~6 < V < ~20**
  about **1 billion objects**
- Astrometry, photometry, spectrophotometry, and spectroscopy (radial velocities)
- Length: 5 (+1) years (70 times all sky)
- Launch (Soyuz rocket, French Guyana) 2013 (September...)
- Final Results: 2022

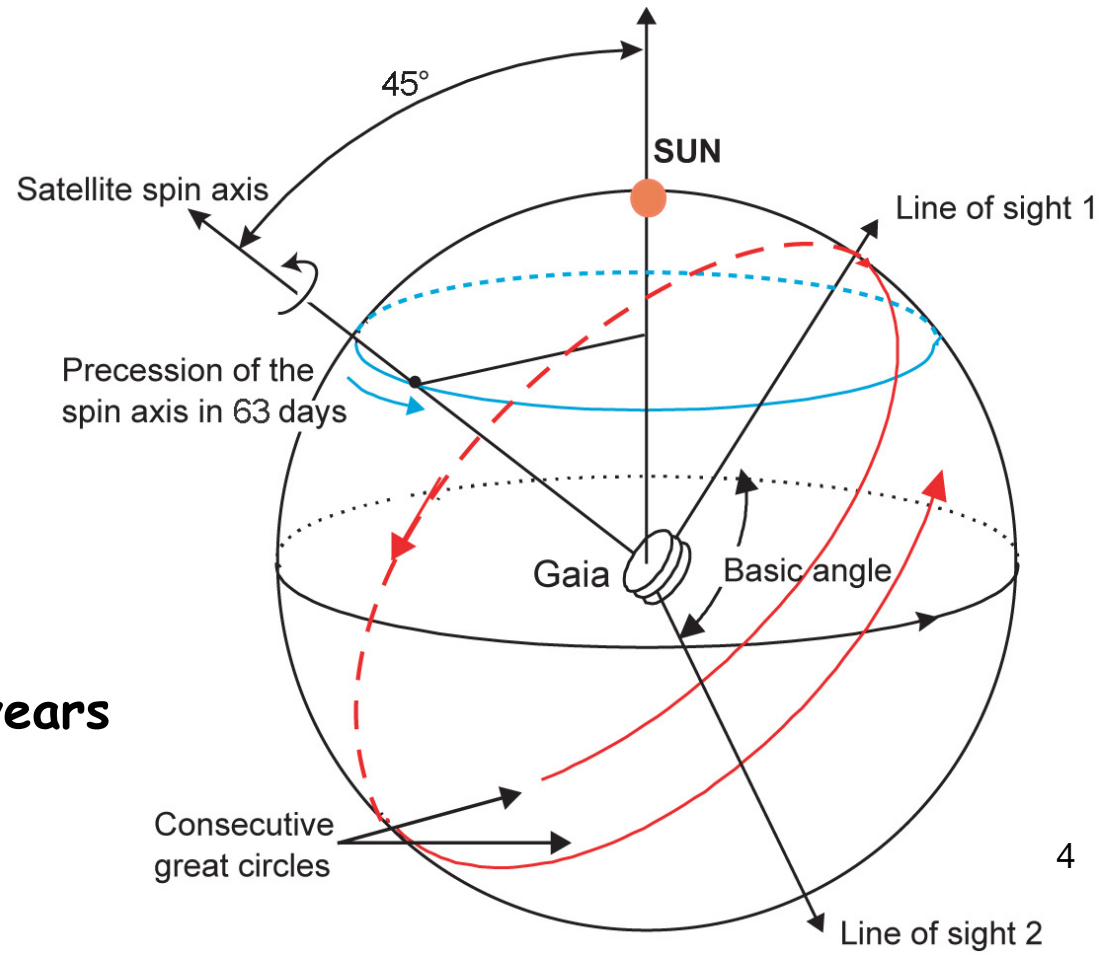
The Gaia mission with 1m class telescopes

The Gaia mission with 1m class telescopes

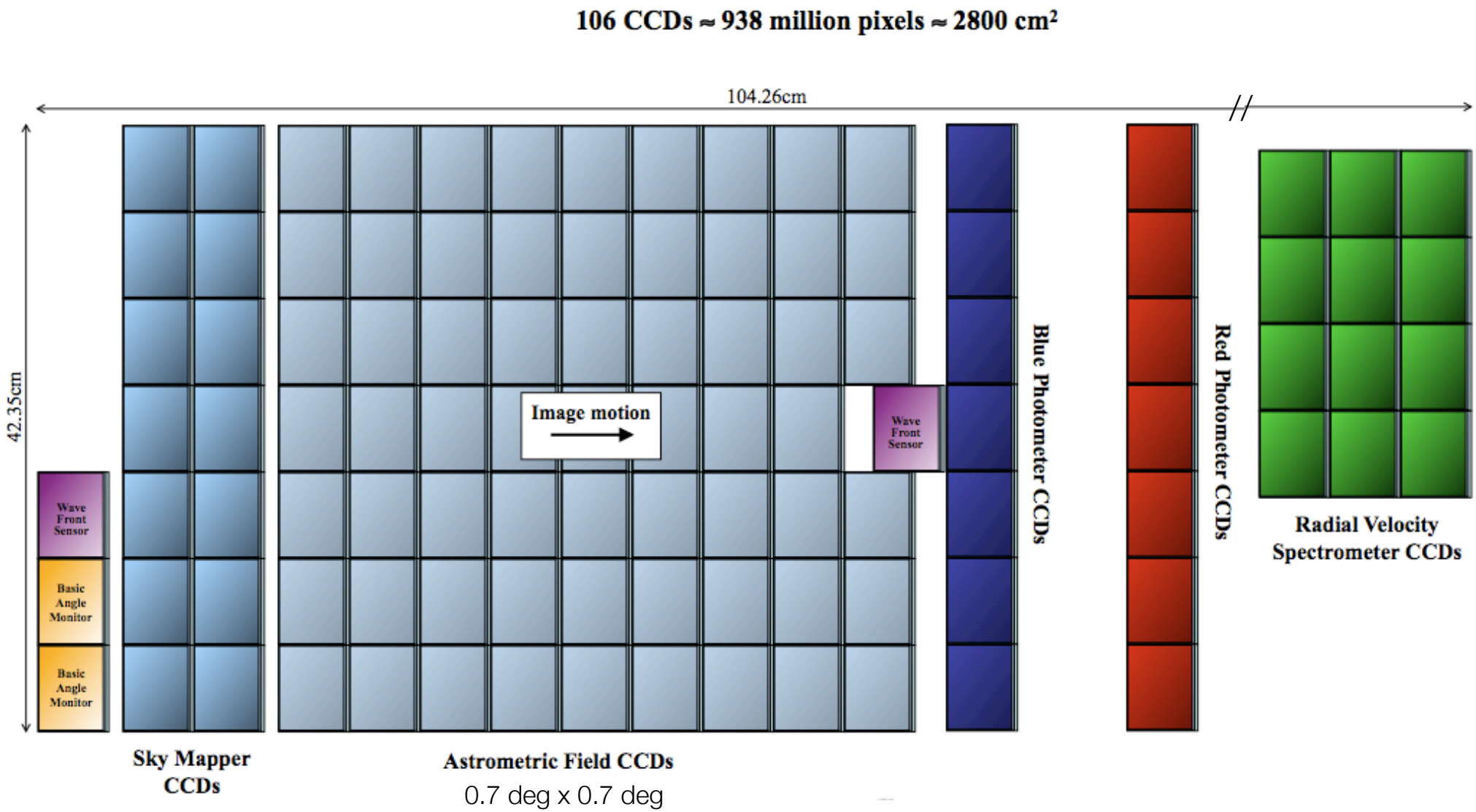
The Gaia mission sampling properties

- Rotation of the satellite 6 hours, precession in 63 days
- From Line of sight "1" to "2": 1h46
- From Line of sight "2" to "1": 4h14
- Gaps of about ~30 days

a mean of 70 transits over 5 years



Gaia Focal Plane



4.4 seconds to cross a CCD

The Gaia astrometric performance: Mean parallax error (end of mission)

Mean parallax error end of mission

	B1V	G2V	M6V
$V-I_C$ [mag]	-0.22	0.75	3.85
Bright stars	5-14 μas (6 mag < V < 12 mag)	5-14 μas (6 mag < V < 12 mag)	5-14 μas (8 mag < V < 14 mag)
V = 15 mag	26 μas	24 μas	9 μas
V = 20 mag	330 μas	290 μas	100 μas

Position error (μas): ... x ~0.7 ~ 1/(mission length)$^{0.5}$

Proper motion error (μas/year): ... x ~0.5 ~ 1/(mission length)$^{1.5}$

Gaia photometric / spectro-photometric / radial velocity performances (end of mission)

Photometry

G ~ 330 - 1050 nm

Spectro-photometry

BP ~ 330 - 680 nm 60 samples

RP ~ 640 - 1050 nm 60 samples

	B1V			G2V			M6V		
G [mag]	G	BP	RP	G	BP	RP	G	BP	RP
6 - 13	1	4	4	1	4	4	1	4	4
14	1	4	4	1	4	4	1	5	4
15	1	4	5	1	4	4	1	6	4
16	1	4	5	1	5	5	1	9	4
17	2	5	7	2	5	5	2	20	5
18	2	7	14	2	9	8	2	49	5
19	2	13	34	2	18	18	2	120	8
20	3	29	83	3	43	43	3	301	17

[milli-magnitude]

Radial Velocity

RVS ~ 847 - 871 nm

R = 11,500

Spectral type	V [mag]	Radial-velocity error [km s^{-1}]
B1V	7	1
	12	9
G2V	13	1
	16.5	13
K1III-MP (metal-poor)	13.5	1
	17	13

The Gaia release scenario

- Launch+22 months: positions, G-magnitudes (all sky, single stars), proper motions for Hipparcos stars (~50 μarcsec/yr) – the Hundred Thousand Proper Motions (HTPM) catalogue

- Launch+28 months: + radial velocities for bright star

- Launch+40 months: + first 5 parameter astrometric results (α, δ, π, $\mu\alpha$, $\mu\delta$) BP/RP data, more RVS spectra, astrophysical parameters, orbital solutions for short period binaries

- Launch+65 months: + variability, solar system objects

- End+3 years: final data release (~ 2022)

- Photometric Alert Systems
- Solar System Objects
- Sub groups of variable objects

Gaia and 1-m class telescopes

Within Data Processing and Analysis Consortium:

- Next slides

Follow-ups for scientific exploitation:

- Some organisation being discussed with the Photometric Alert group
- Left to the community

GBOG (Ground Based Observations for Gaia)

Caroline Soubiran, Bordeaux University

- Regroup all activities related to the Gaia consortium and observations: mostly to help the calibration, the data processing of Gaia

- Many programs, more than 80 observing proposals written, ~40 with telescopes below 2 meters (amongst others):

  - Radial velocity standards: 1m20 Euler telescope, 1m93 OHP

  - Spectro-photometric standards: 1m20 San Perdo Martir, 1m52 Loiano

  - Reference stars for stellar classification: 1m20 Mercator telescope

  - ....

GBOT (Gaia Ground Based Optical Tracking)

Martin Altmann, Heidelberg University

To reach Gaia astrometric precision, we need an accurate satellite position:

- 150 m
- 2.5 mm/sec

requirement: 20 mas precision

Tests have been done (using Planck satellite). Telescopes (amongst others):

- 2.6m ESO VST
- 2m Liverpool telescope (La Palma)
- 2m North (Hawaii) and South (Australia) Faulkes telescope + 1 m LCOGT telescopes (tests have started)
- 1m20 Euler (La Silla) and 1m20 Mercator (La Palma) telescopes

Early phase of the mission daily measurements

Gaia photometric alert system

Simon Hodgking, Cambridge University
Lukasz Wyrzykowski, Warsaw University

Definition: Data meriting alerts are data that would have little or no value without quick ground-based follow-up

Examples of alerts:

-Supernovae: 6,000 ; 2,000 before peak
-Microlensing 1,000 (and also astrometric)
-CVs:, novae, dwarf novae
-Eruptive: Be, RCrB stars, FU Ori
...
-Watch list (your preferred object)

Verification phase: 3 months, set of telescopes is being defined (~40 telescopes are registered)

- Tests were done with Catalina survey transients:
  - 1m20 Swiss Euler telescope
  - Italian telescopes: 1m50 Loiano, 1m80 Asiago, 0.72m Teramo, 0.80m Catania telescopes

http://www.ast.cam.ac.uk/ioa/research/gsawg

Gaia Solar System Objects

William Thuillot, Observatoire de Paris

Goals (in contact with IAU Minor Planet Center):

- to confirm new detections
- avoid loss of objects
- improve the orbit

Network of telescopes (https://www.imcce.fr/gaia-fun-sso/):

- ~39 sites, 55 telescopes, 6 robotic: from 25cm to 2m40

Training/true alerts done:

- 2005 YU55: 15 sites participated
- 1996 FG3: 3 sites participated
- 2012 BS67 (faint V~20): 4 sites participated
- 9942 Apophis (faint V~21): 4 sites participated

Gaia variable stars

Gisella Clementini, Bologna university
Laurent Eyer, Geneva University

Network of telescope in support of the variability pipeline

Validation of the results.

Network of telescopes: 9 sites, 15 telescopes, 8cm-2m size

Some programs (on specific issue, related to < 2m size):

- Observations of Be stars (P.Koubsky)
- Observations related to period changes of Cepheids (L.Szabados)
- Short period variable stars (M.Varadi)

Conclusions

1-m class telescopes are useful for the Gaia mission

- Astrometric precision
- Photometric/spectroscopic standards, so helping the data processing
- Validation of the results

1-m class telescopes have a bright future

- They are ideal size telescopes to scientifically exploit Gaia data

National and "local" facilities play a crucial role