Gaia Mission:
looking at the first data release

Dr. Giorgia Busso
Institute of Astronomy, Cambridge University

King’s Lynn and District Astronomical Society

April 3 2017

Gaia Mission: looking at the first data release

Prof. Gerry Gilmore

Dr. Anna Hourihane

Gaia Team at IoA

King’s Lynn, April 3 2017

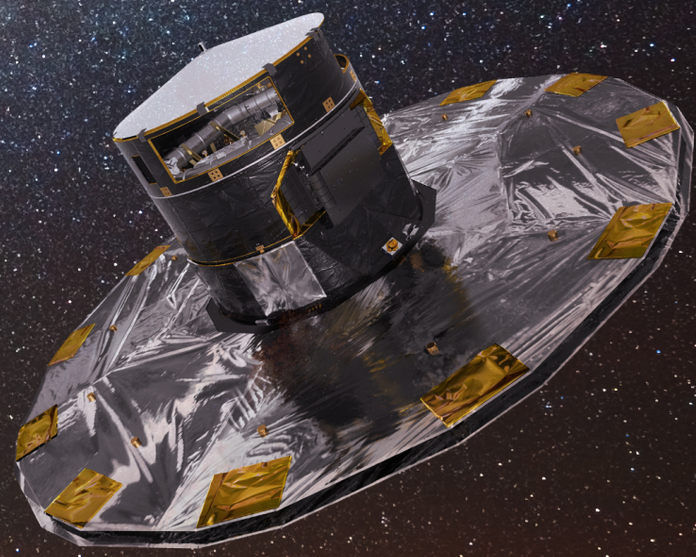
G. Busso

Gaia: the billion star surveyor

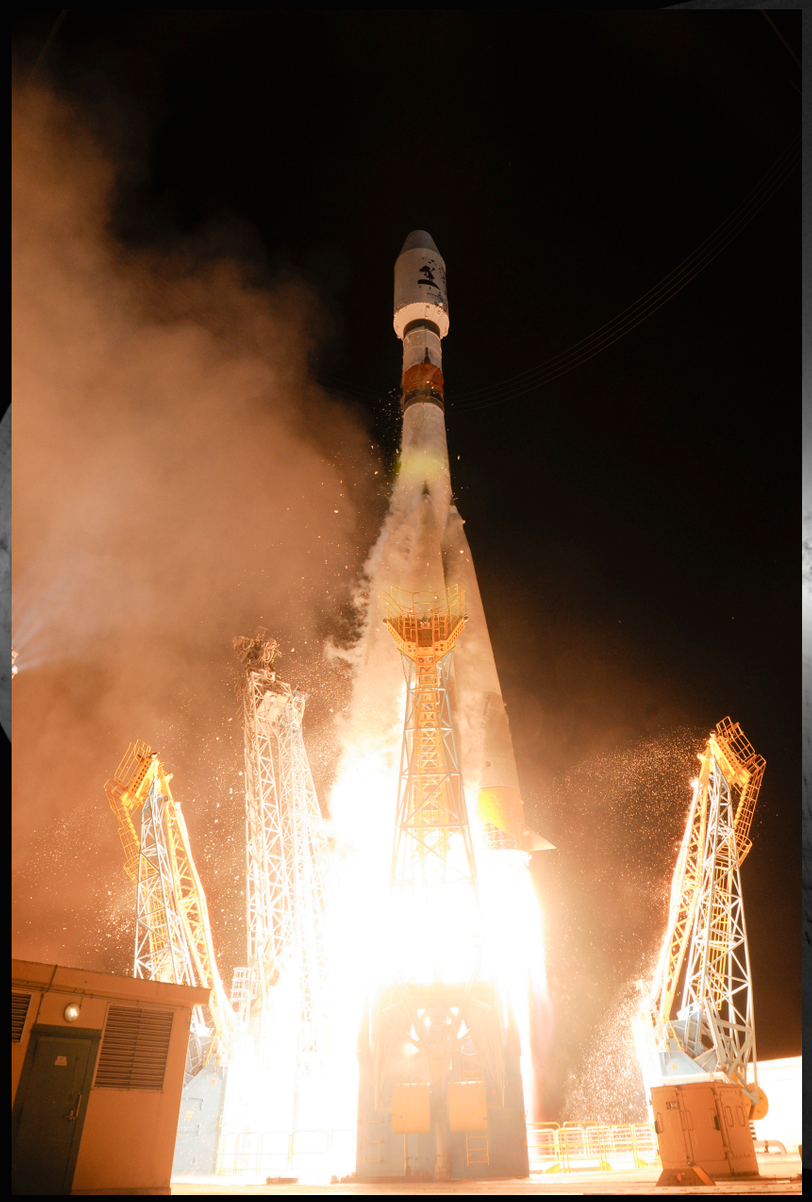
ESA corner mission

1% the visible Milky Way

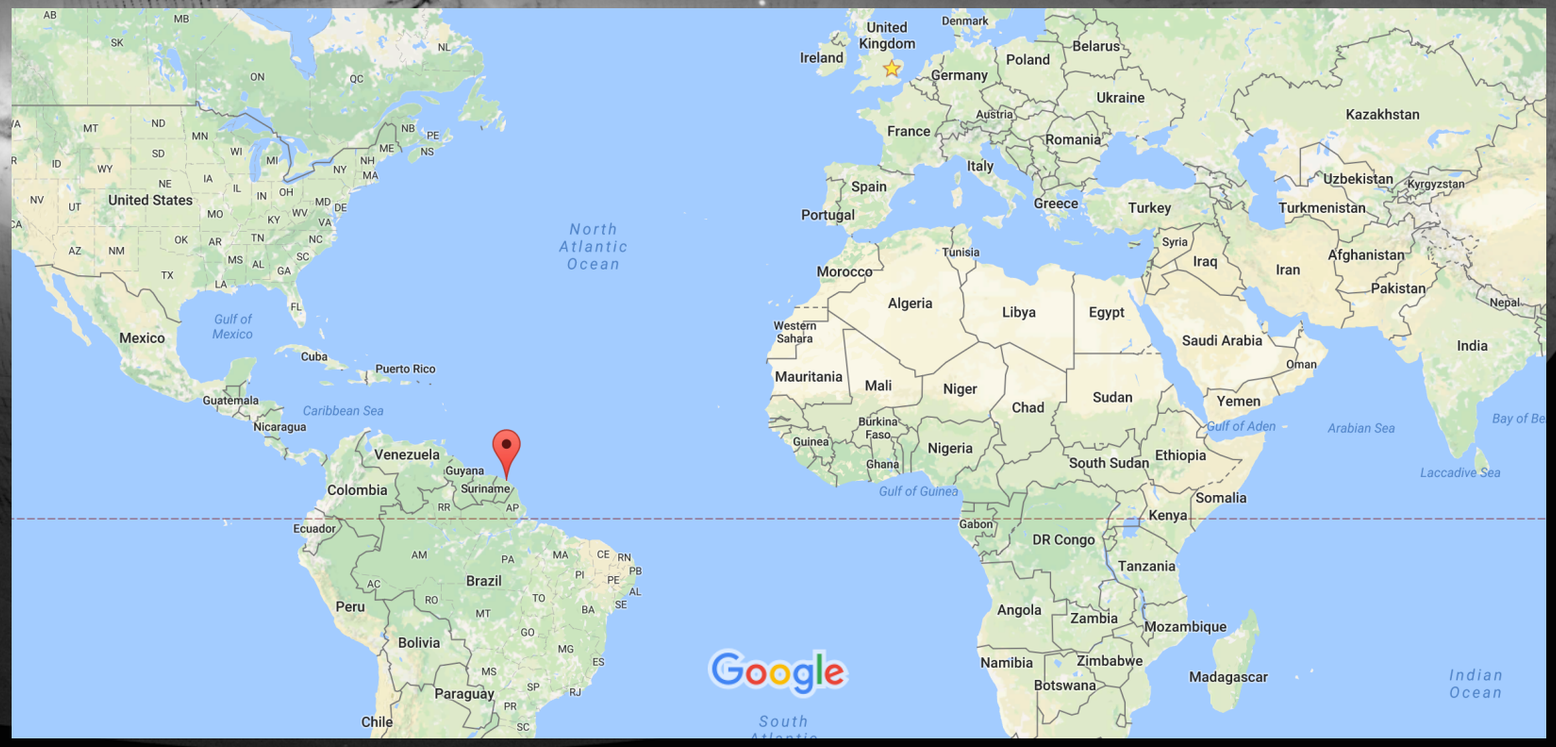
Unprecedented accuracy (μMag and mas)



The Mission



Launched on December 19th, 2013 at 09:12:19 UTC from Kourou in French Guiana.



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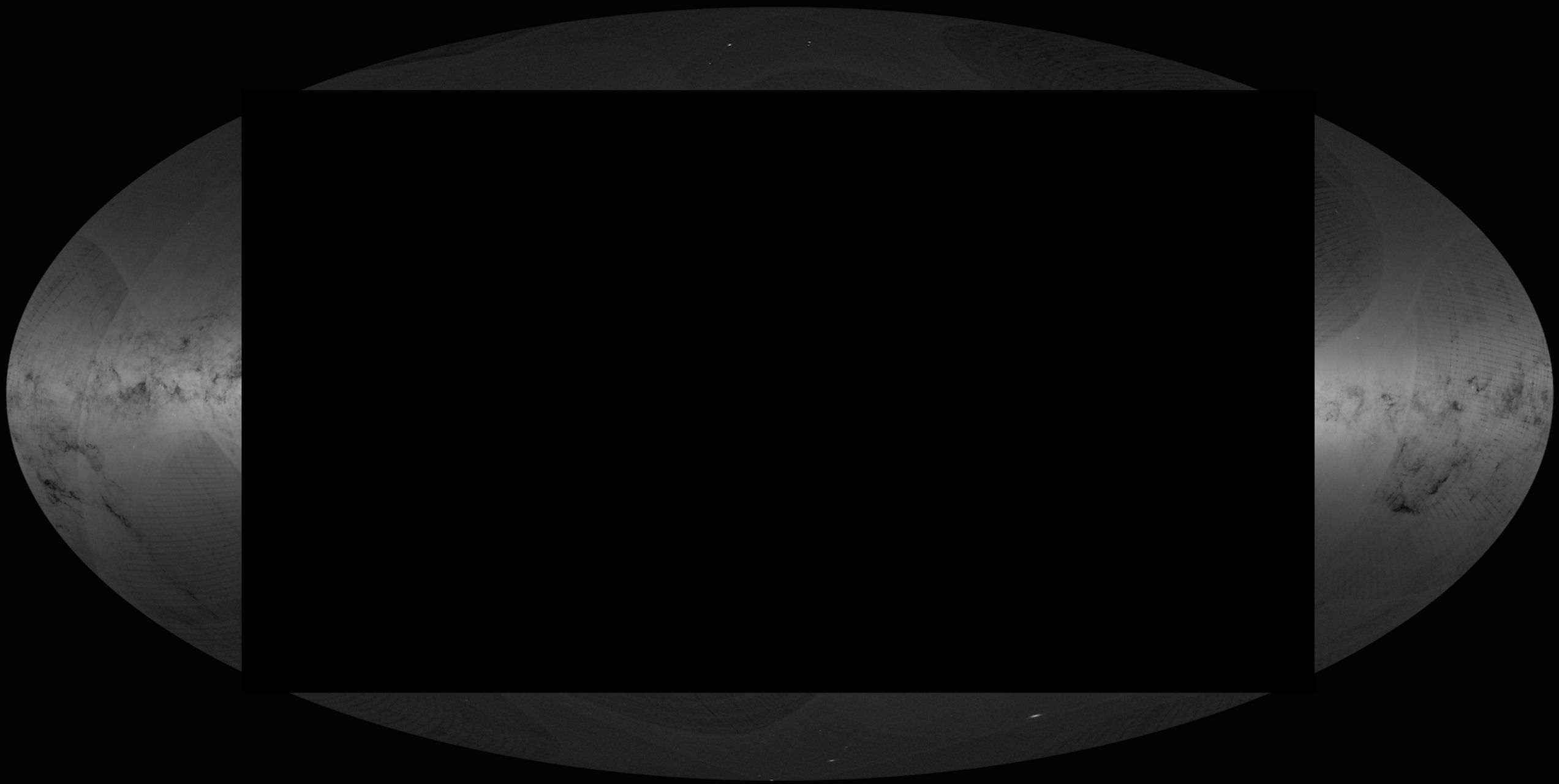
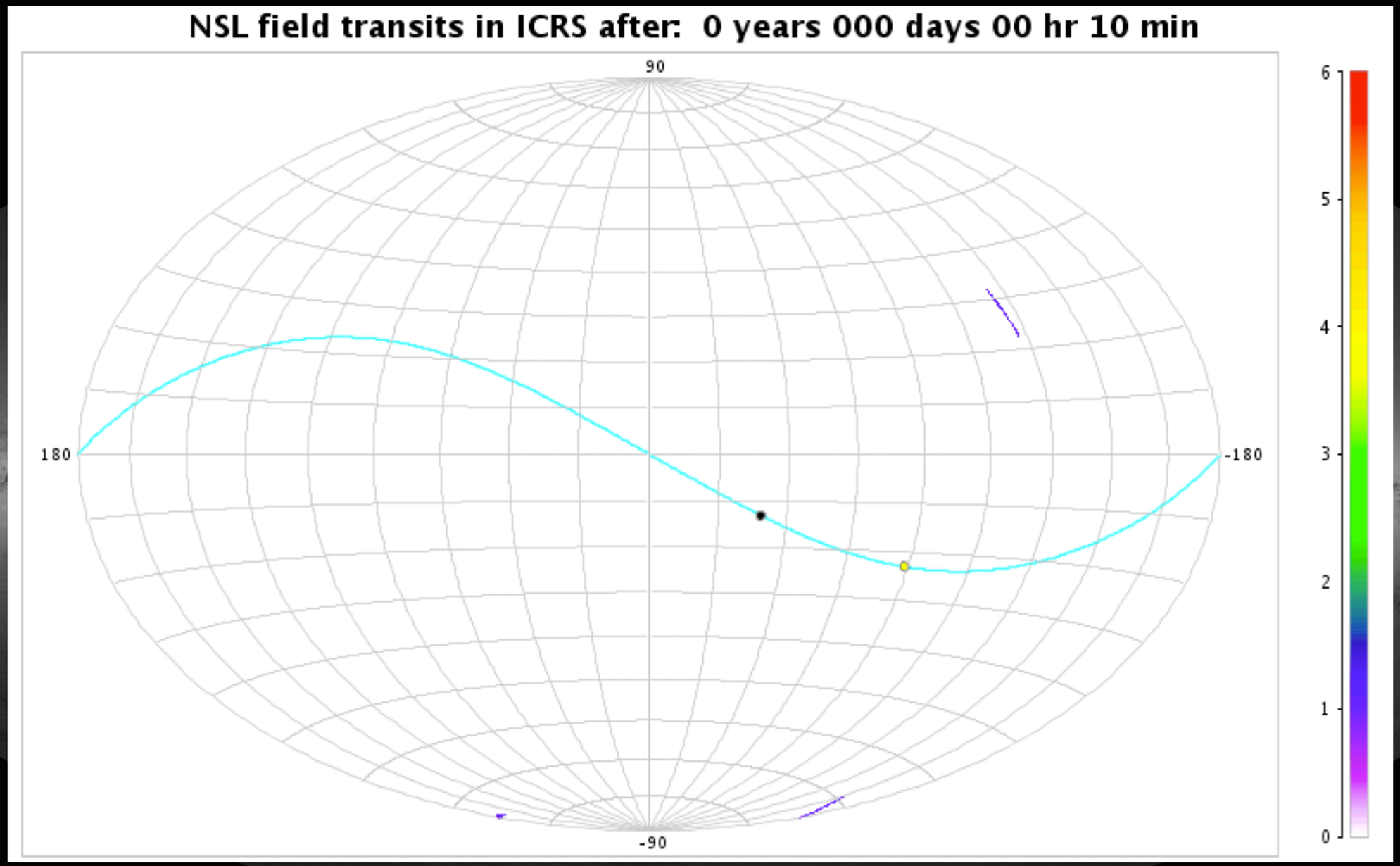


The Mission



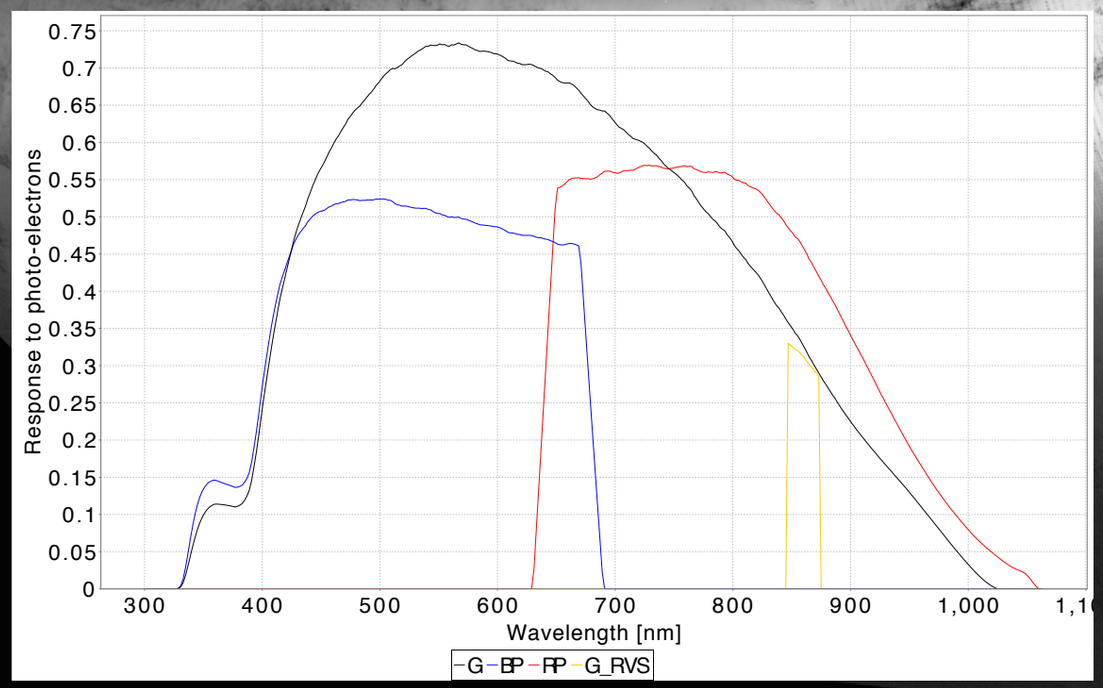
1 spin in 6 hours
Whole Sky coverage in ~6 months
In average a star is observed ~80 times

Gaia Mission: looking at the first data release

On board:

The Mission

- 2 telescopes with 1.45 x 0.5 m primary mirrors
- Astrometric Field (White Light)
- Blue And Red Photometers
- High-Res Spectrometer



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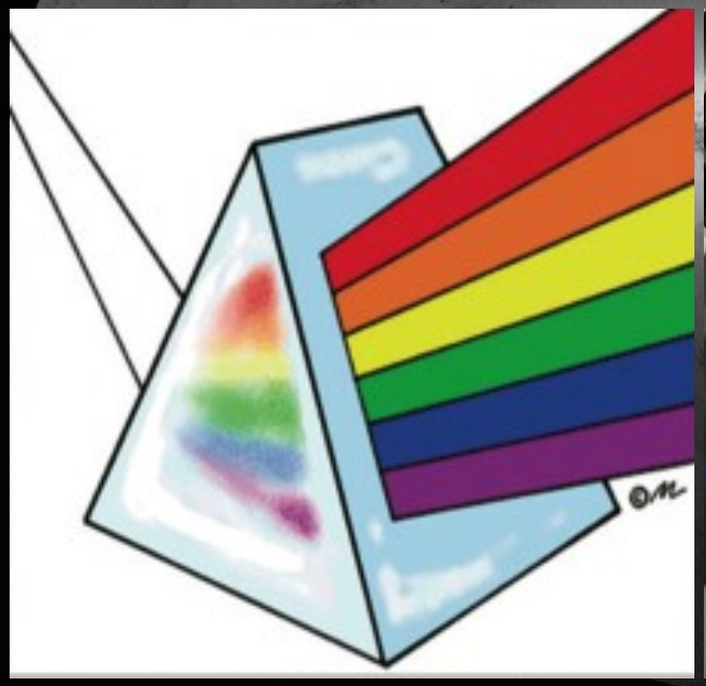
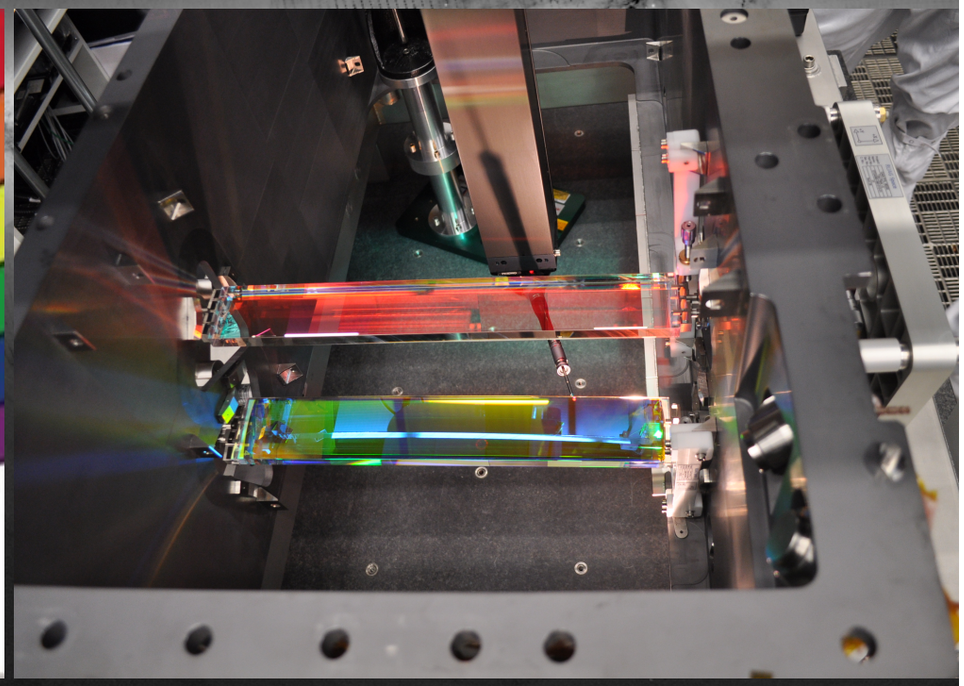
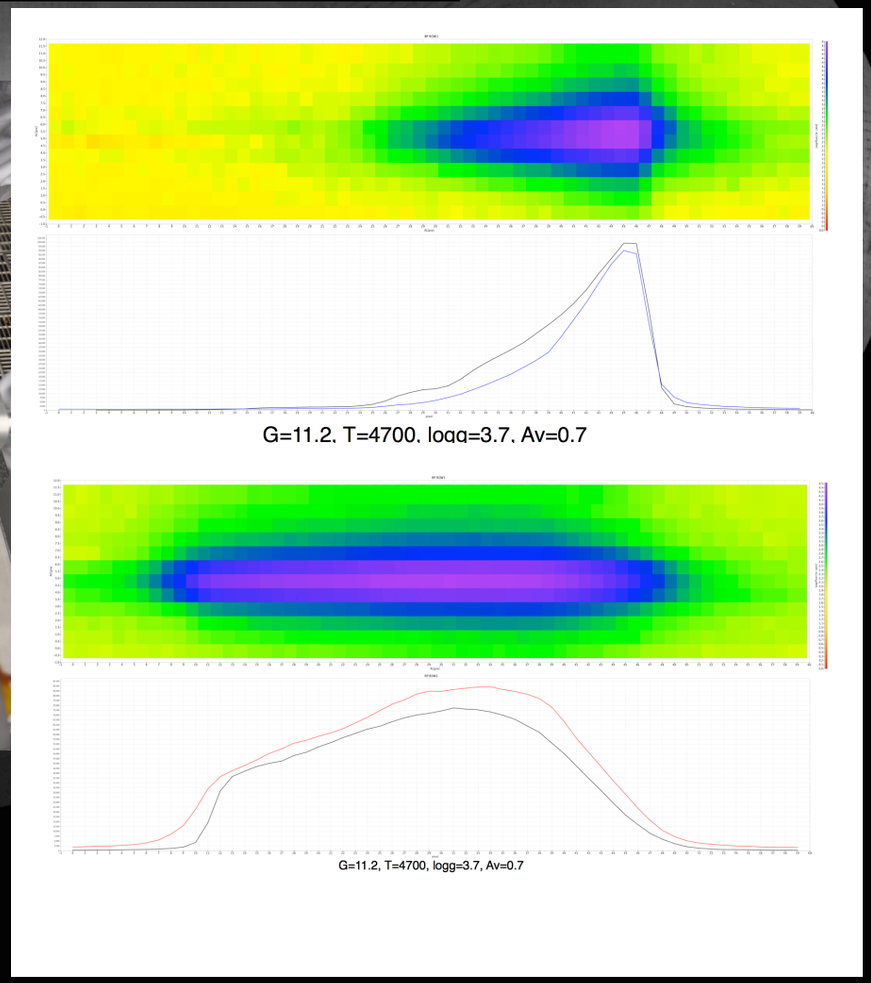


Light dispersion



BP/RP



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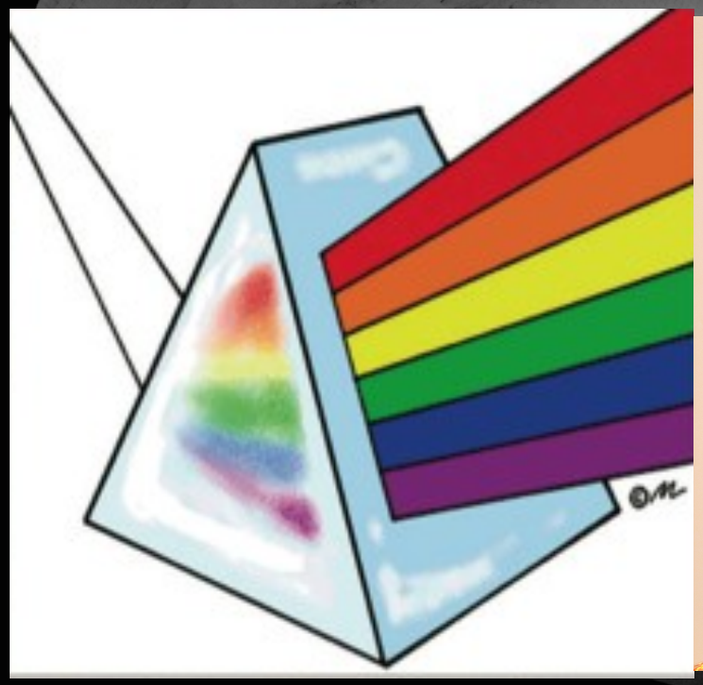
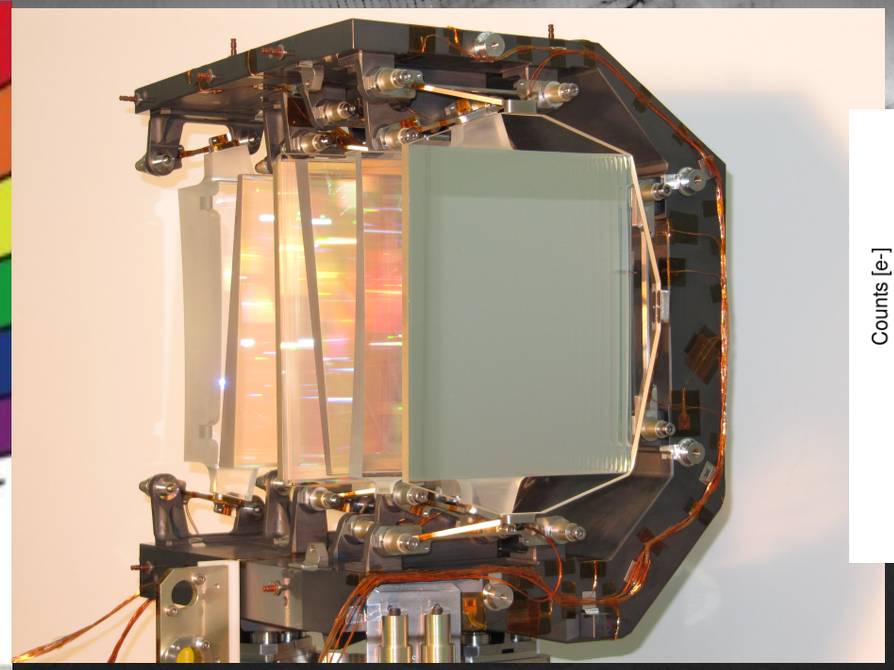
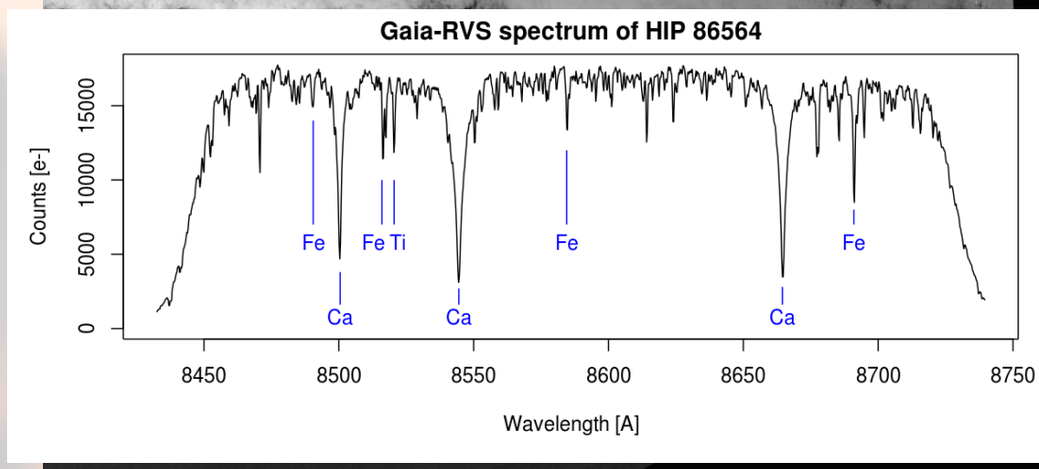


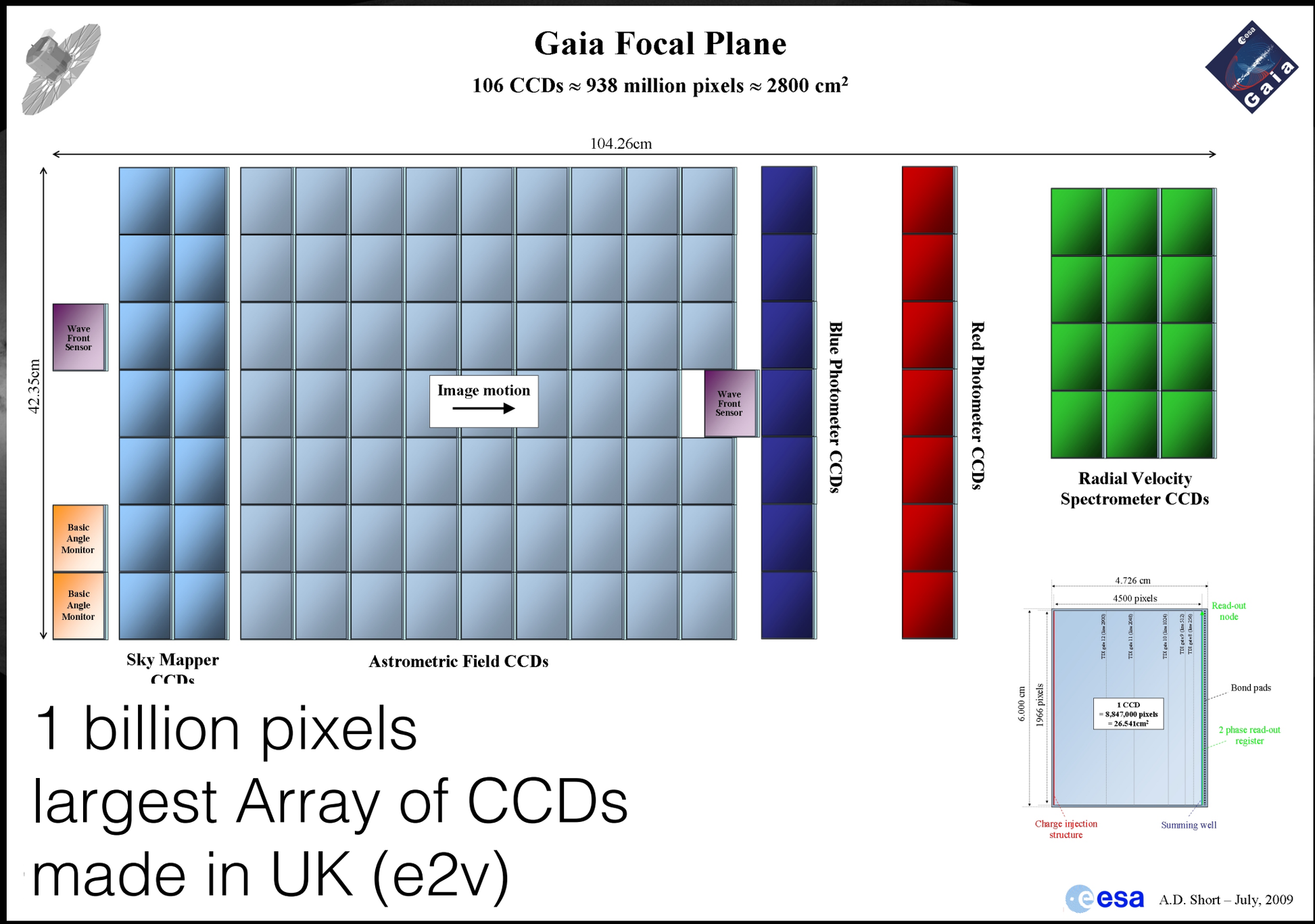
Light dispersion



RVS



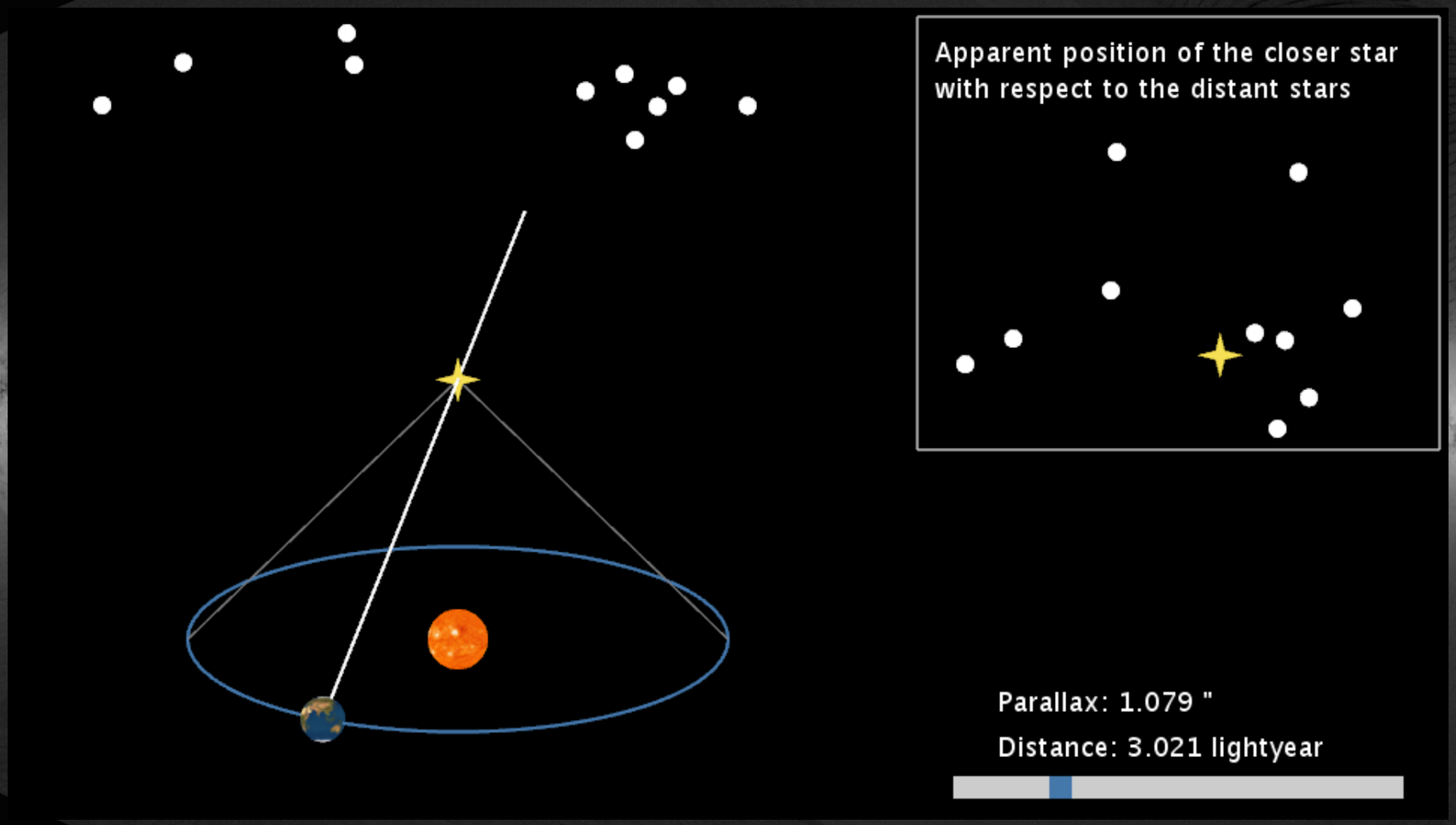
On board: The Mission



1 billion pixels
largest Array of CCDs
made in UK (e2v)

The Mission

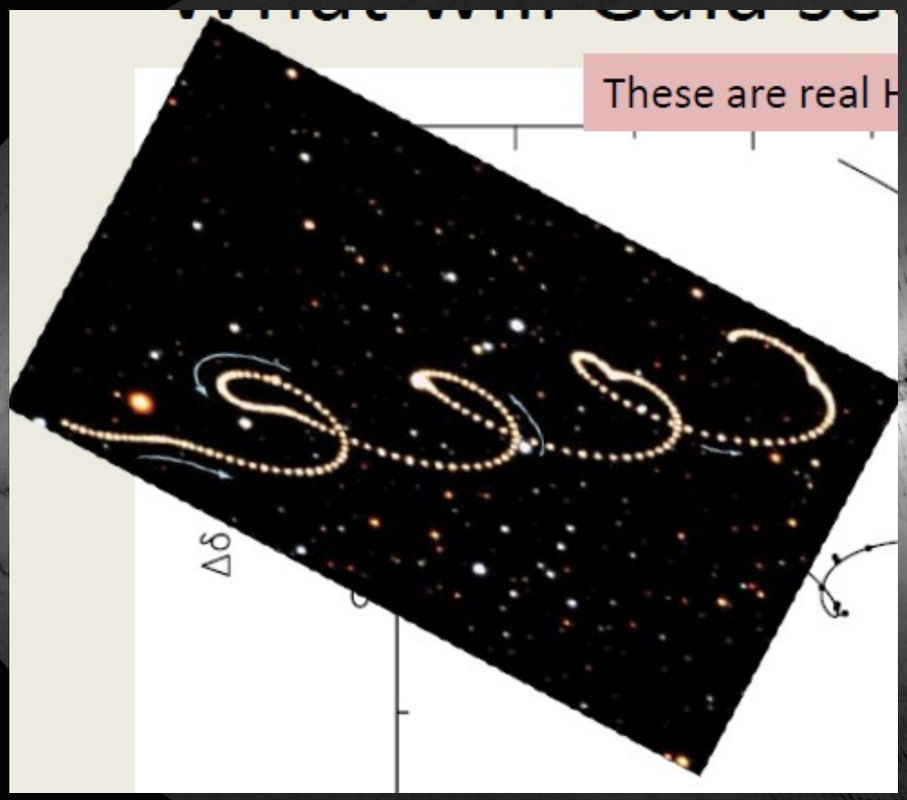
Measure Position and Parallax to get distances

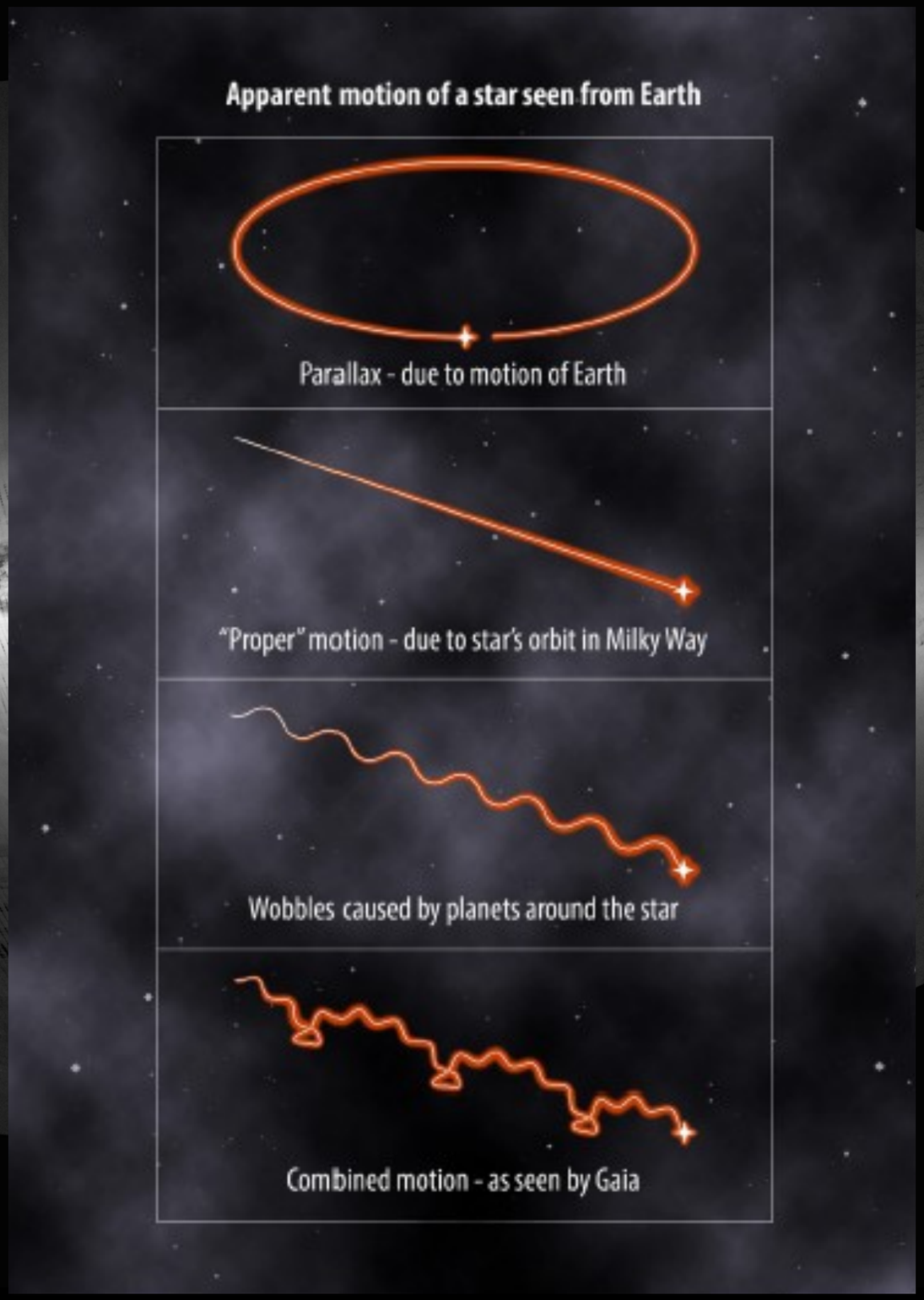


Not only distances but also..

The Mission

Proper Motions,





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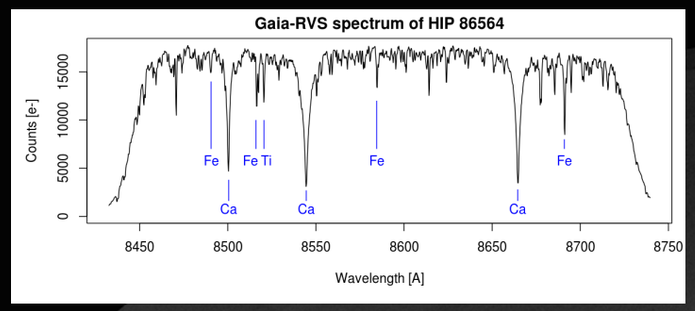
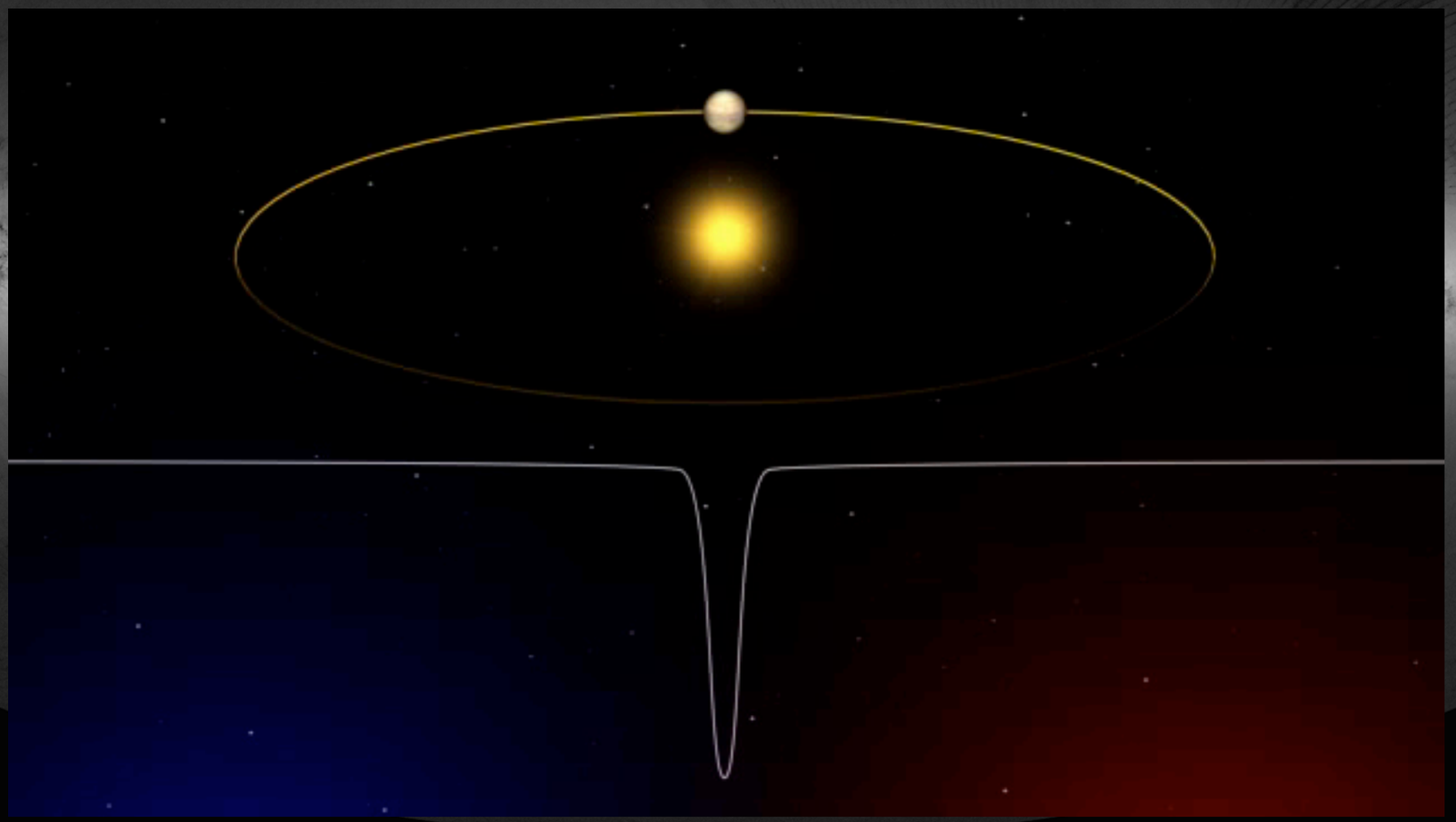
Radial Velocities,

The Mission



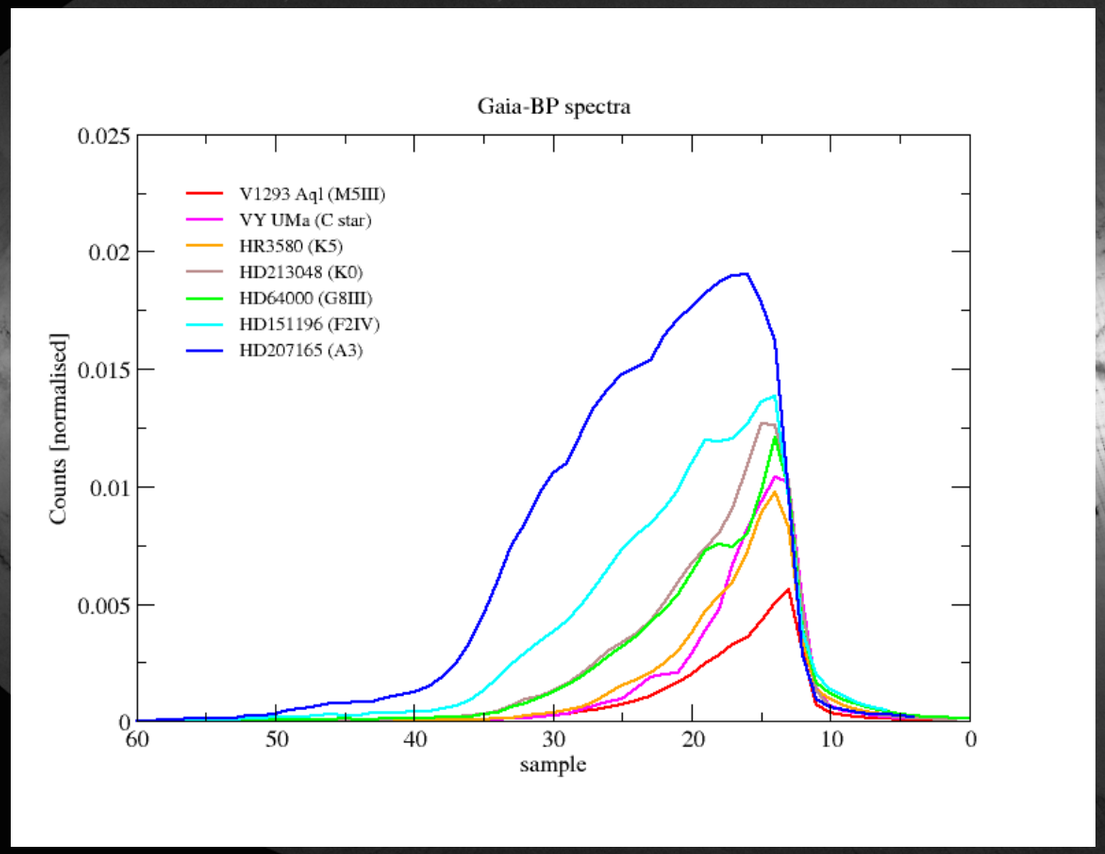


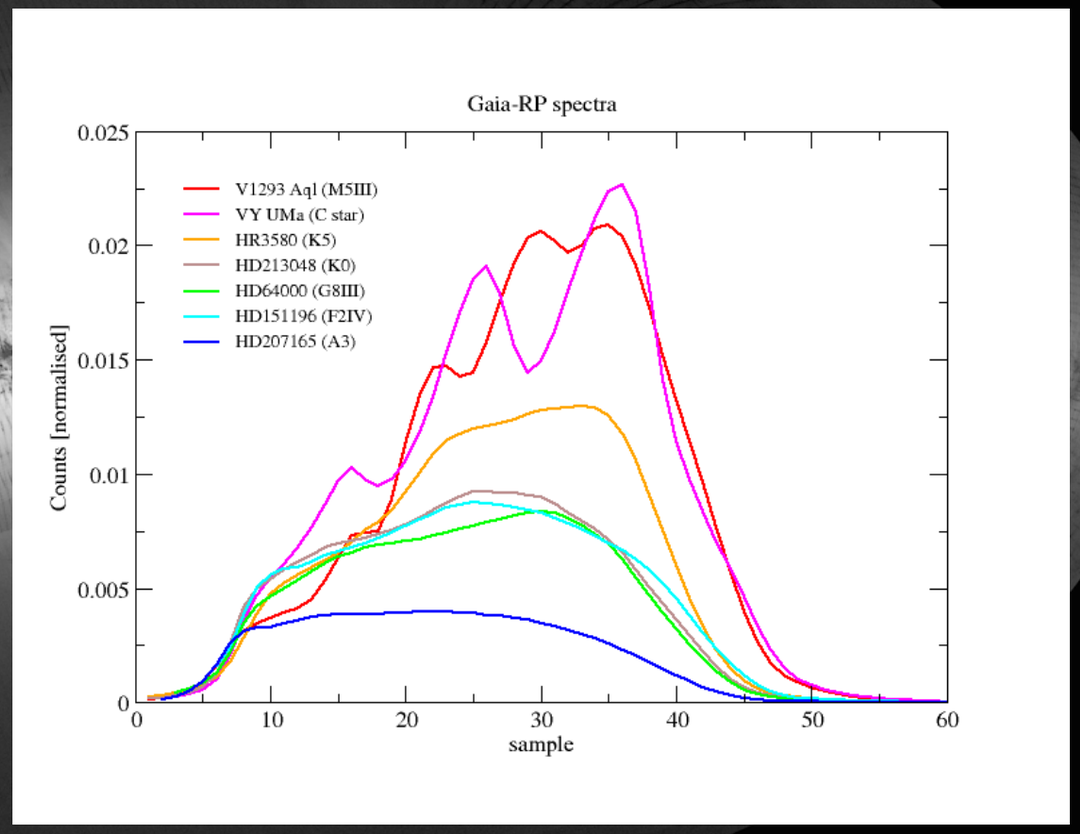
Credit: ESO/H. Zodet

The Mission

and Astrophysical Parameters!

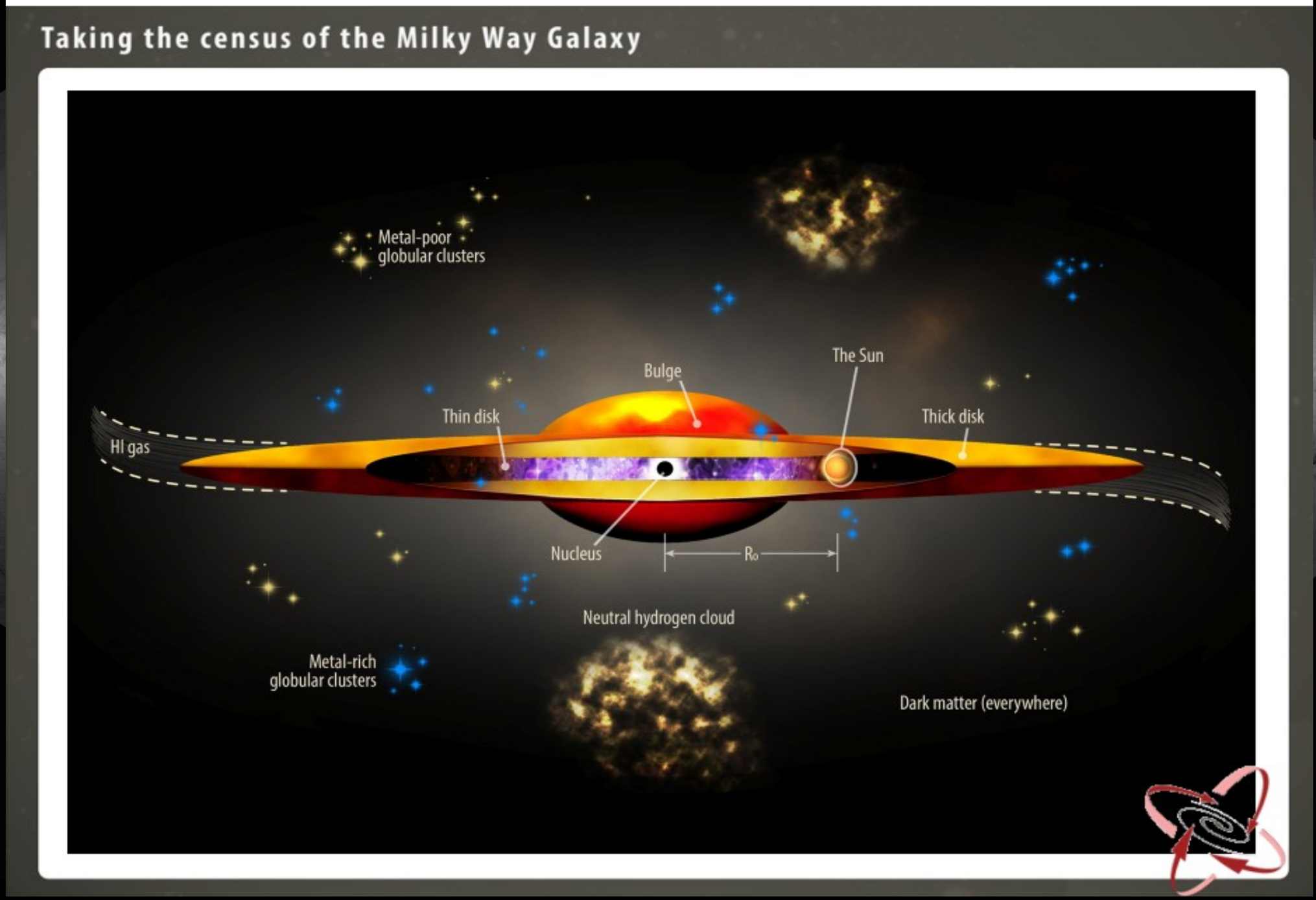
Temperature, Chemical Composition, Surface Gravity





The Mission

Putting it all together...



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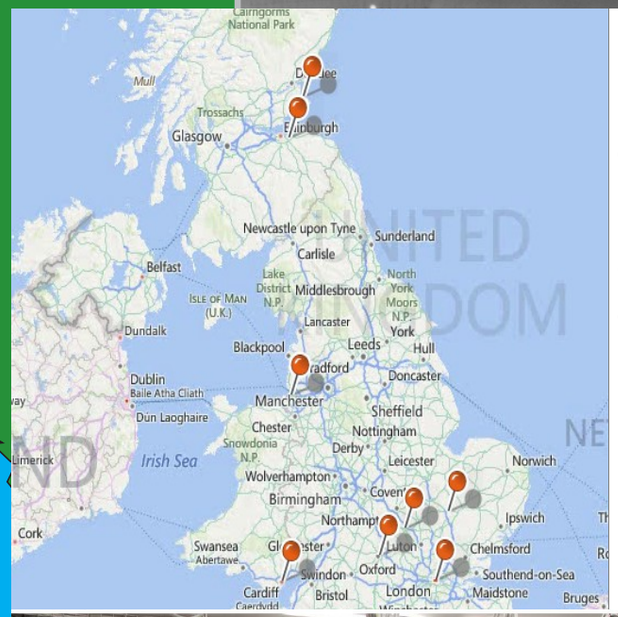
The Mission

Gaia in UK



Gaia Data Analysis and Processing:
400 people in 6 processing Centres across Europe

The Cambridge team is responsible for processing the photometric data: 50 GB/day for 5+ years

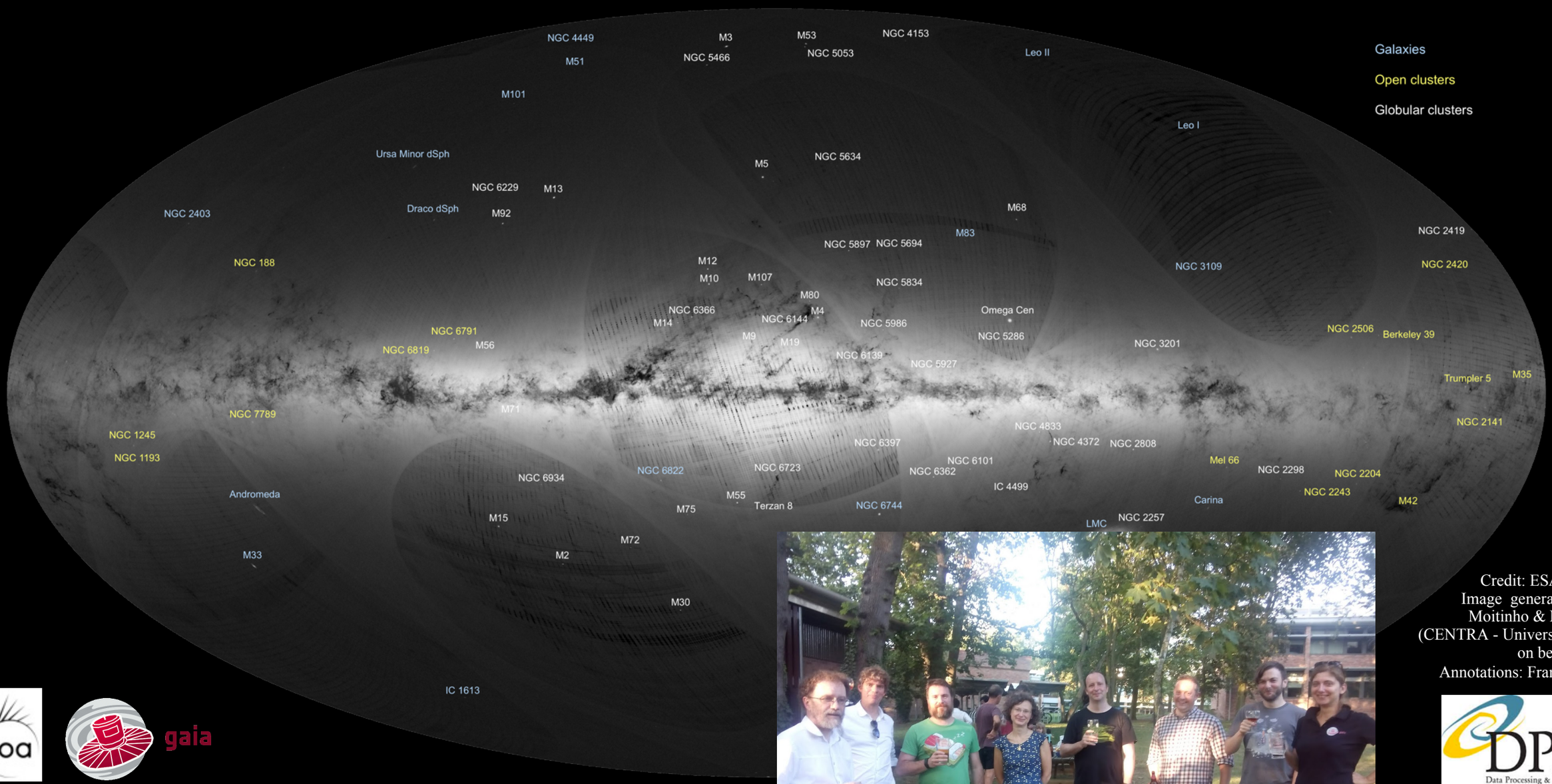
UK involvement:

- University of Cambridge
- University of Edinburgh
- Open University
- University College London
- Liverpool John Moore's
- University of Oxford
- University of St Andrews
- Cardiff University/Faulkes Telescope Project
  + educational and industrial partners (e2v, Airbus D&S)

September 14th, 2016

Gaia DR1 Sky: all sky high resolution

image shows Gaia source densities



Credit: ESA/Gaia/DPAC
Image generated by: André Moitinho & Márcia Barros (CENTRA - University of Lisbon) on behalf of DPAC
Annotations: Francois Mignard (OCA, Nice)

King's Lynn, April 3 2017

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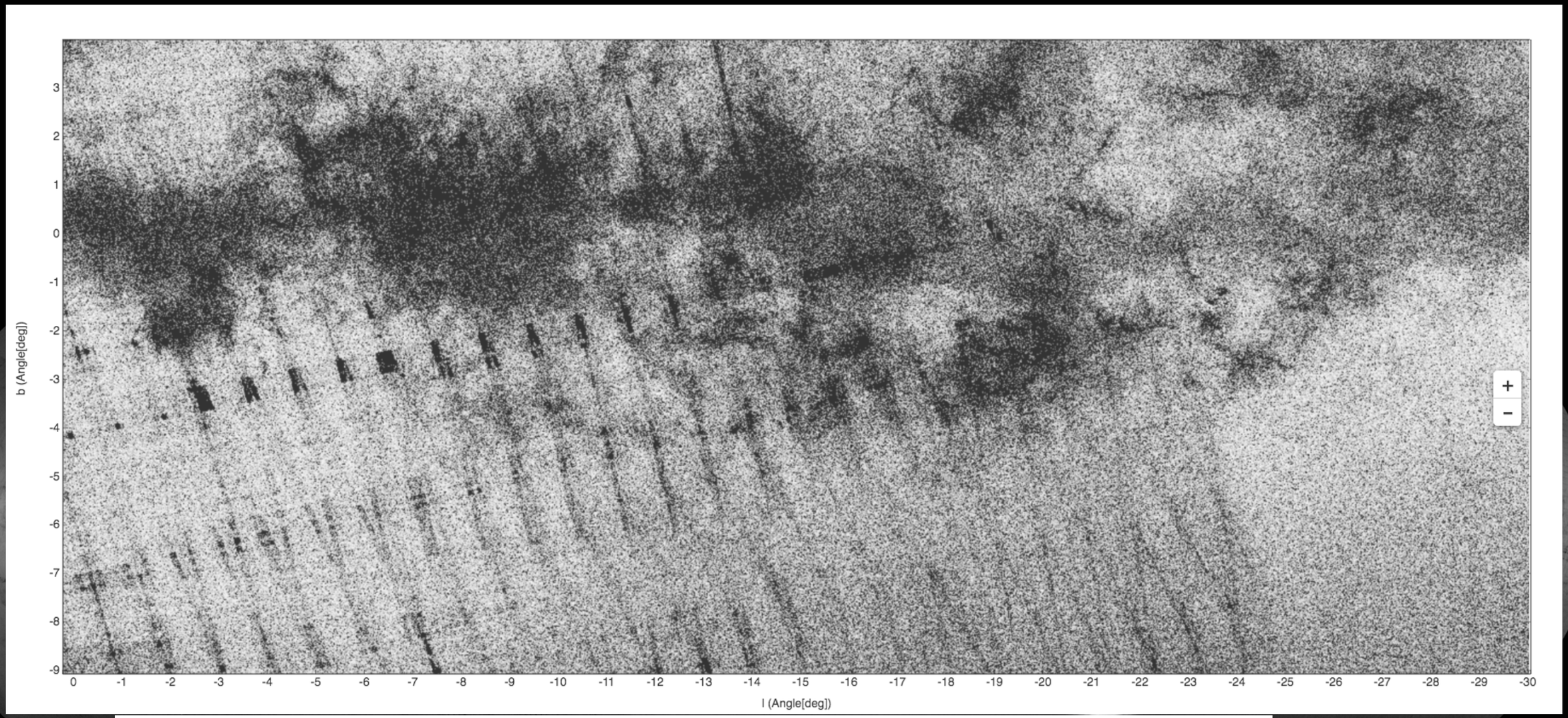
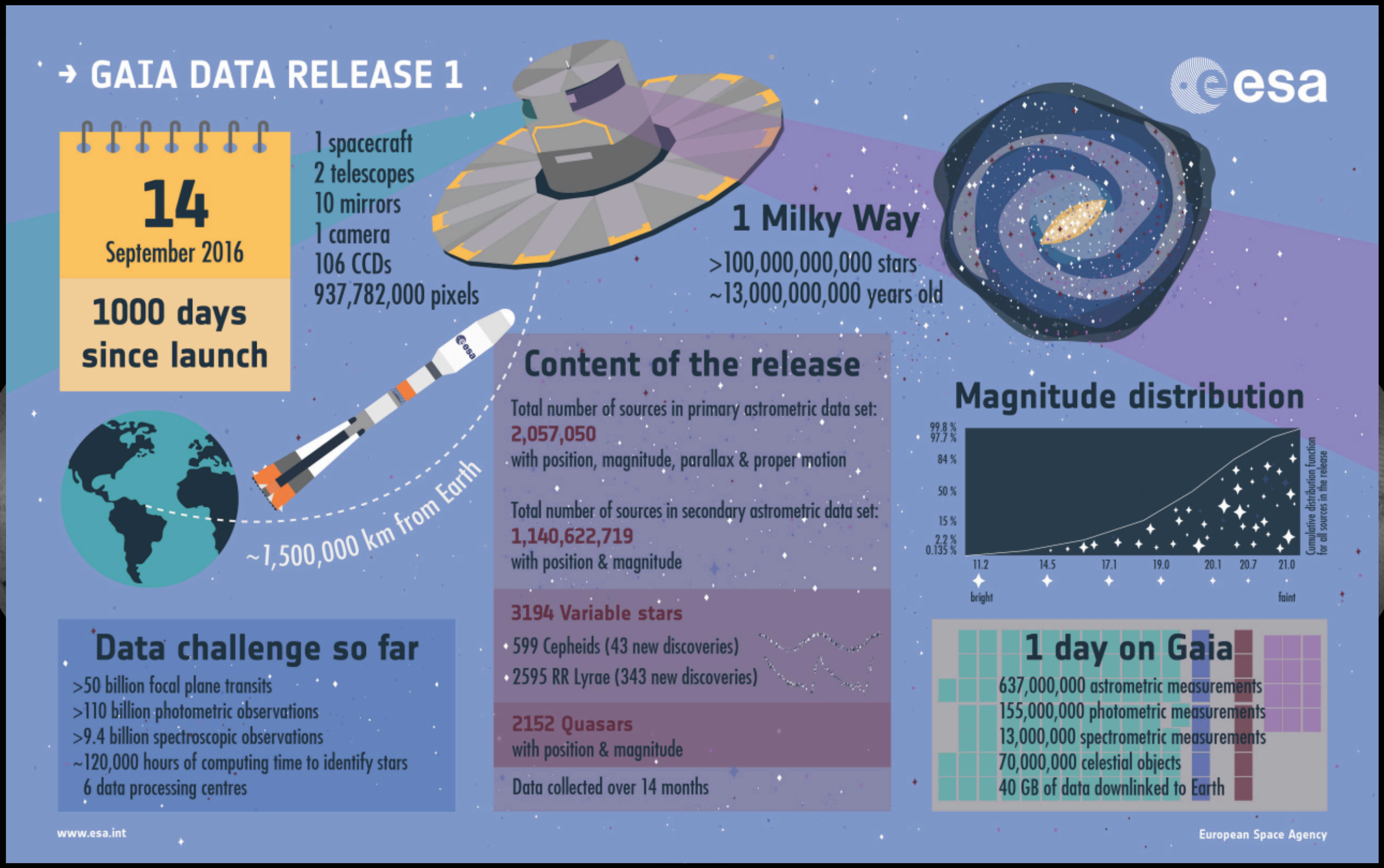


Scanning pattern is visible

- dense regions
- areas with poor scanning law coverage
- filtering on number of observations

Gaia Mission: looking at the first data release



Intermediate release -> Only positions and some proper motions

No Colors or Radial Velocities

Precisions: in mas (but will be in μas at the end)

ASTROMETRIC UNCERTAINTY

TGAS - astrometric uncertainties

	All TGAS sources			Hipparcos subset		
	10%	50%	90%	10%	50%	90%
G magnitude	9.29	11.04	12.05	7.00	8.32	9.73
position (mas)	0.20	0.32	0.75	0.20	0.26	0.46
parallax (mas)	0.24	0.32	0.64	0.23	0.28	0.48
proper motion (mas yr^{-1})	0.72	1.32	3.19	0.04	0.07	0.14

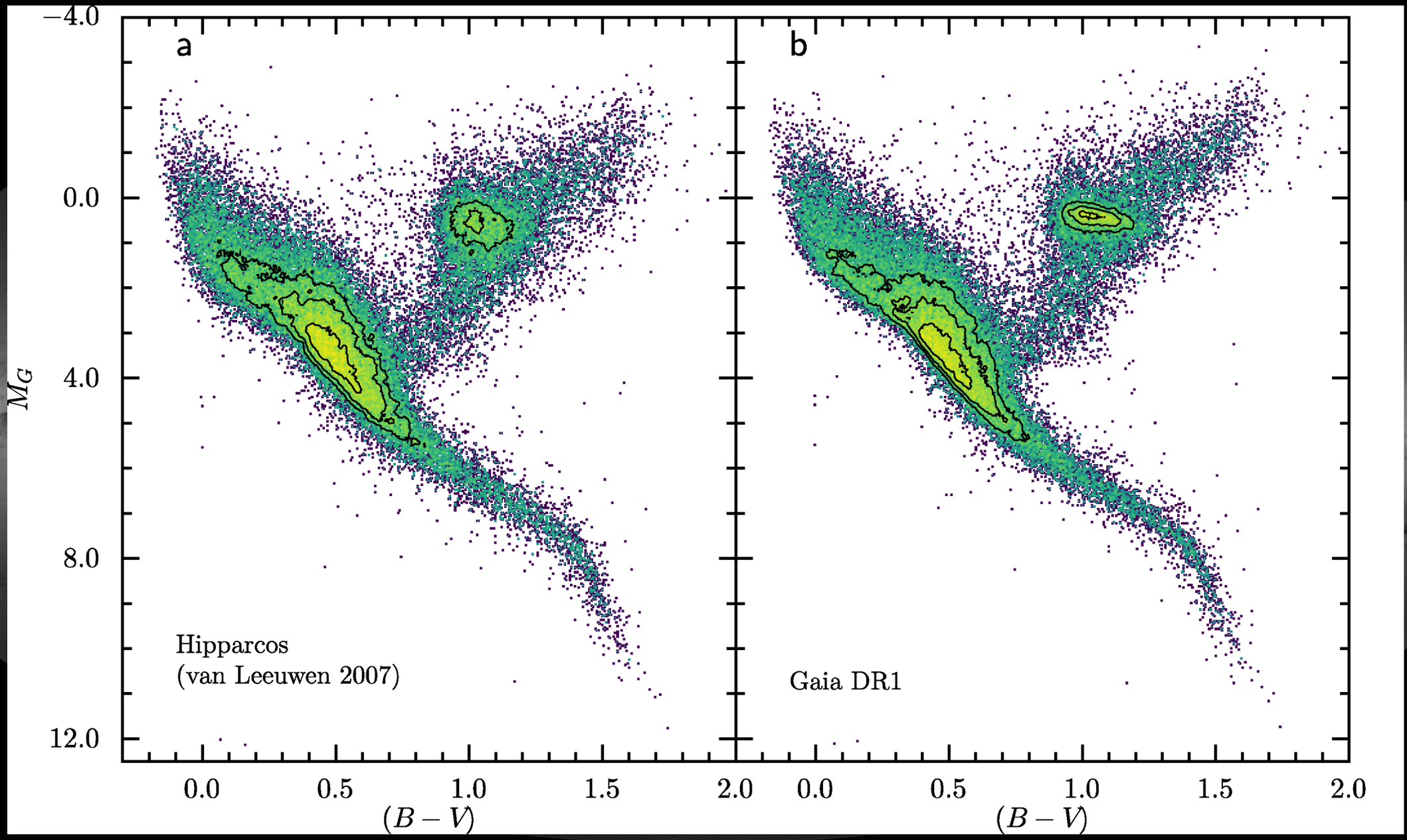
These are precisions. There is an additional systematic parallax error of ±0.3 mas.

Secondary set - positional uncertainties

G mag	fraction	10%	50%	90%
< 16	7%	0.1	0.3	5.3
16-17	7%	0.2	0.5	12.1
17-18	12%	0.3	0.8	12.4
18-19	21%	0.5	1.5	13.7
19-20	30%	0.9	2.7	16.6
20-21	22%	1.9	2.4	21.5
All	100%	0.35	2.4	16.3

Quantile positional precisions in mas.

Comparison with Hipparcos



Gaia Collaboration et al. 2016

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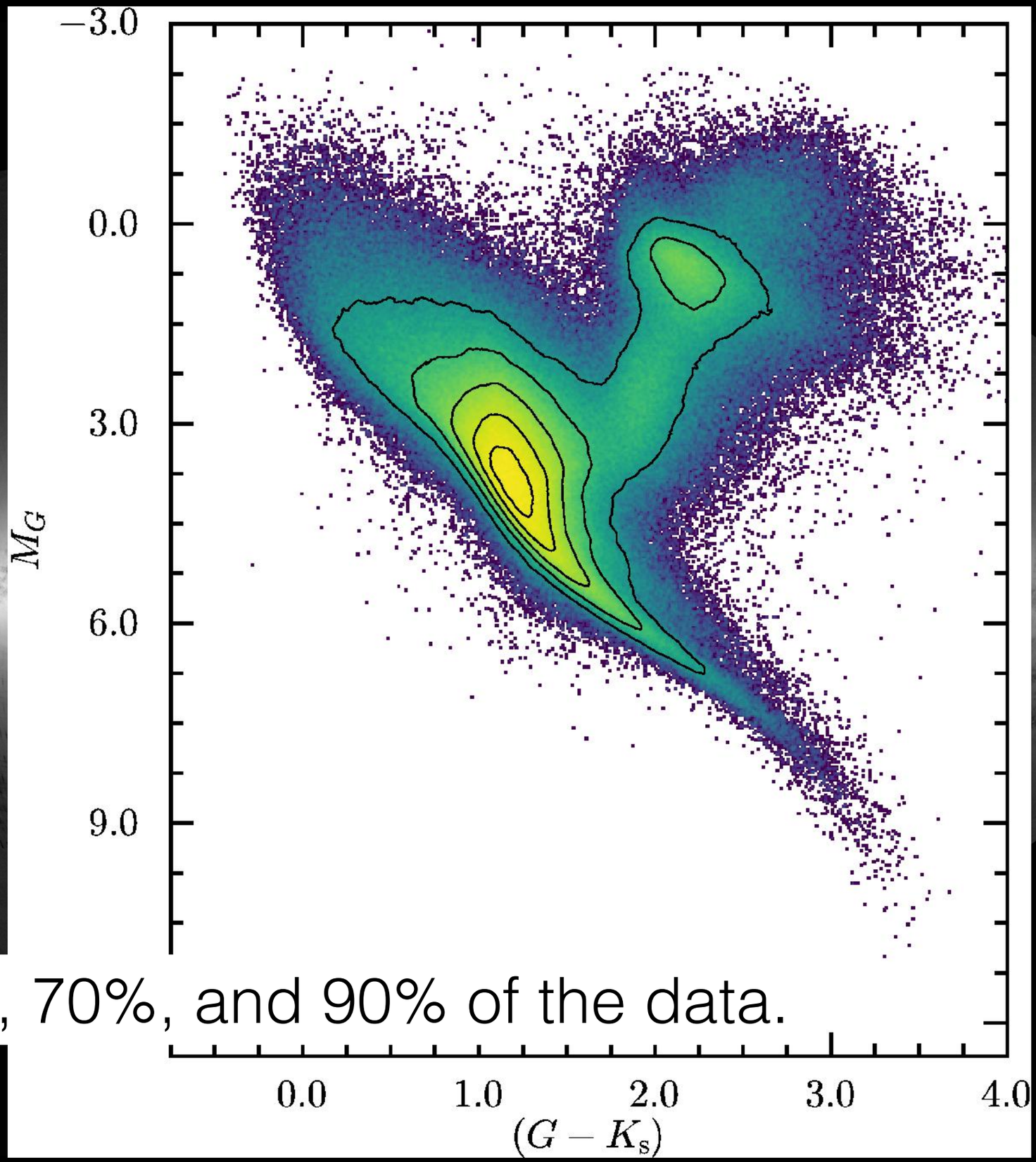
Color Magnitude Diagram



10%, 30%, 50%, 70%, and 90% of the data.

Gaia Collaboration et al. 2016

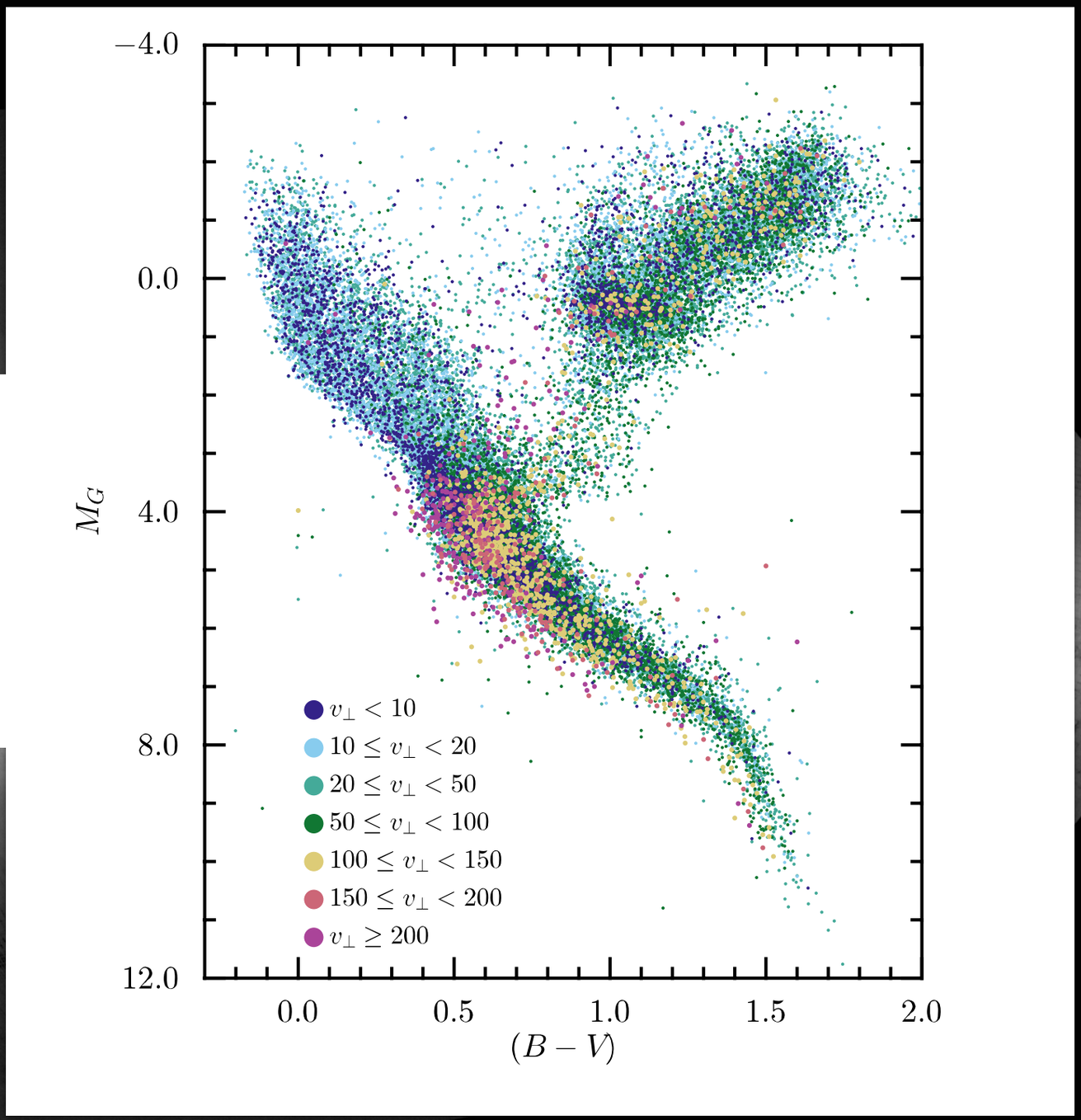
Gaia Mission: looking at the first data release

Color Magnitude Diagram

Young disk

Old disk (metal rich)

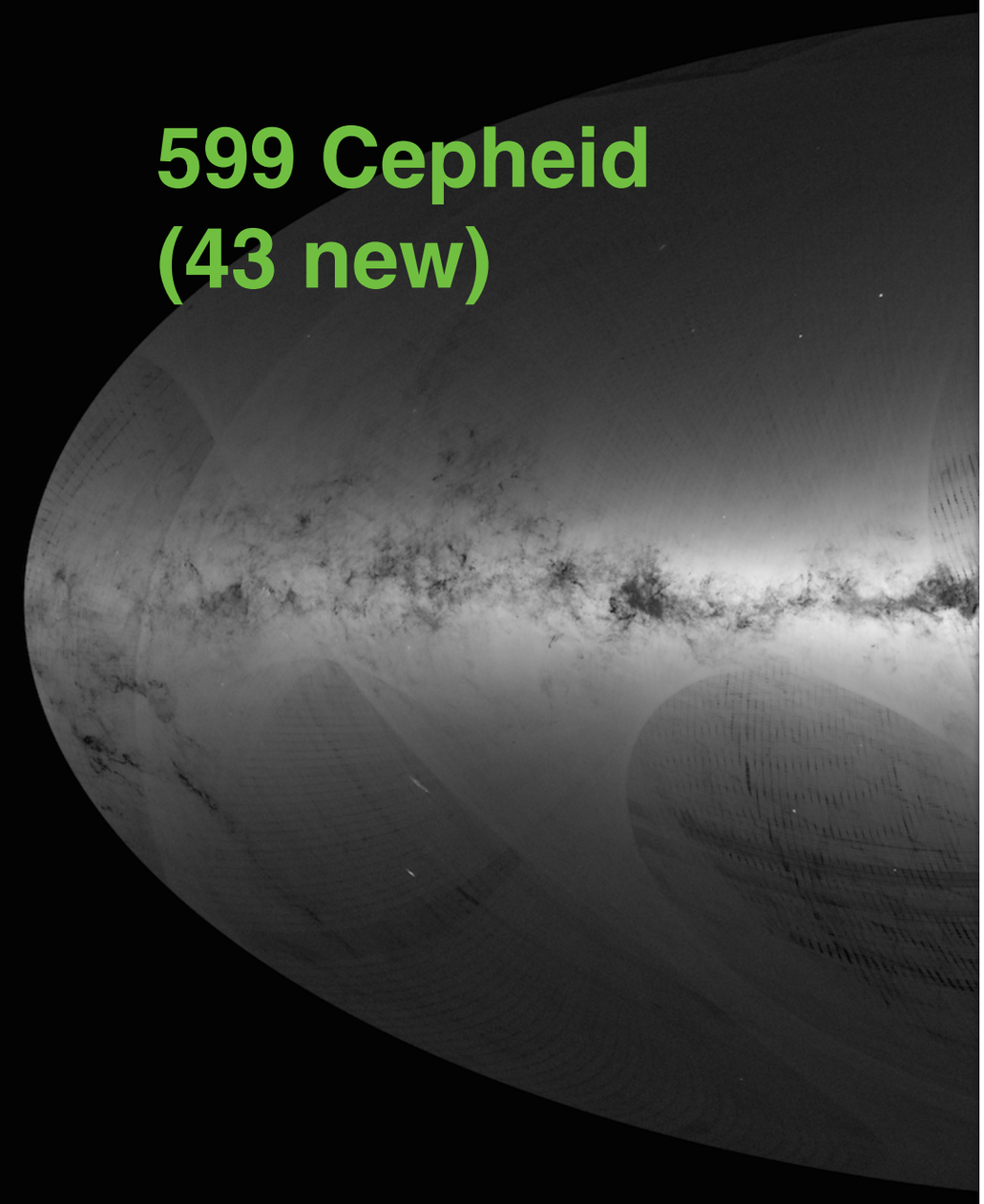
Halo (metal poor)

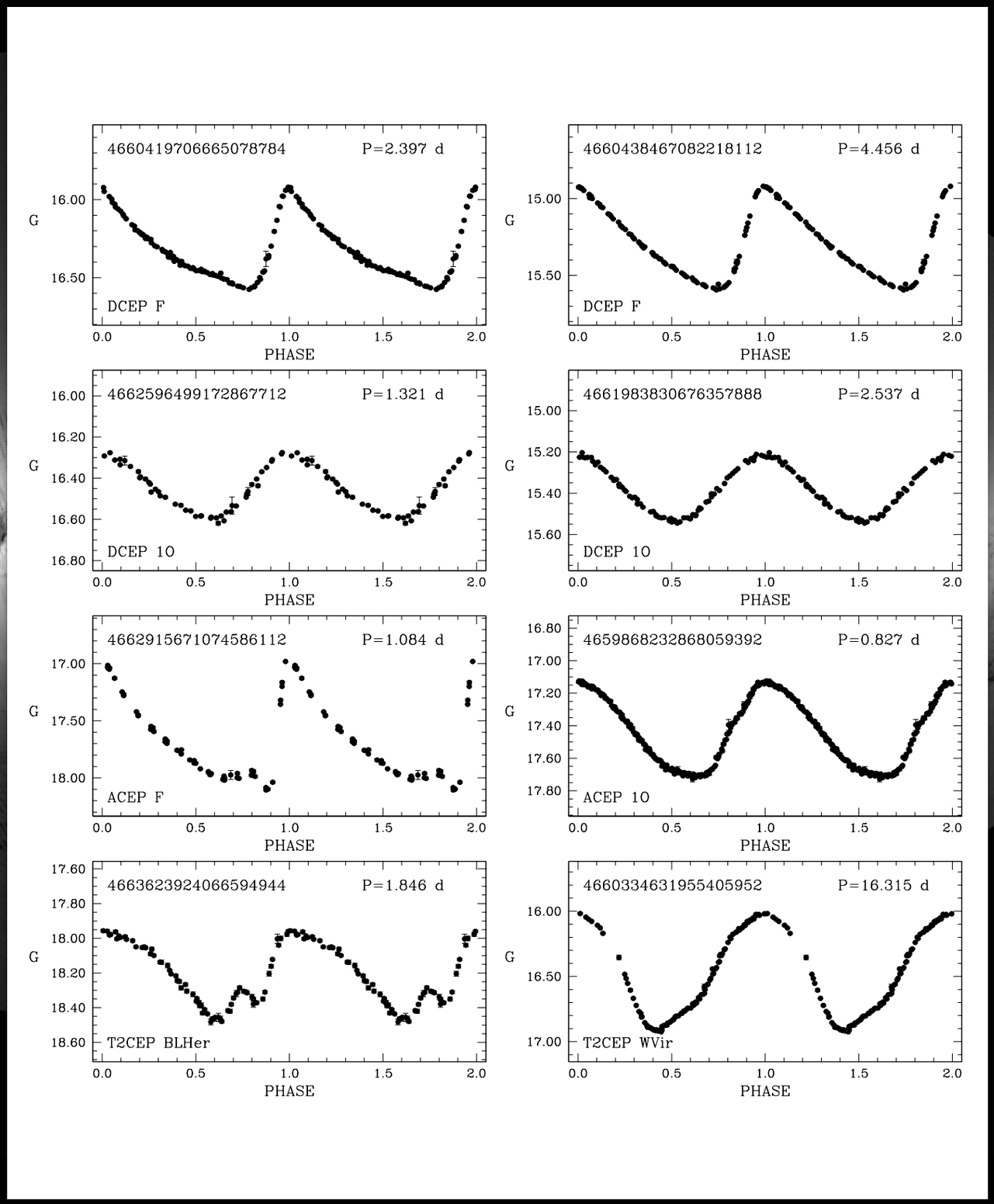


Gaia Collaboration et al. 2016

Variable stars Light Curves

599 Cepheid (43 new)

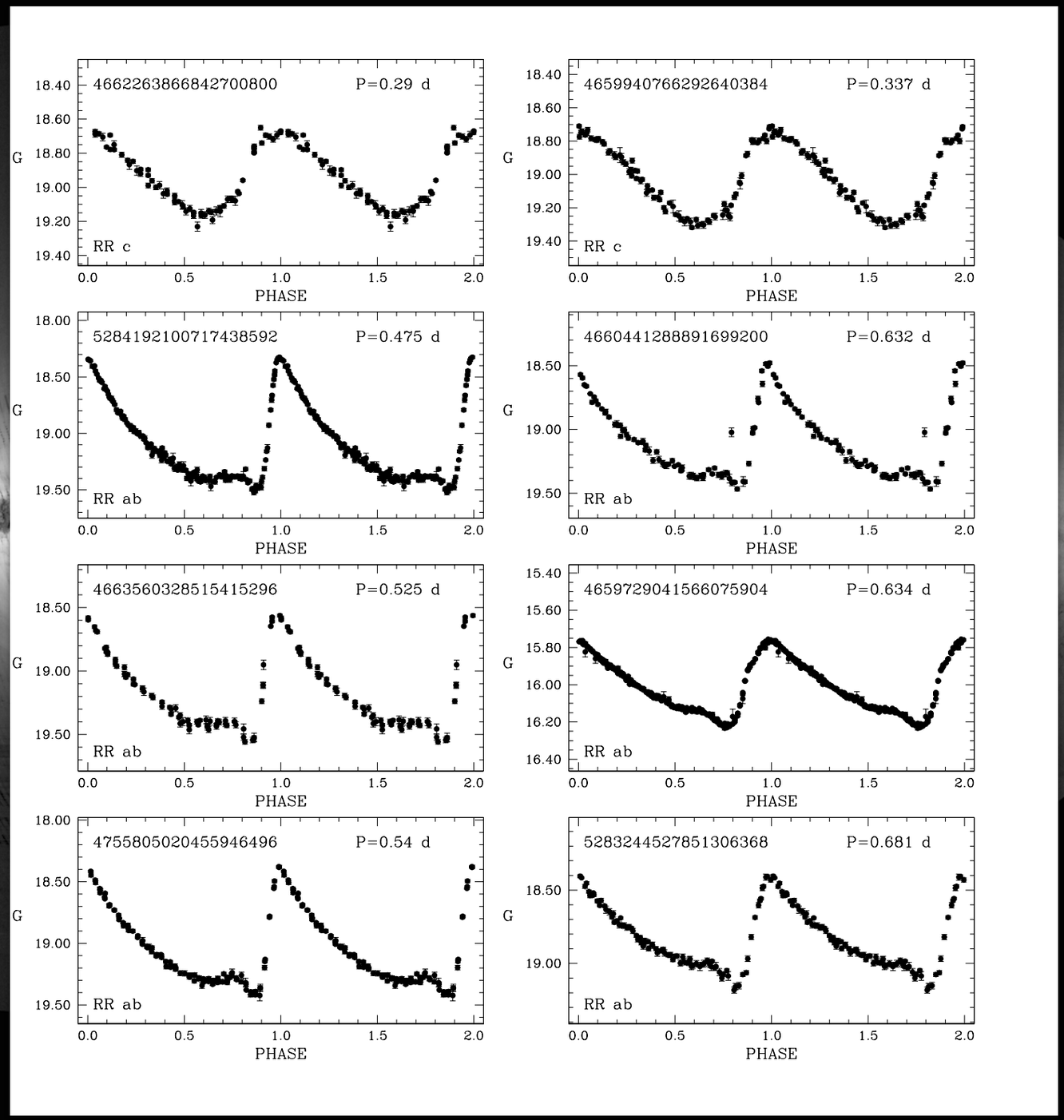




Gaia Mission: looking at the first data release

Variable stars Light Curves

2595 RR-Lyrae (343 new)



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The very first paper after GDR1

ApJ Letters, submitted, September 14, 2016
Preprint typeset using LaTeX style emulateapj v. 5/2/11

FIRST GAIA LOCAL GROUP DYNAMICS: MAGELLANIC CLOUDS PROPER MOTION AND ROTATION

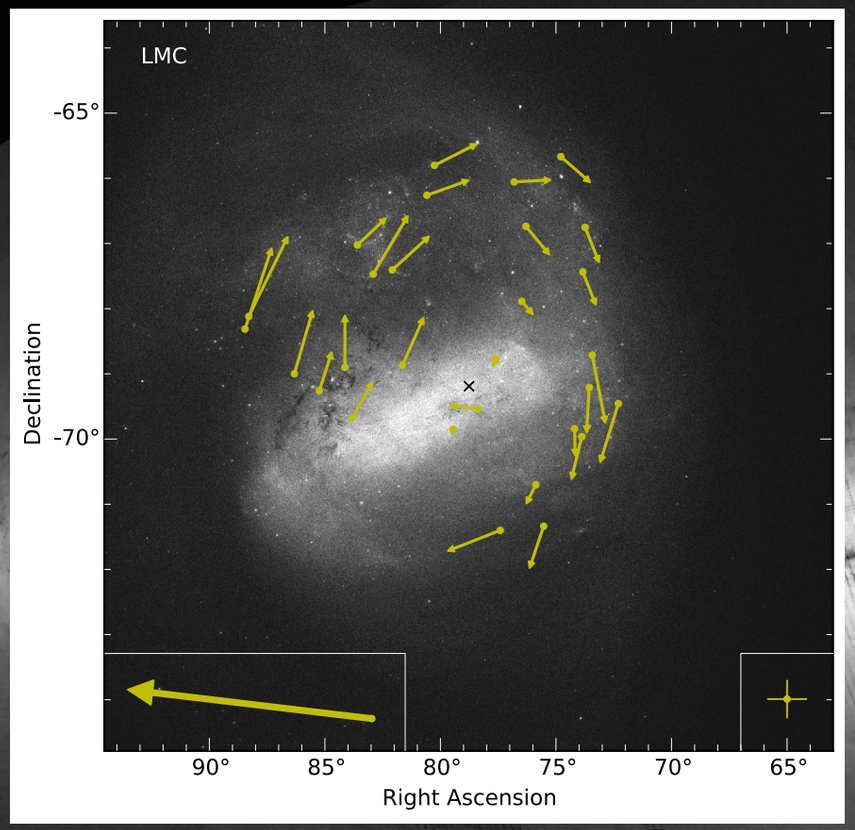
Roeland P. van der Marel
Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218

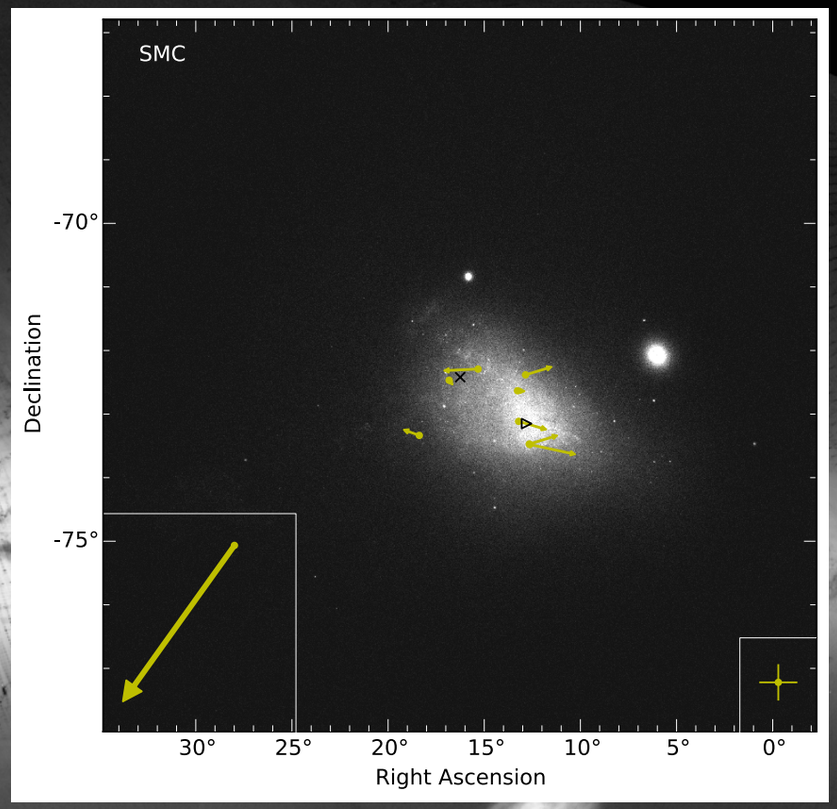
Johannes Sahlmann
European Space Agency, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA
ApJ Letters, submitted, September 14, 2016

ABSTRACT

We use the *Gaia* data release 1 (DR1) to study the proper motion (PM) fields of the Large and Small Magellanic Clouds (LMC, SMC). This uses the *Tycho-Gaia* Astrometric Solution (TGAS) PMs for 29 *Hipparcos* stars in the LMC and 8 in the SMC. The LMC PM in the West and North directions is inferred to be $(\mu_W, \mu_N) = (-1.872 \pm 0.045, 0.224 \pm 0.054)$ mas yr^{-1} , and the SMC PM $(\mu_W, \mu_N) = (-0.874 \pm 0.066, -1.229 \pm 0.047)$ mas yr^{-1} . These results have similar accuracy and agree to within the uncertainties with existing Hubble Space Telescope (*HST*) PM measurements.

The very first paper after GDR1

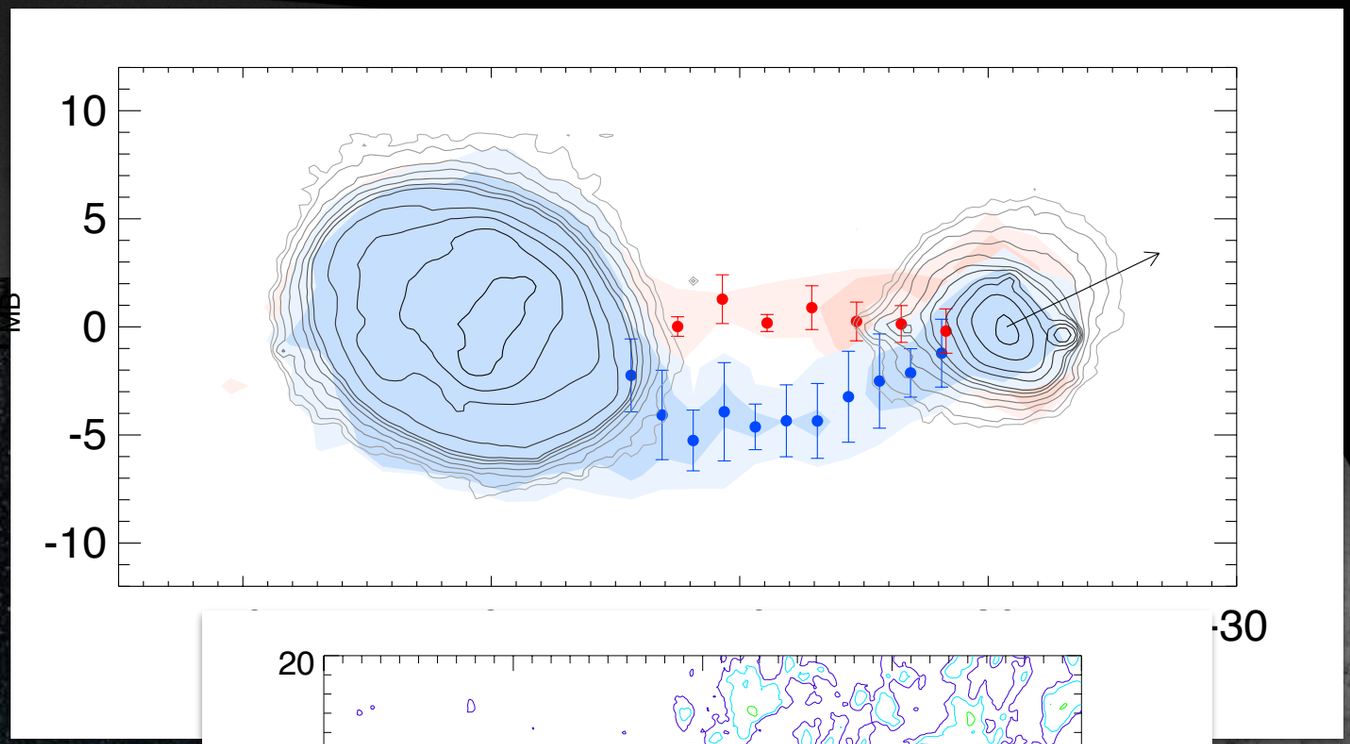




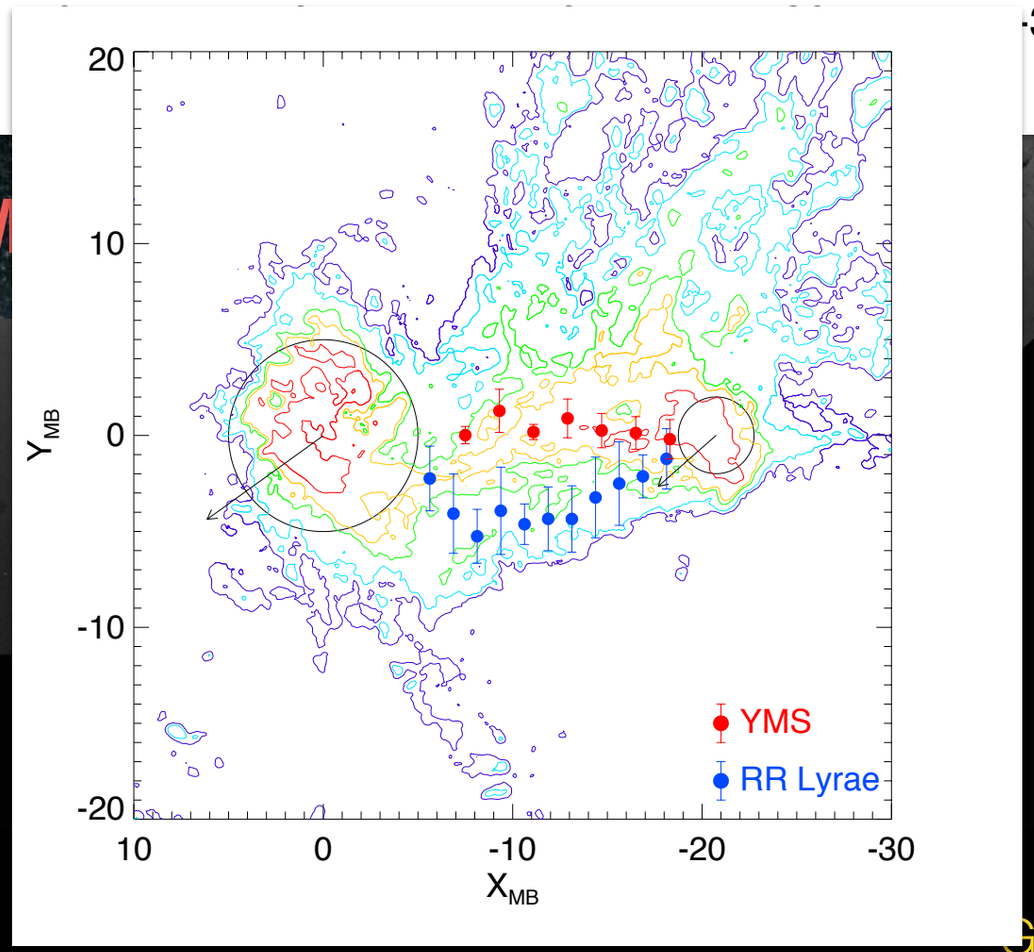
Confirm of rotation of Large and Small Magellanic Clouds

Magellanic Clouds, Streams and Bridges

Known bridge of neutral H



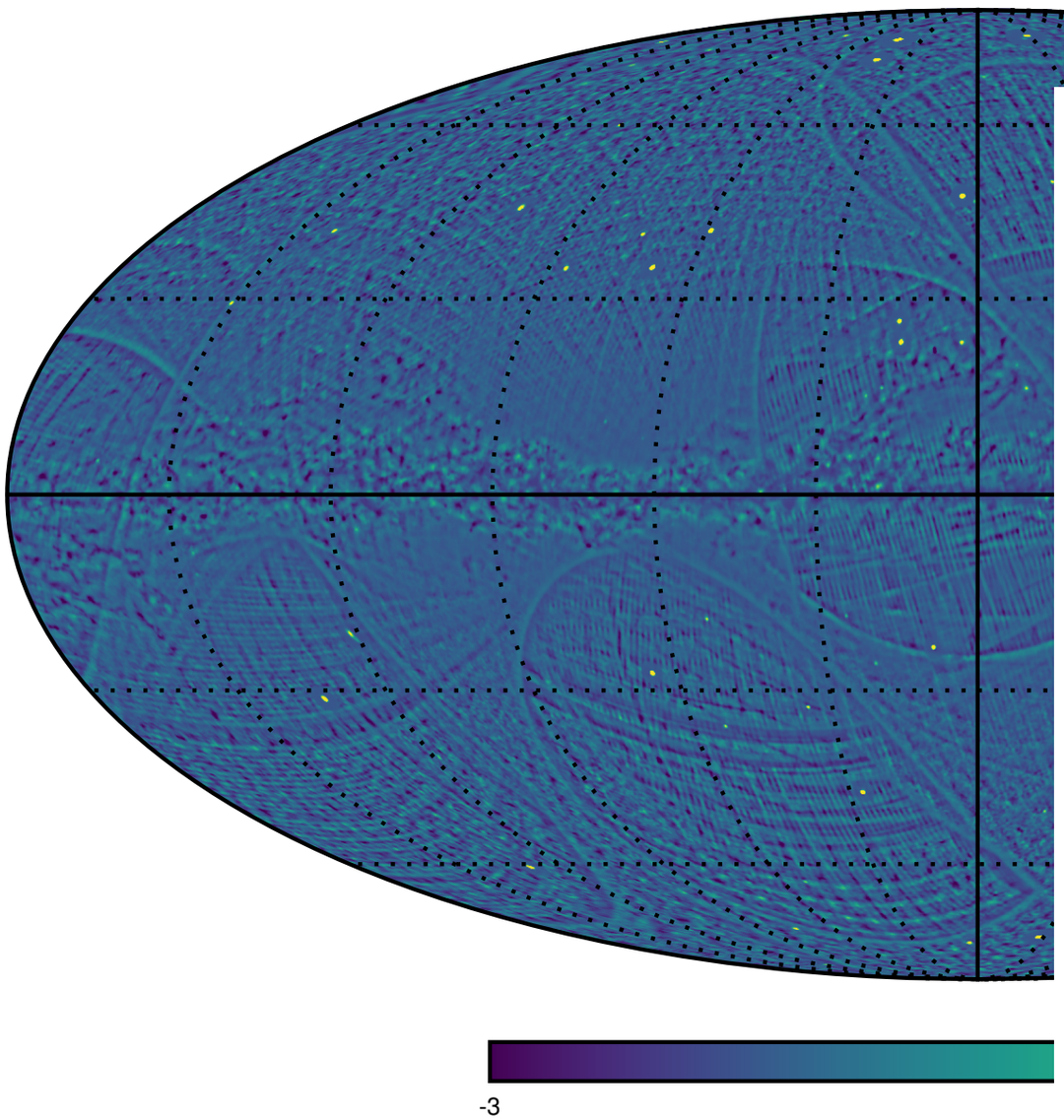
YM

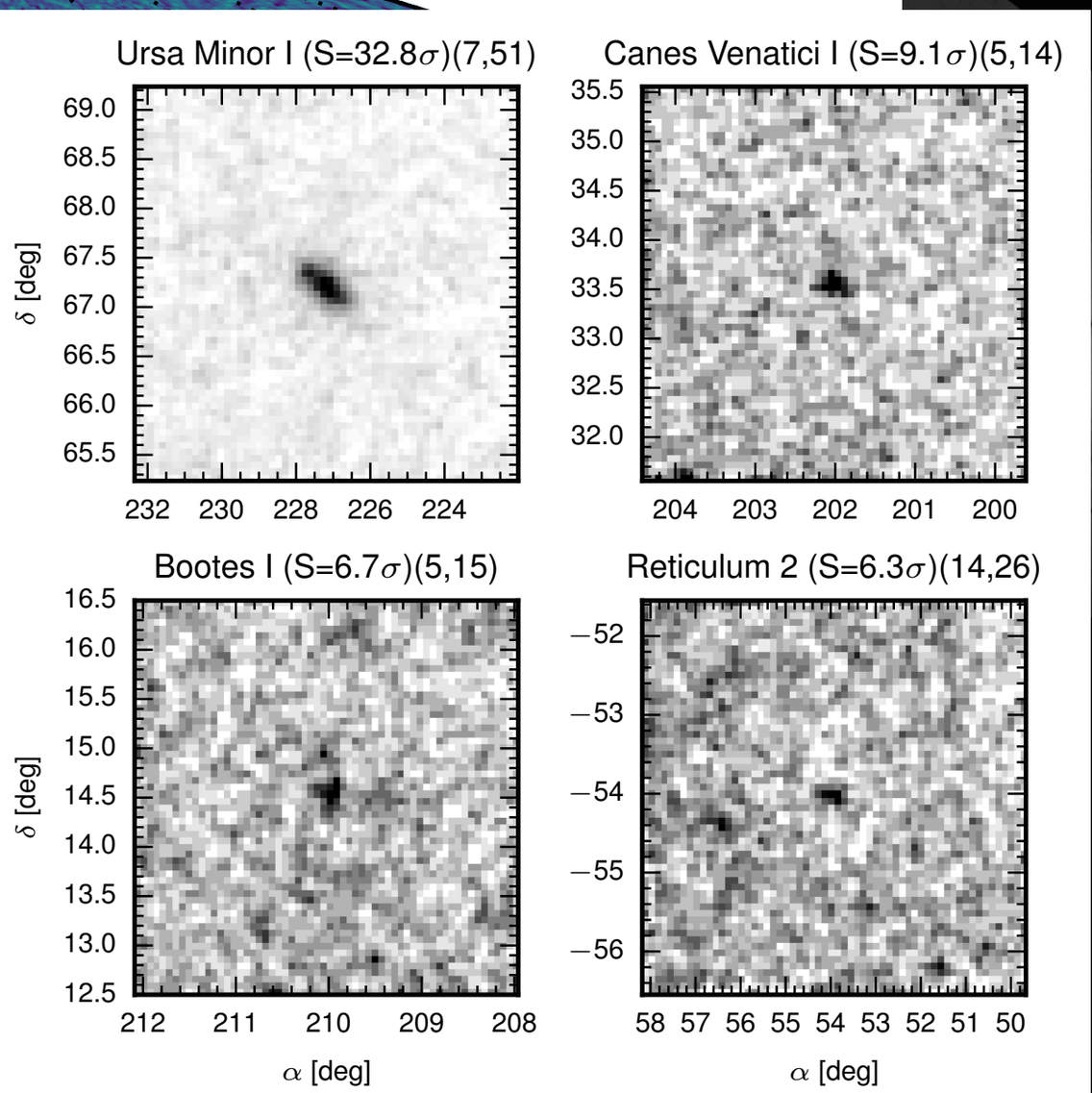


Two new star clusters!

(Koposov, Belokurov and Torrealba, IoA, Cambrigde)

Looking at star overdensities





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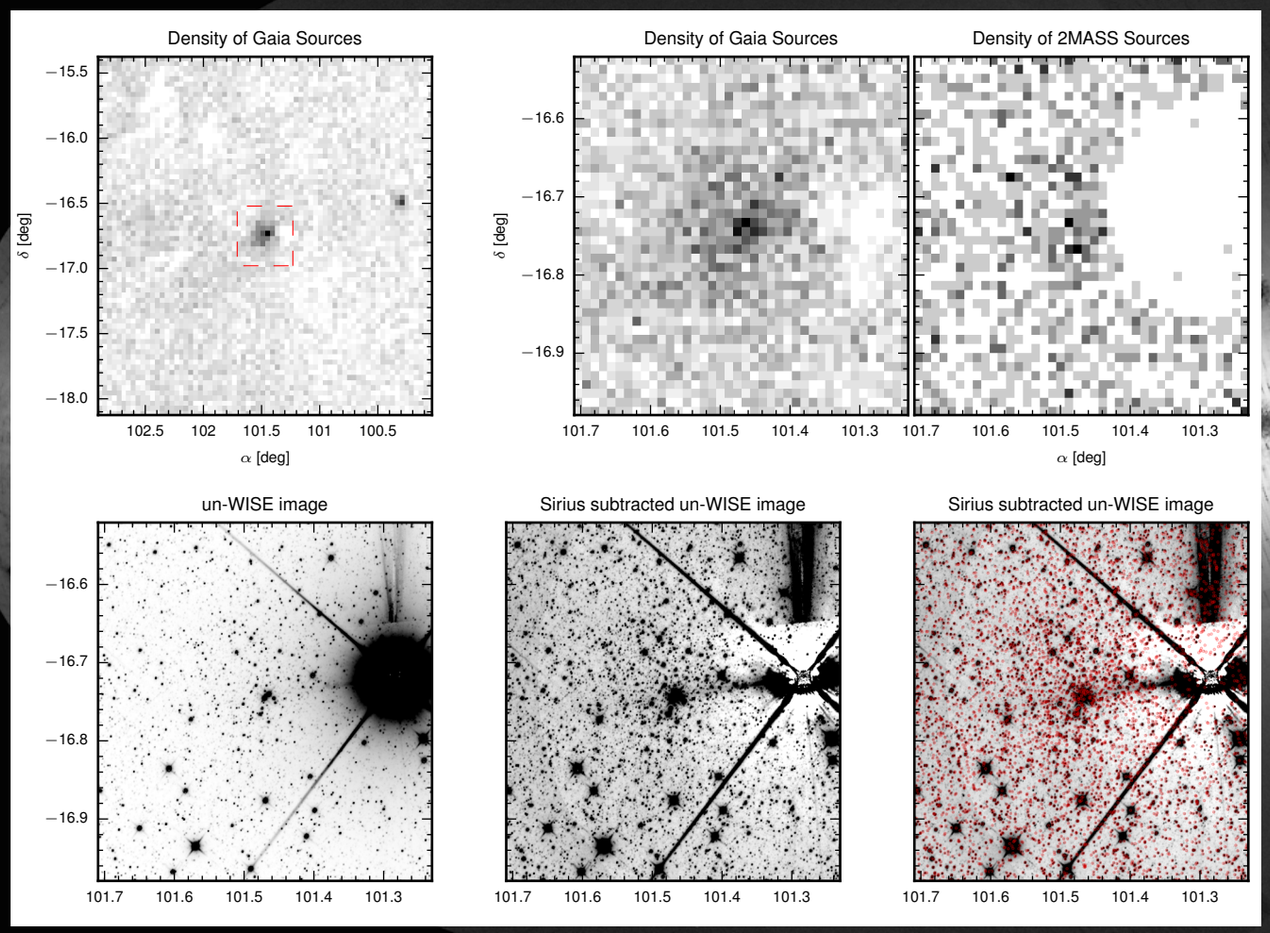
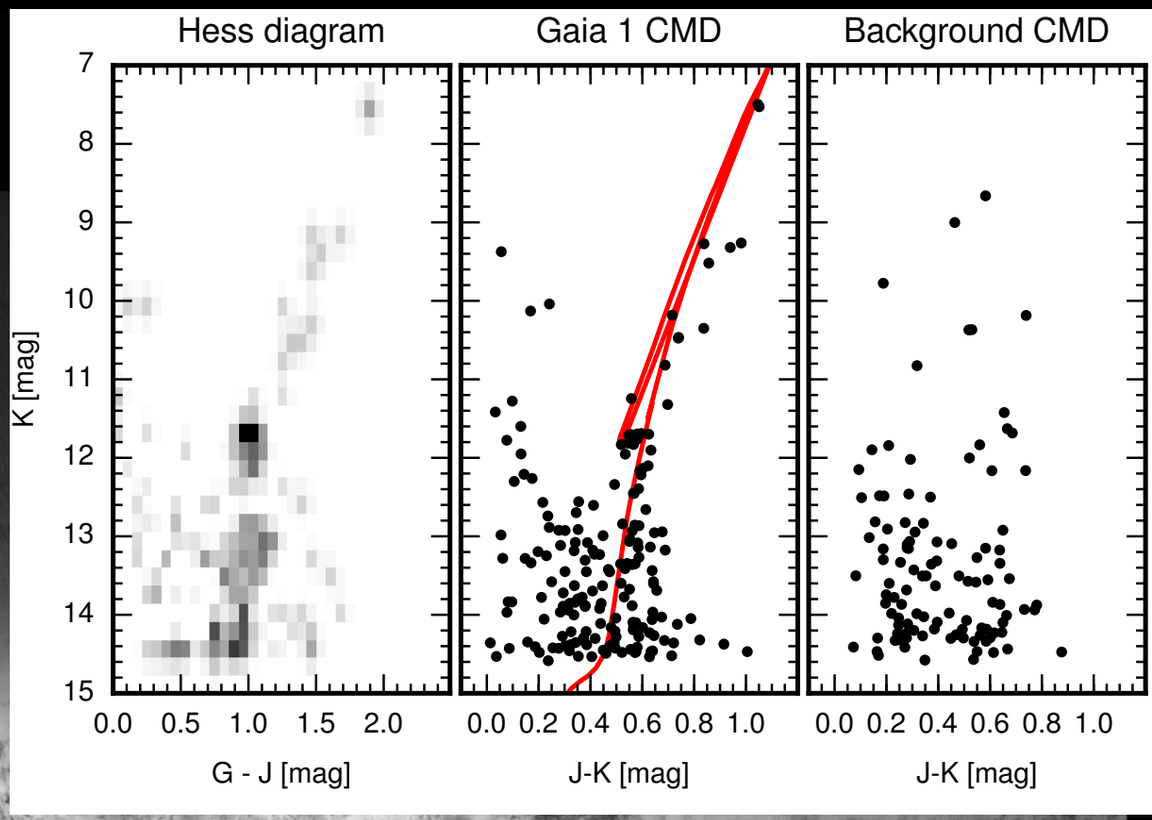
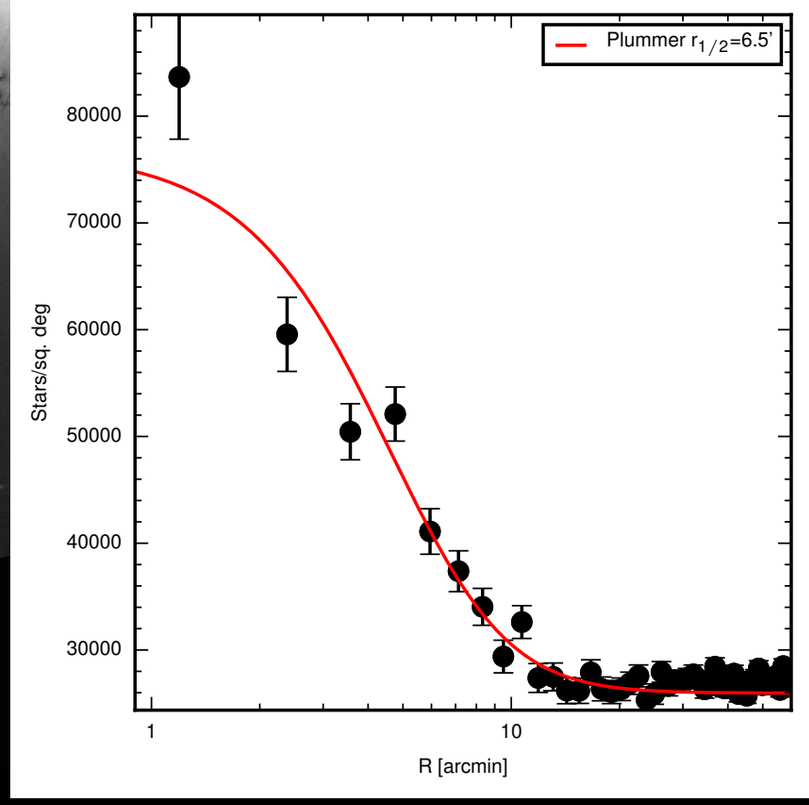
Two new star clusters!

Gaia 1 (10σ) It can't be Sirius..







d = 4.6 kpc +/- 0.2kpc
Age = 6.3 Gyr
[Fe/H] = -0.7

Globular cluster
or
Old Open Cluster

King's Lynn, April 3 2017

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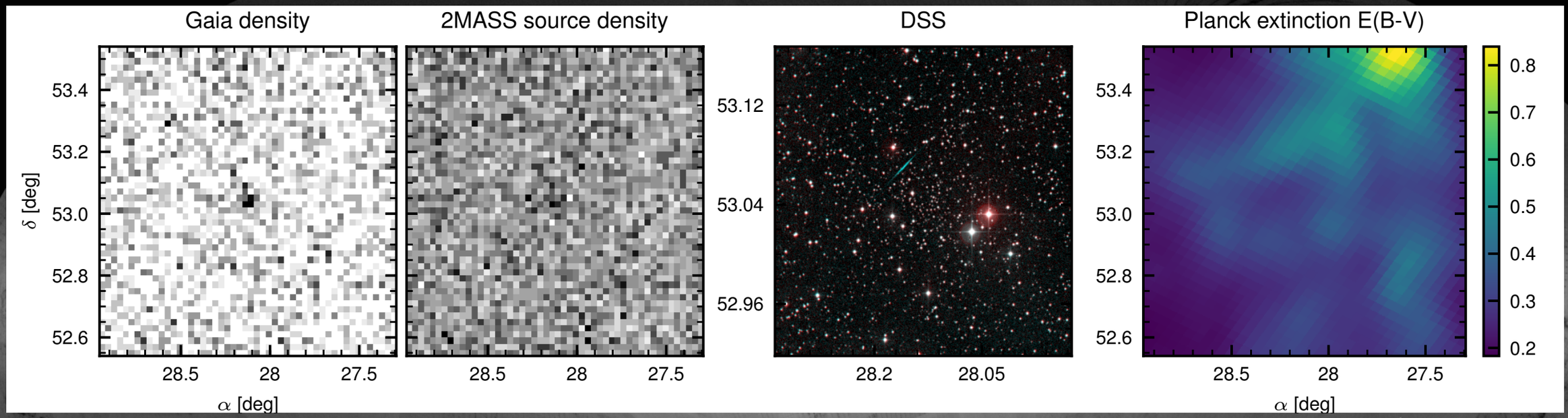
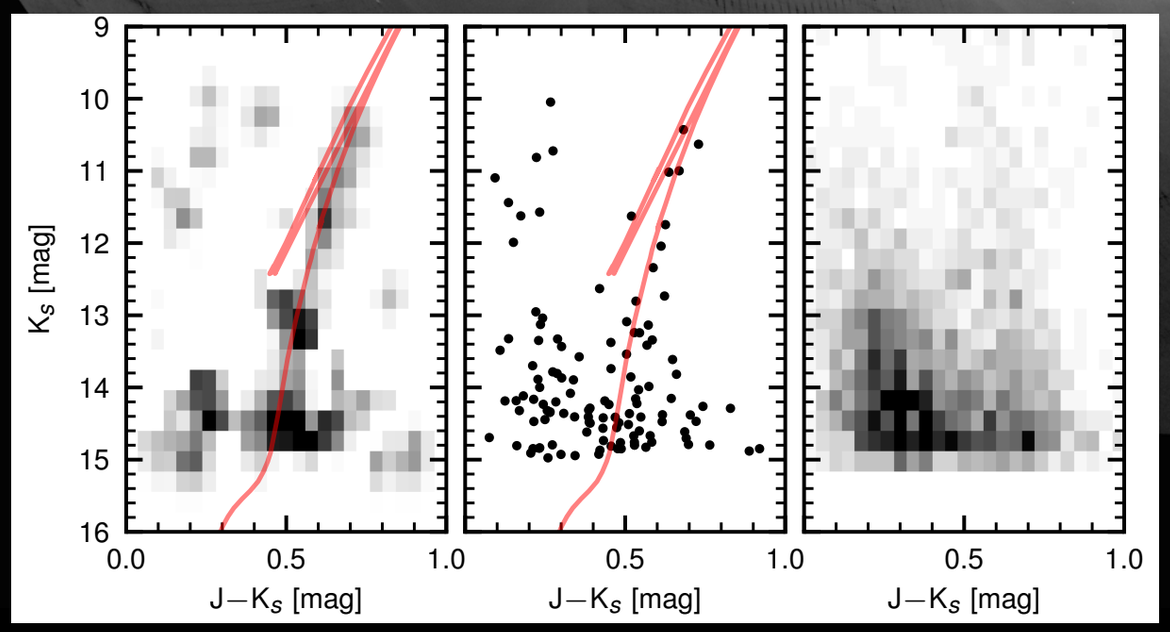
Gaia Mission: looking at the first data release

Two new star clusters!

Gaia 2 (9σ)





d = 5.5 kpc +/- 0.2kpc
Age = 10 Gyr
[Fe/H] = -1

Globular cluster
or
Old Open Cluster

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Science Alerts

Promptness of publication

- Upstream processing delivers data **~24+ hours after observation**, roughly one run per day
- Alerts processing (light-curve assembly, calibration, transient detection and classification) takes up to **6 hours per run**
- Publication latency after alerts processing:
  - If classification & selection is automatic: ~ **minutes**
  - If classification & selection is manual: ~ **hours** to ~ **days**

Science Alerts

http://gsaweb.ast.cam.ac.uk/alerts/home

ioa

Gaia Photometric Science Alerts

To browse the alerts published so far, please see the Alert Index tab. The table provides links to the per-source alert pages, including lightcurves and BP/RP spectra.

STATUS: Operational. Now you can receive al

Index to Gaia Photometric Alerts

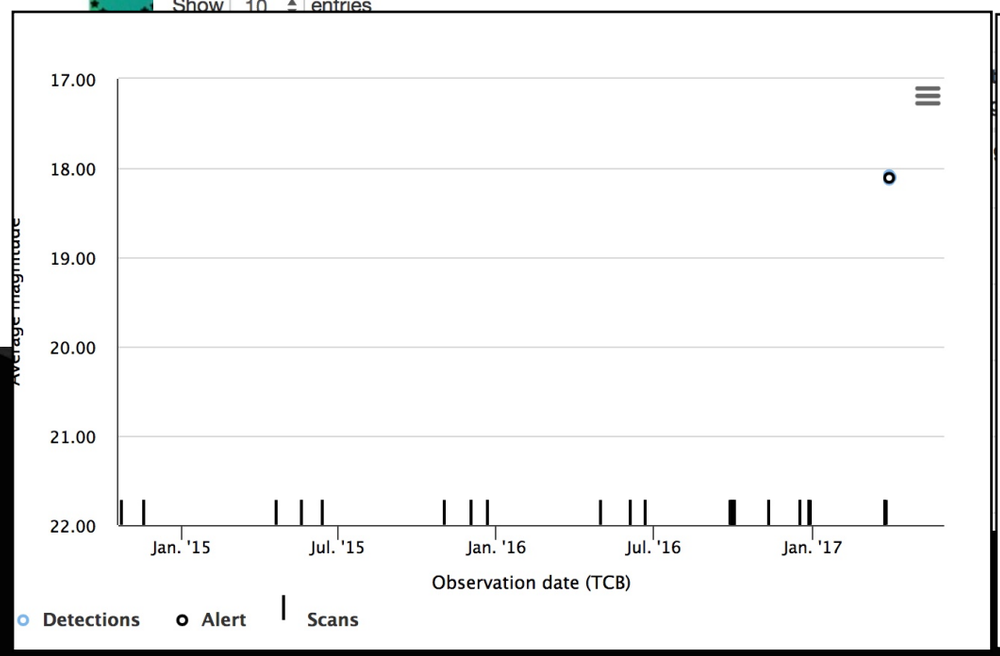
If you publish any results based on these Gaia discoveries, we would appreciate an acknowledgement along the lines of: *We acknowledge ESA Gaia, DPAC and the Photometric Science Alerts Team (http://gsaweb.ast.cam.ac.uk/alerts).*

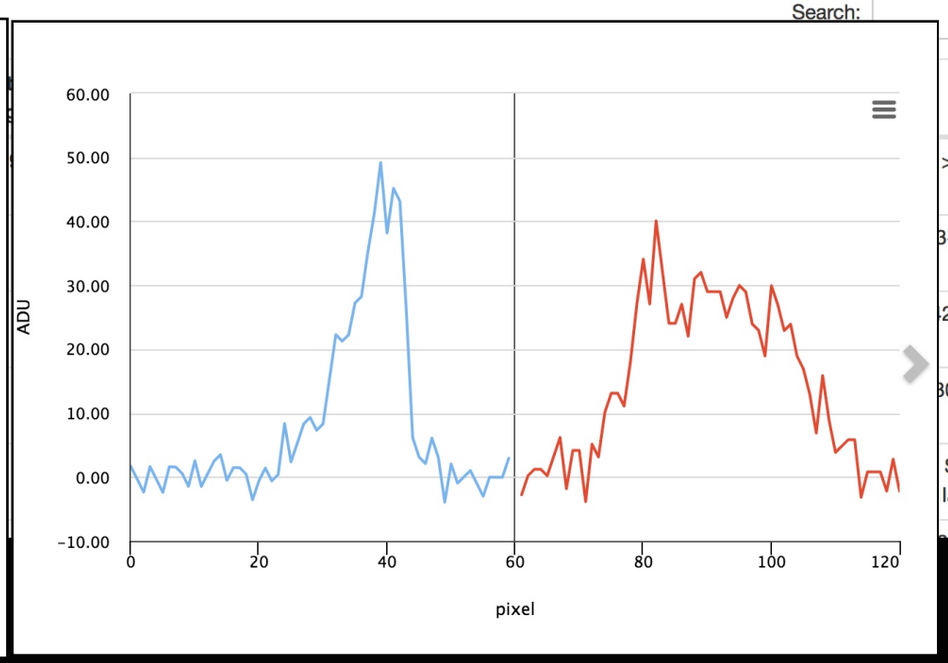
These are all the alerts raised to date. You might wish to view or download these as a table in CSV format or using any of the tools described in Tools page.

See here for an explanation of the columns.

Show 10 entries

Search:





> 0.5 mag fainter

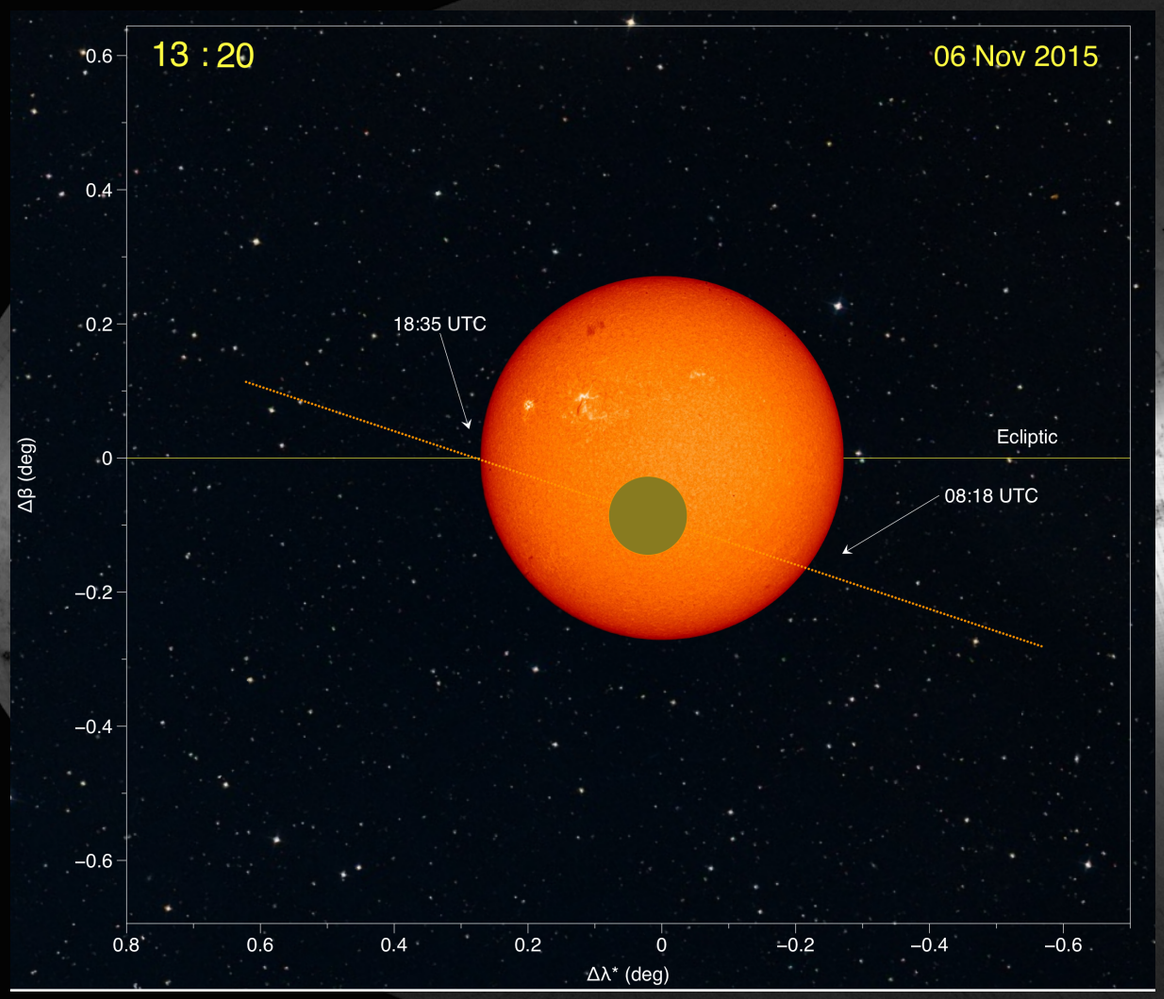
3+7059453

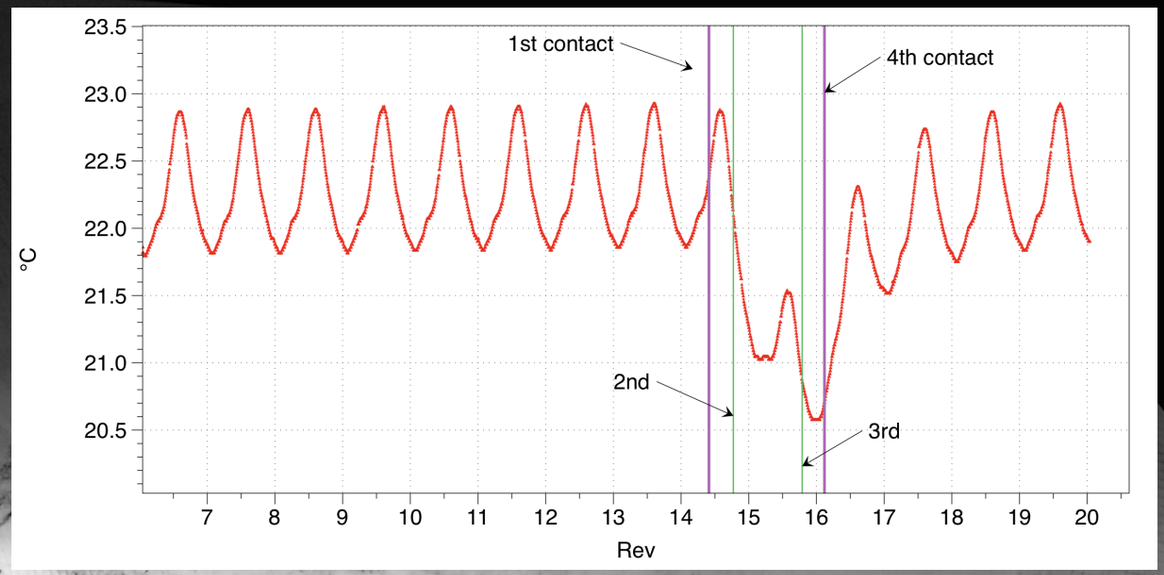
-254514, GS-TEC

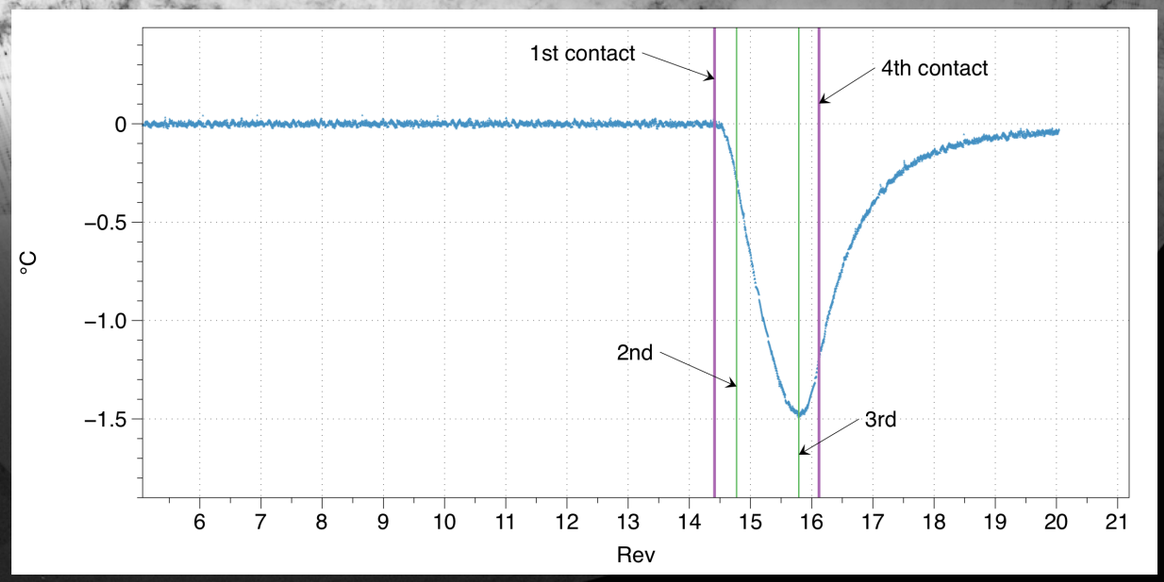
30018.4, GS-TEC

SDSS
Ia at t=2

Another way of looking at Moon Transits



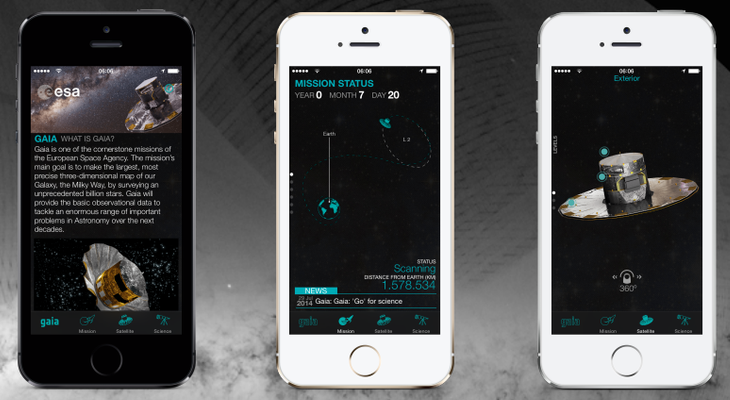


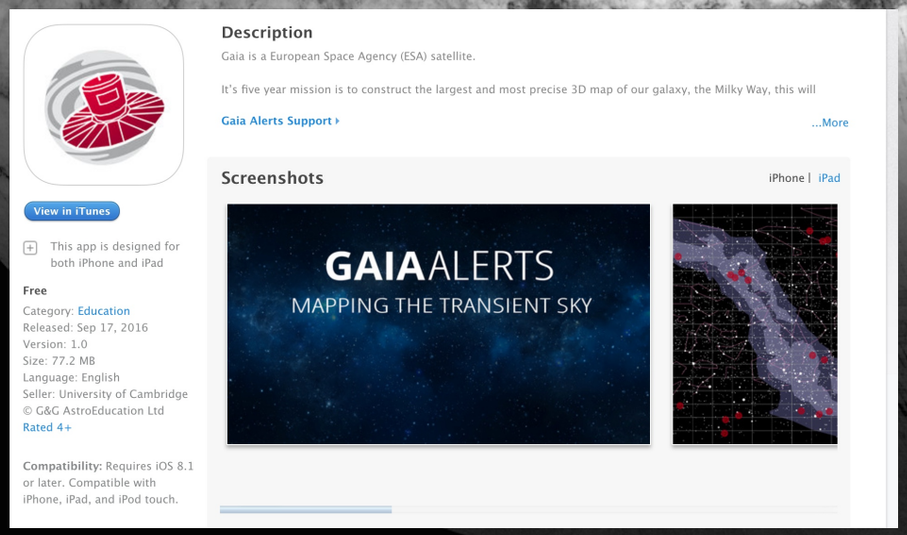


Gaia Mission: looking at the first data release

If you want to follow Gaia on your phone:

https://www.cosmos.esa.int/web/gaia/gaia-app





https://itunes.apple.com/us/app/gaia-alerts/id1144470584?mt=8

Android soon on GooglePlay

King's Lynn, April 3 2017

G. Busso

GDR2

- 5-parameter astrometric solutions for all sources (positions, parallax, proper motions);
- G and integrated GBP and GRP photometric fluxes and magnitudes for all sources. -> colors!
- Median radial velocities for sources brighter than GRVS=12 mag.
- For stars G<17 mag T_eff and line-of-sight extinction
- Photometric data for a sample of variable stars.
- Epoch astrometry for a pre-selected list of >10,000 asteroids

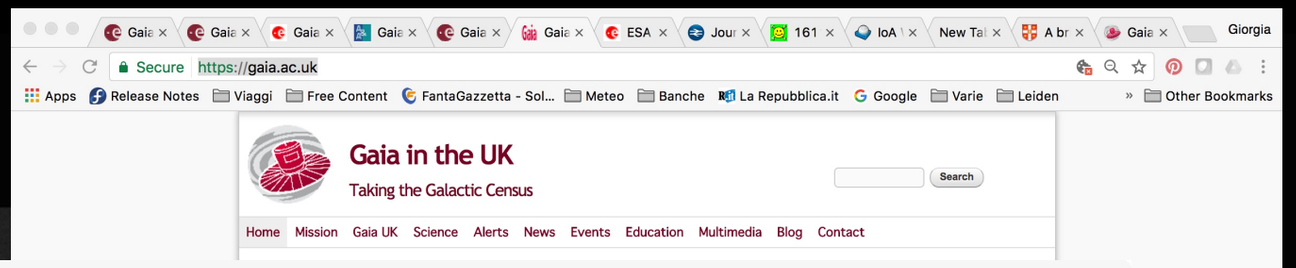
!!April 2018!!

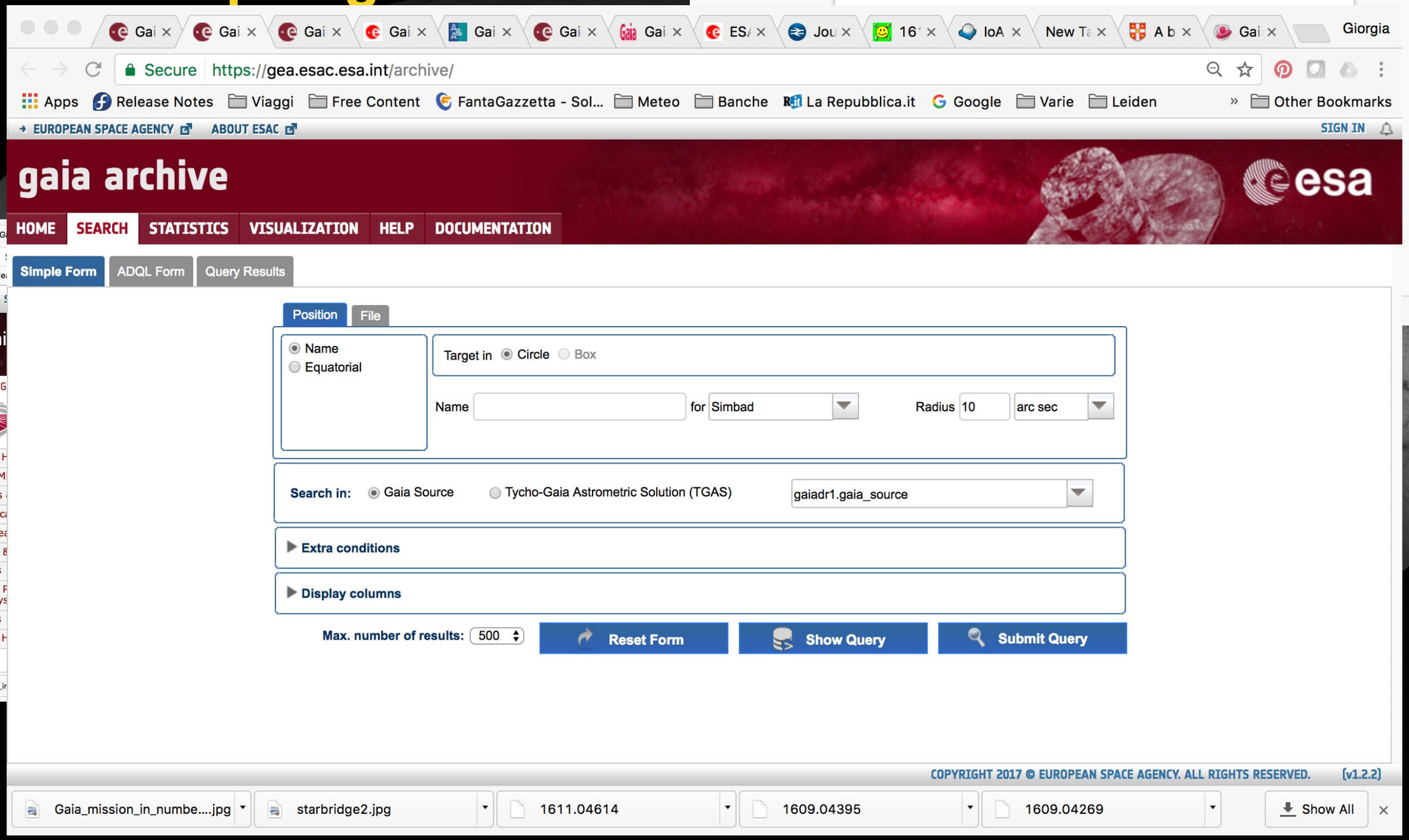
stay tuned..

Gaia Mission: looking at the first data release

Links

https://gaia.ac.uk/





https://gea.esac.esa.int/archive/

GaiaSky

https://zah.uni-heidelberg.de/gaia/outreach/gaiasky/