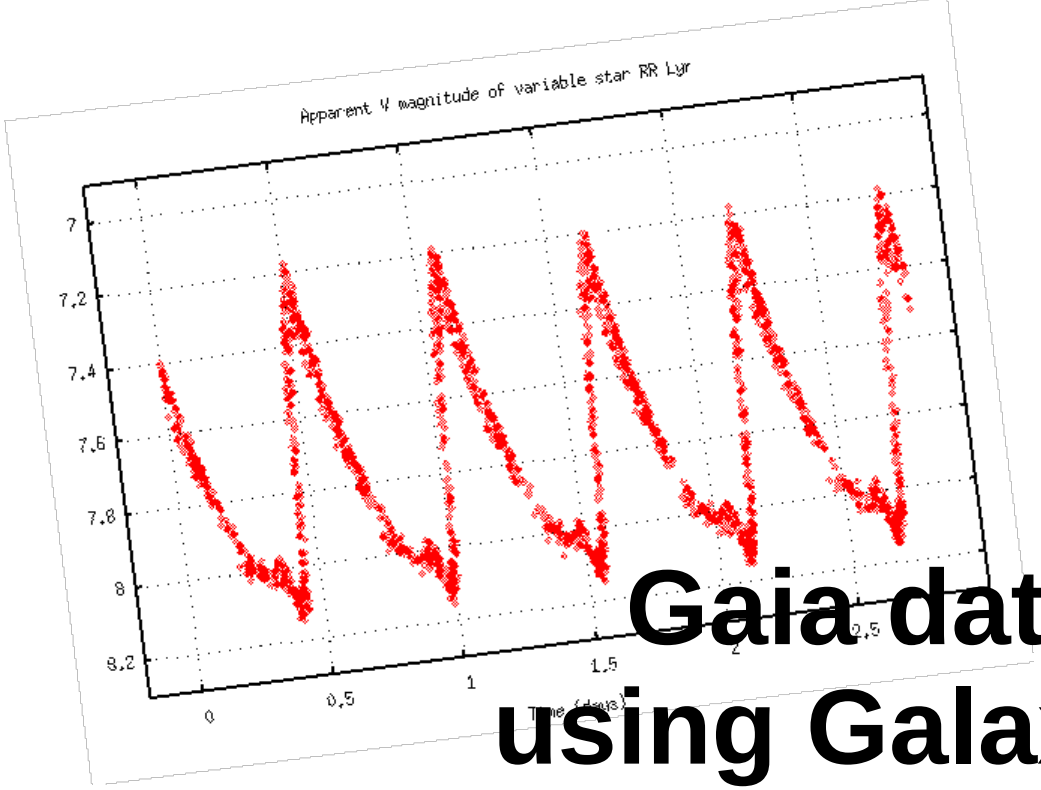
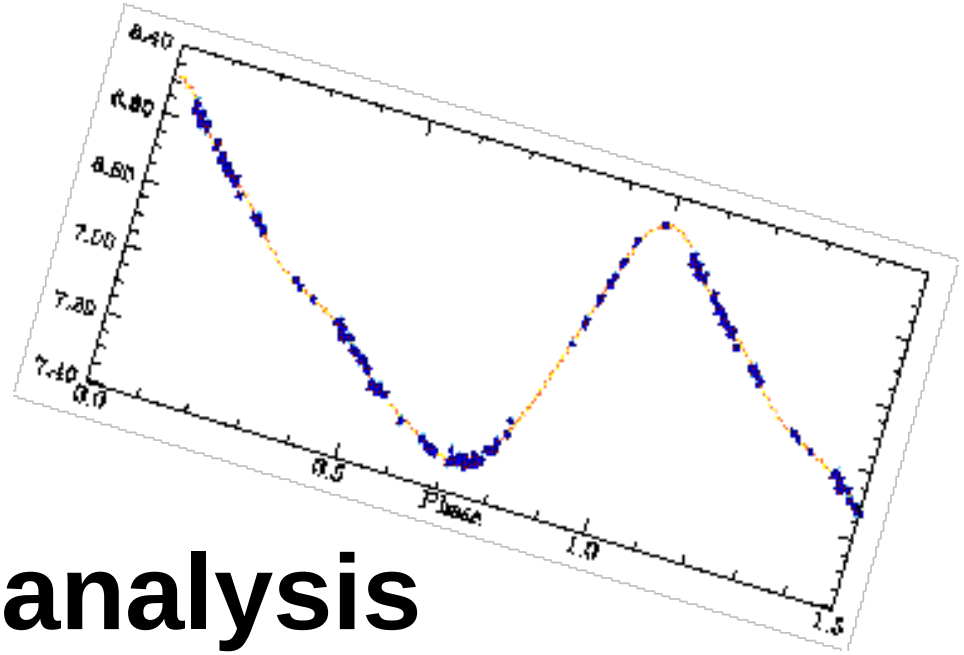




Gaia data analysis using Galaxy modelling

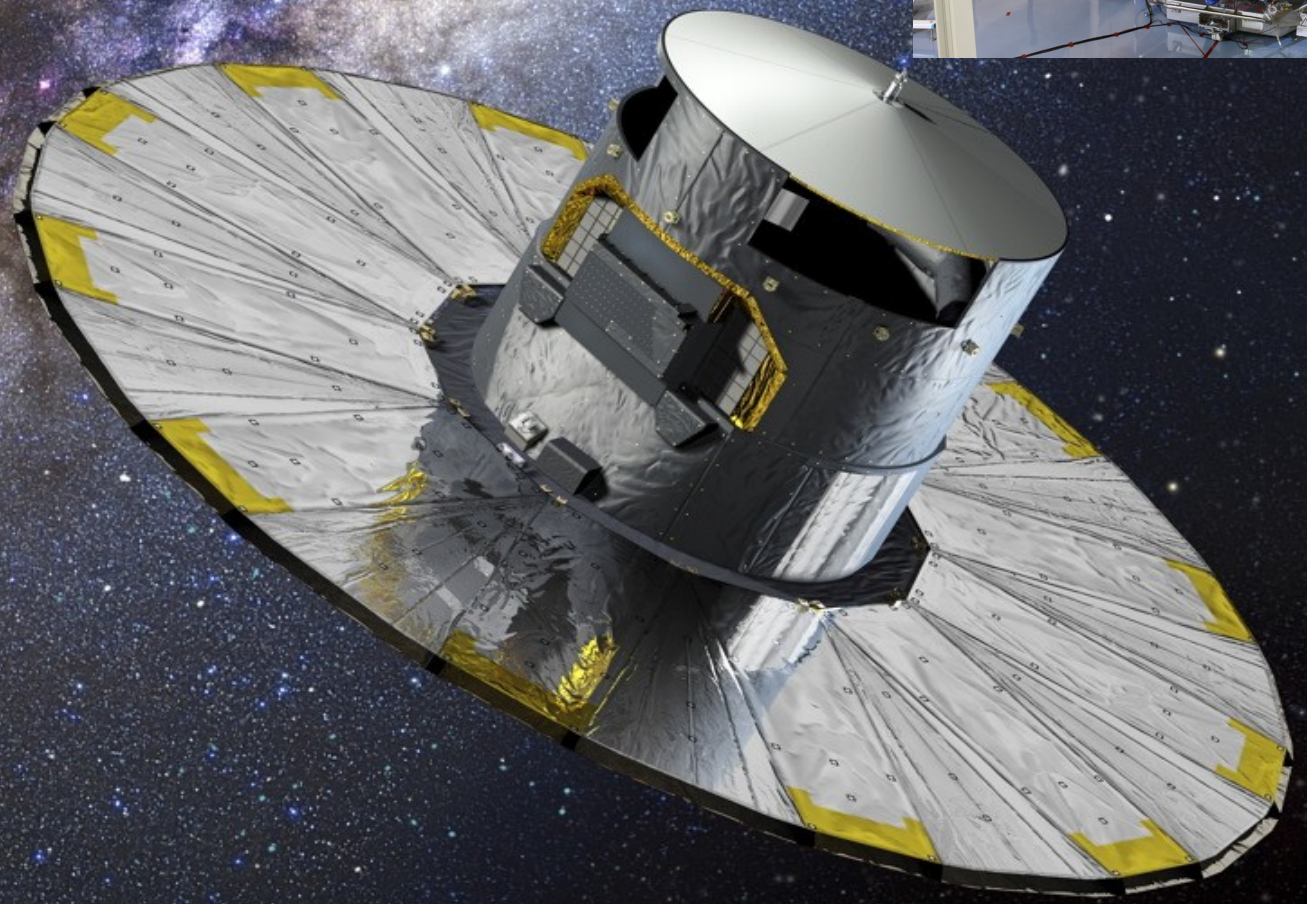
J. G. Fernández-Trincado

Bogota, March 2014

¿What is GAIA?

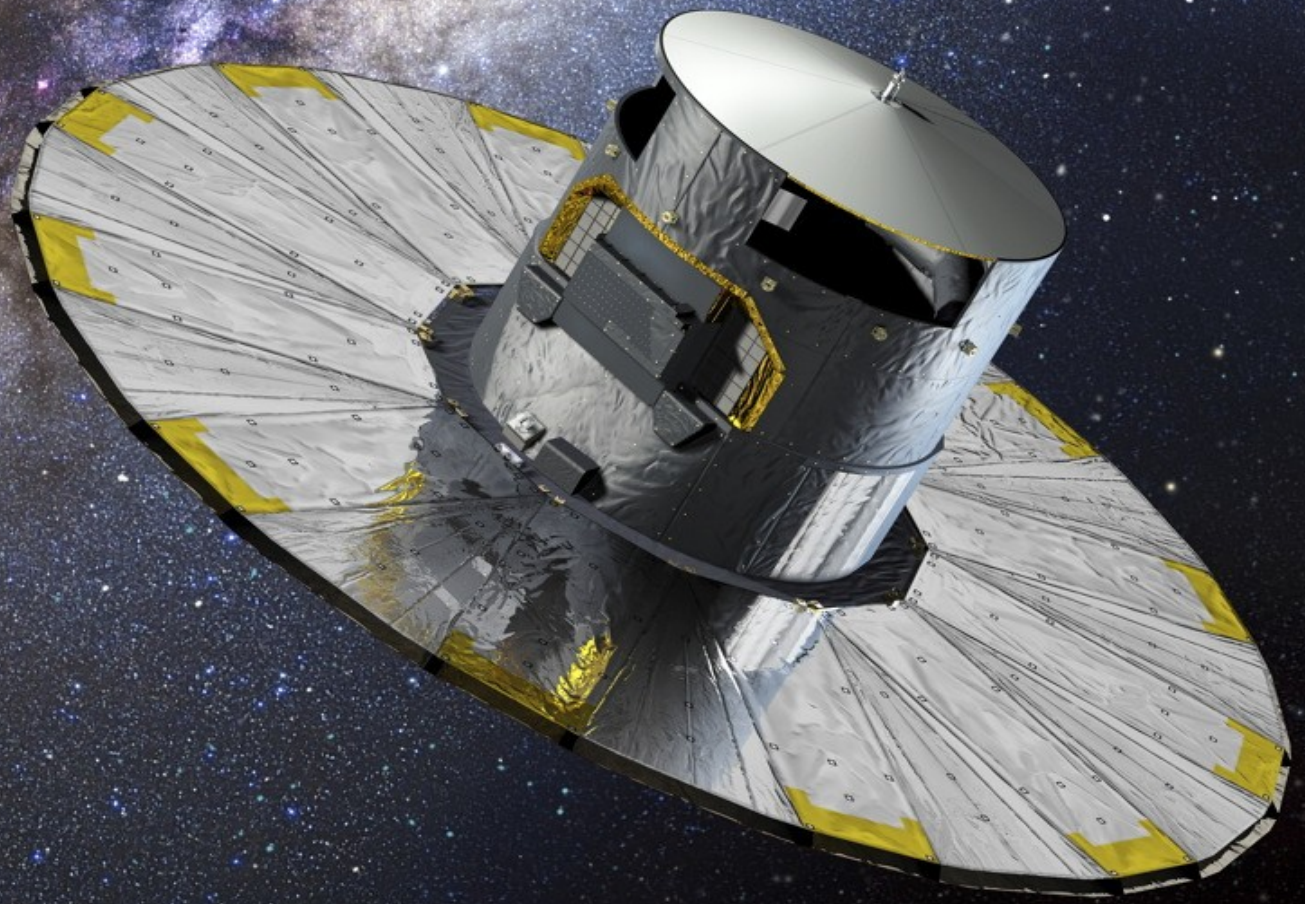
€740 million

¿What is GAIA?



Gaia is a satellite by the European Space Agency (ESA),which main goal is to make the largest, most precise three-dimensional map of our Galaxy by surveying a billion stars (about one per cent of its population) with an unprecedented precision in position

$10^{12} = 1.000.000.000.000$



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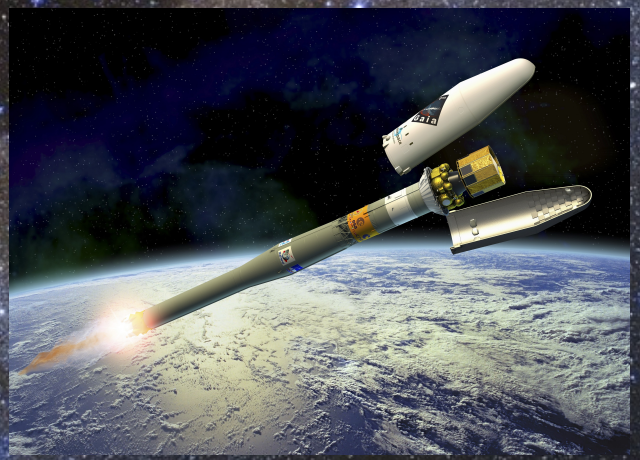
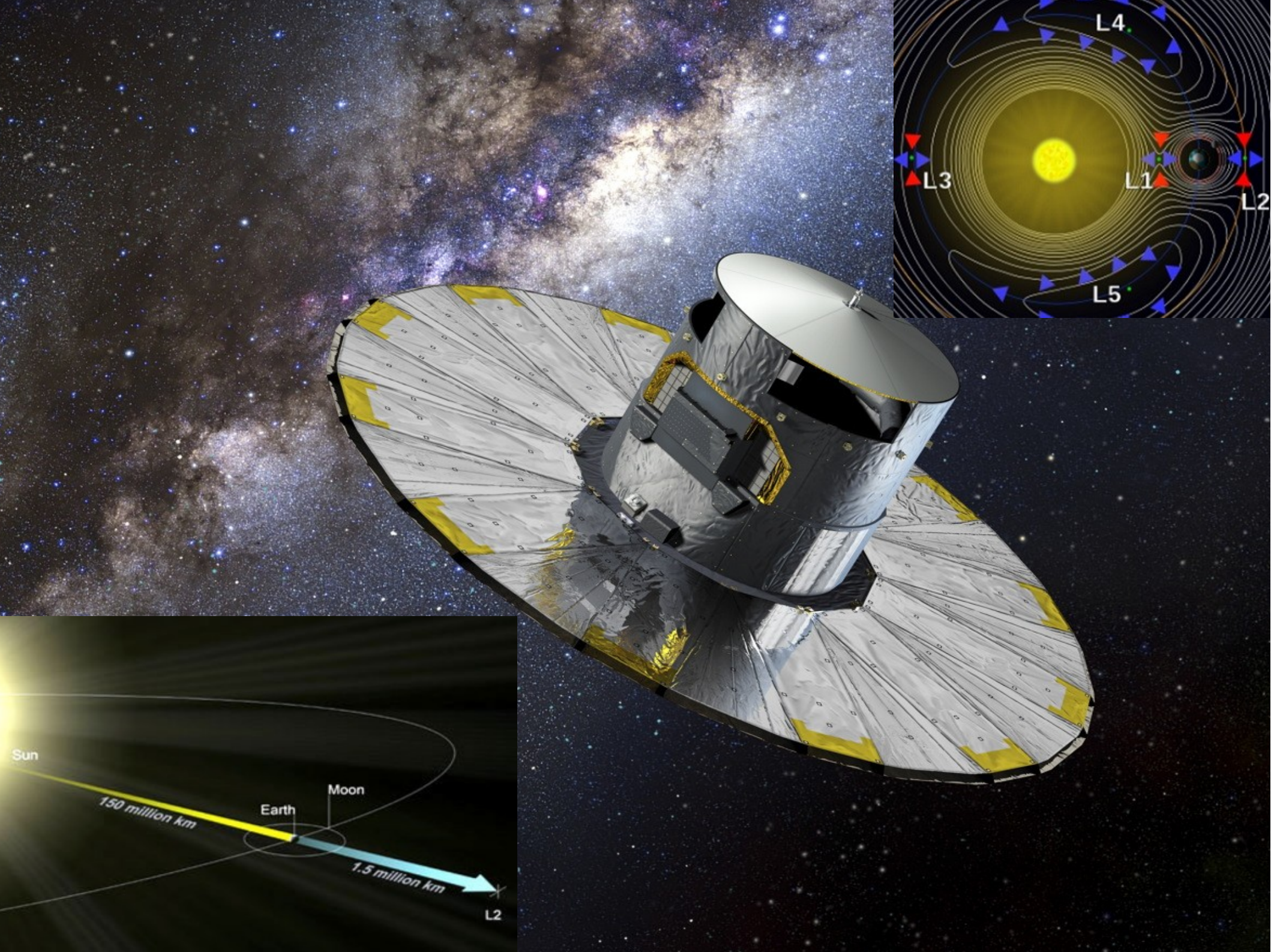
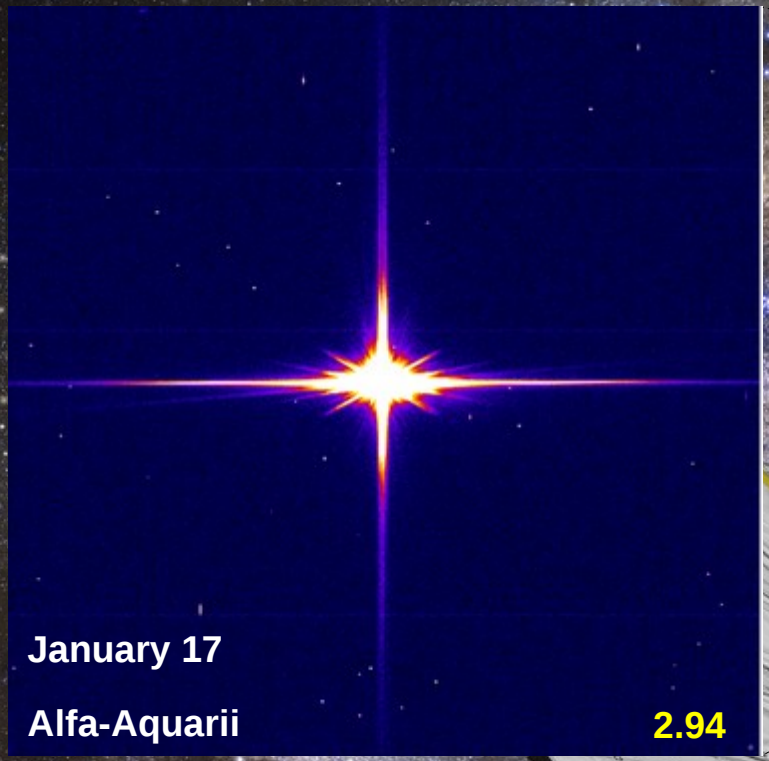


GAIA Launch, 19 December 2013

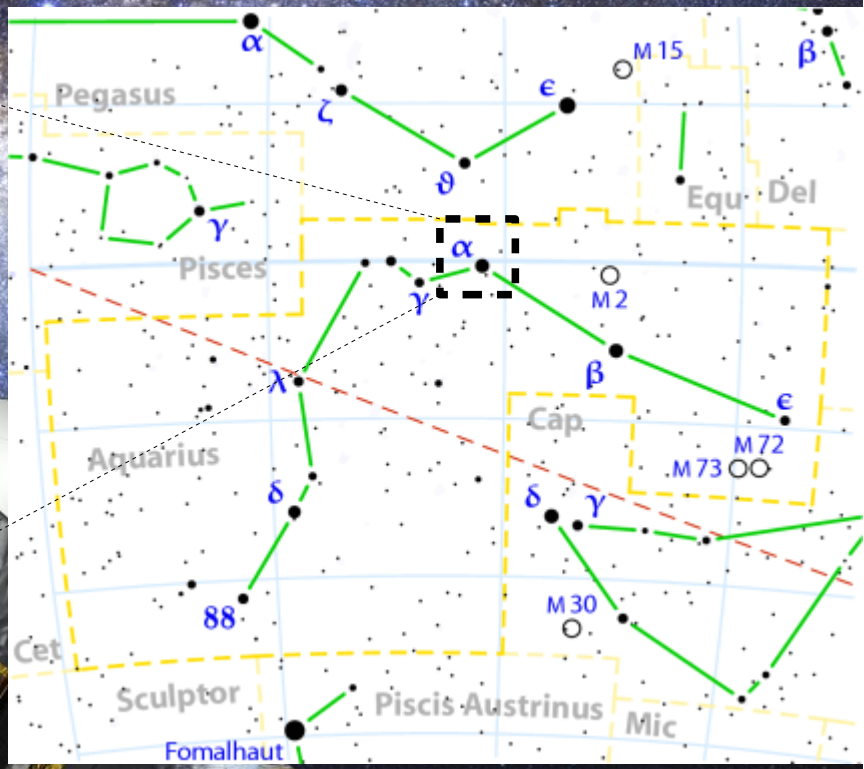
Gaia arrived to Kourou (French Guiana) for finally be launched.


L4
L3
L1
L2
L5
Sun
Moon
Earth
150 million km
1.5 million km
L2



January 17

Alfa-Aquarii 2.94

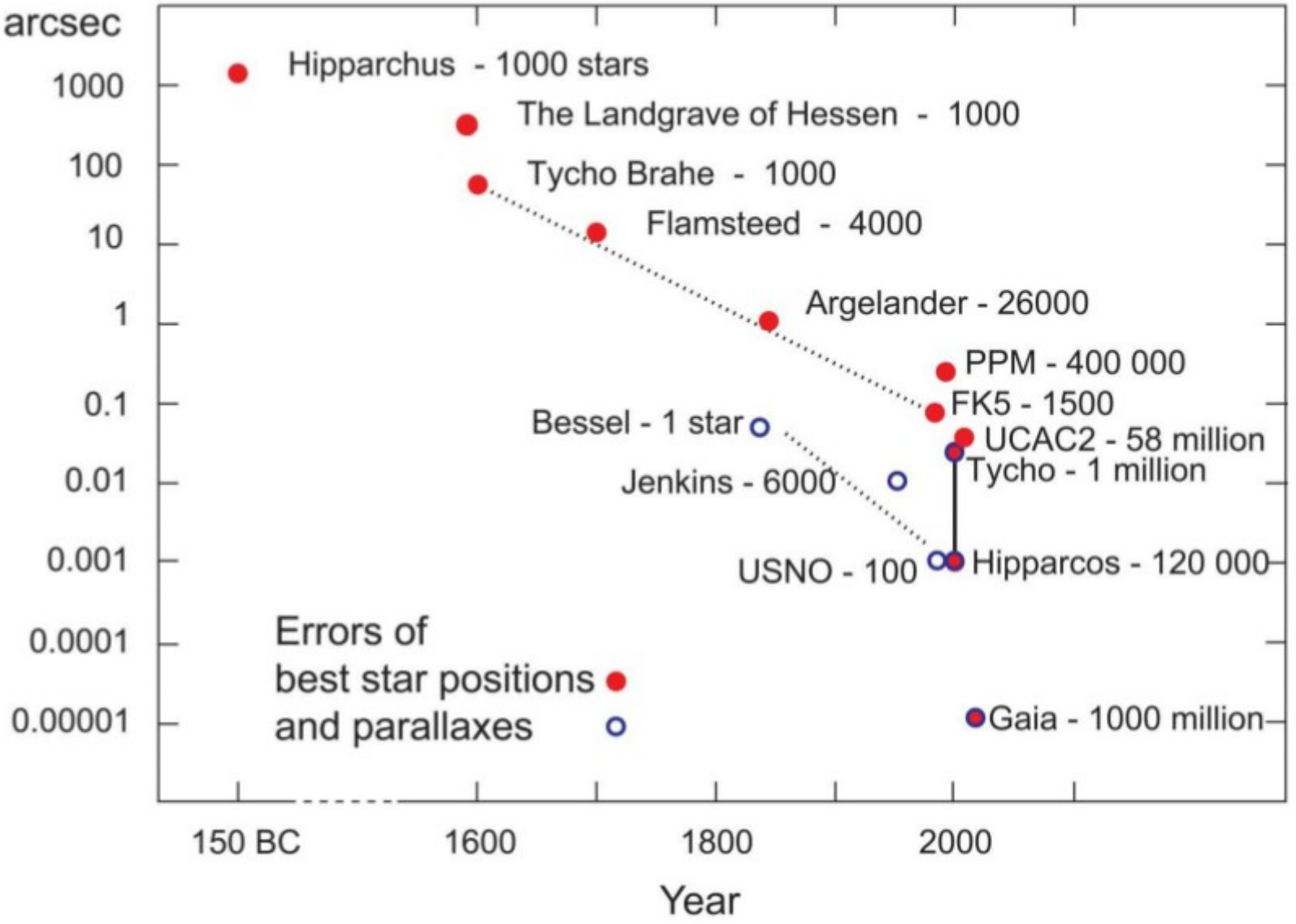


February 06

Cluster of stars in the Large Magellanic Cloud

Goal:

To create a large and **highly accurate stereoscopic map of the Galaxy**
Astrometric mission



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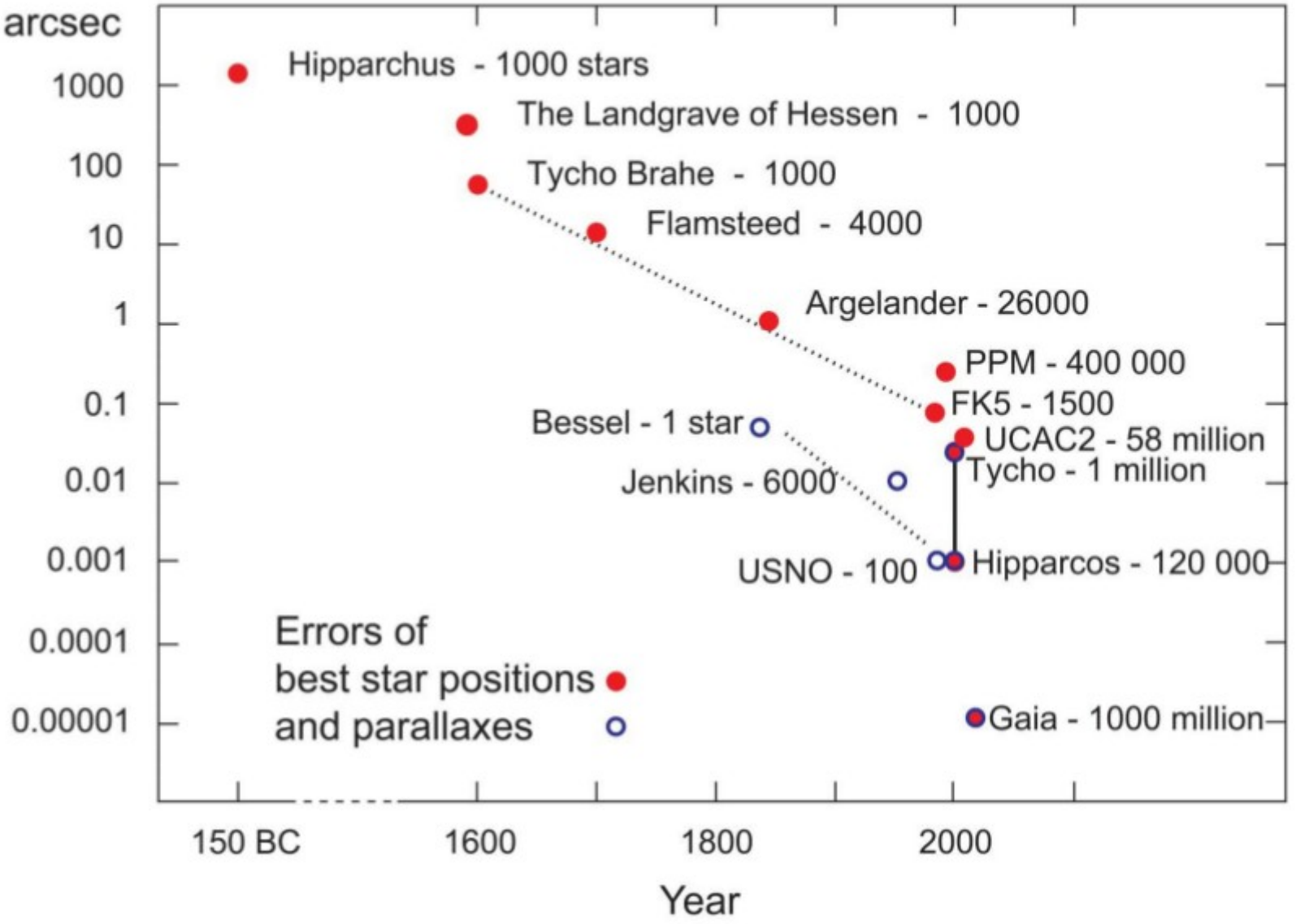

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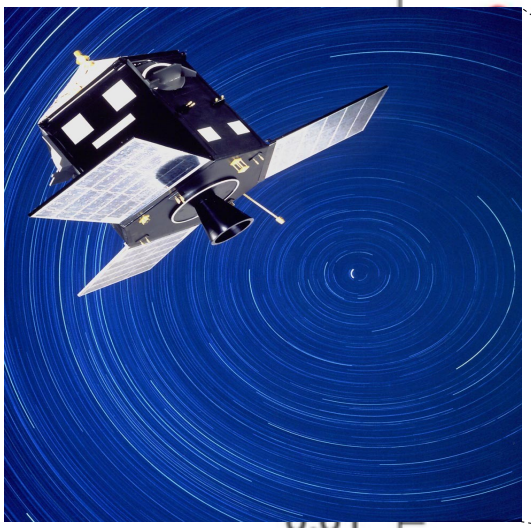

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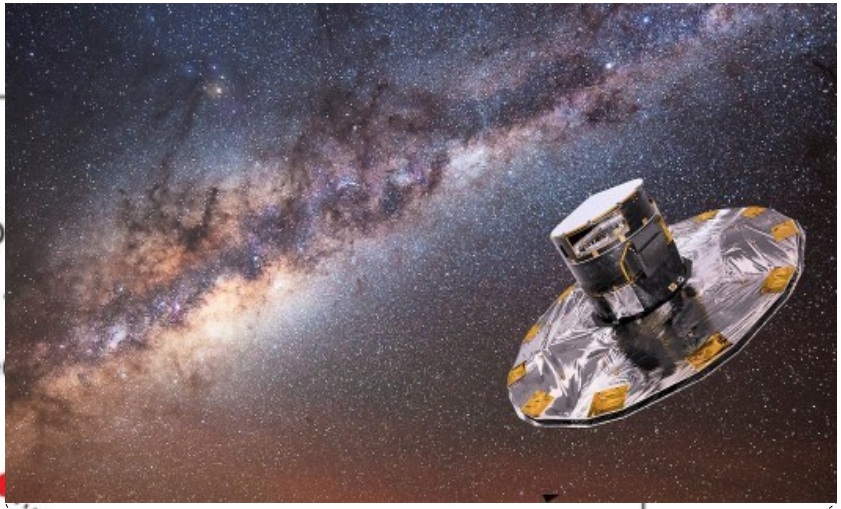
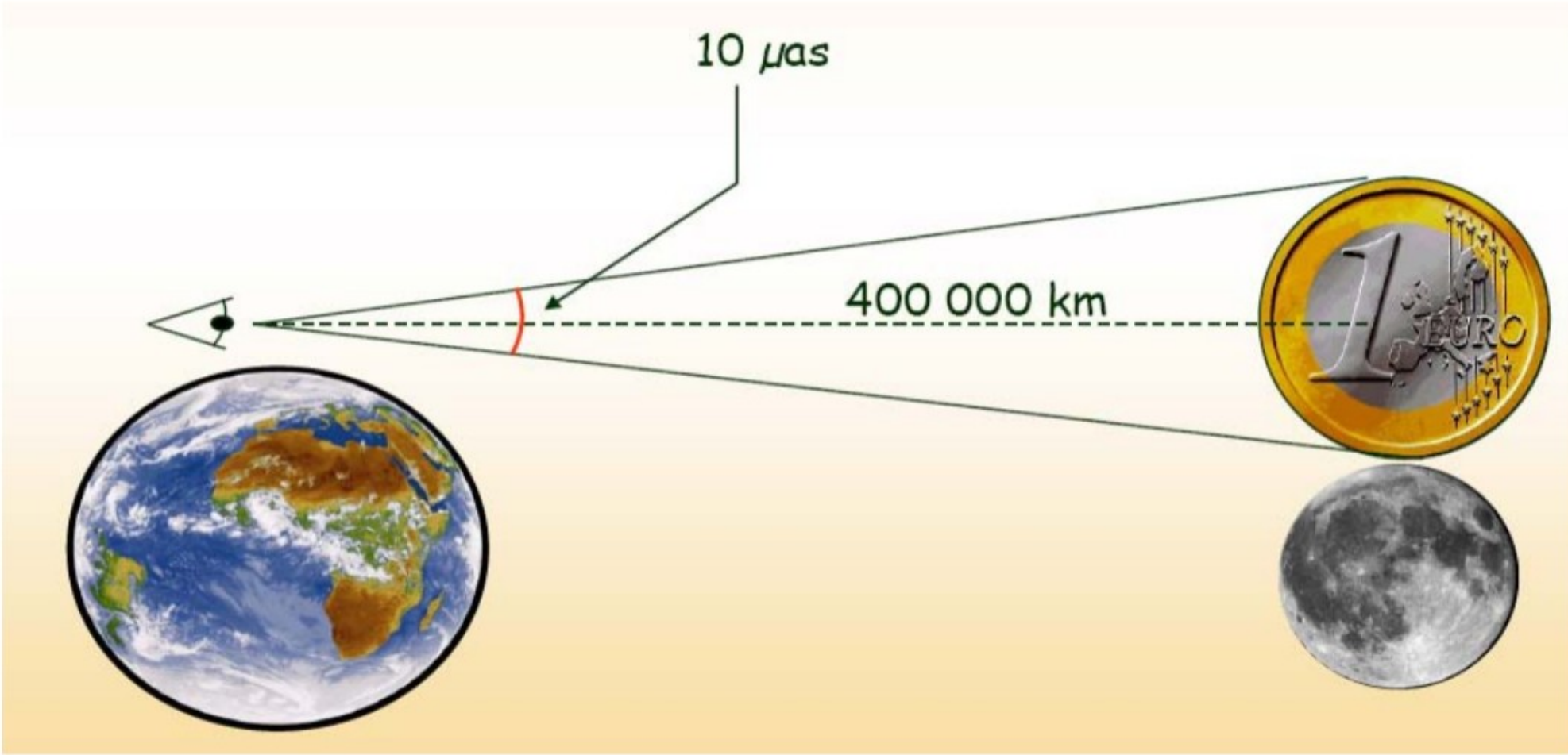
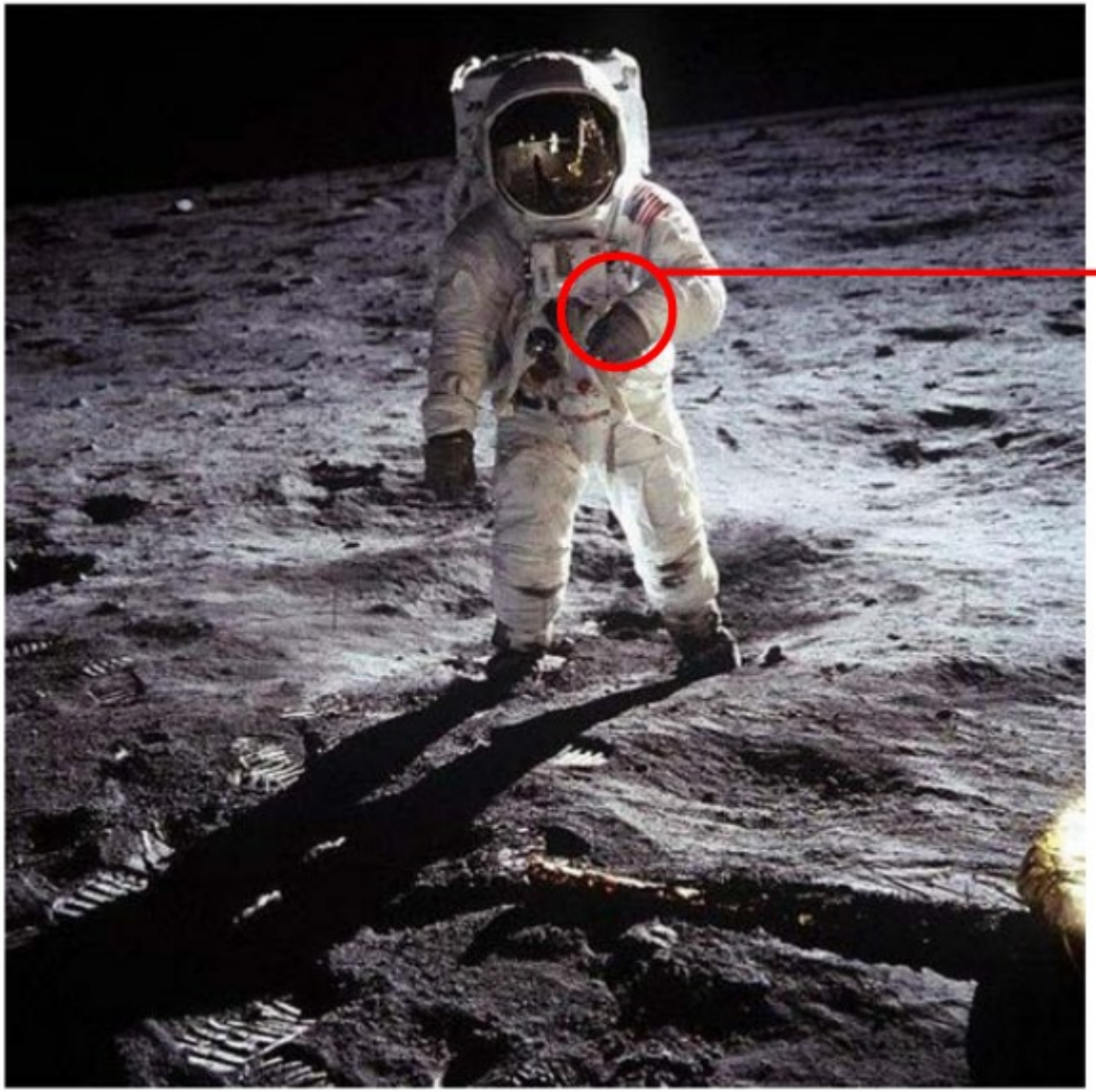


Gaia astrometric accuracy



Gaia astrometric accuracy

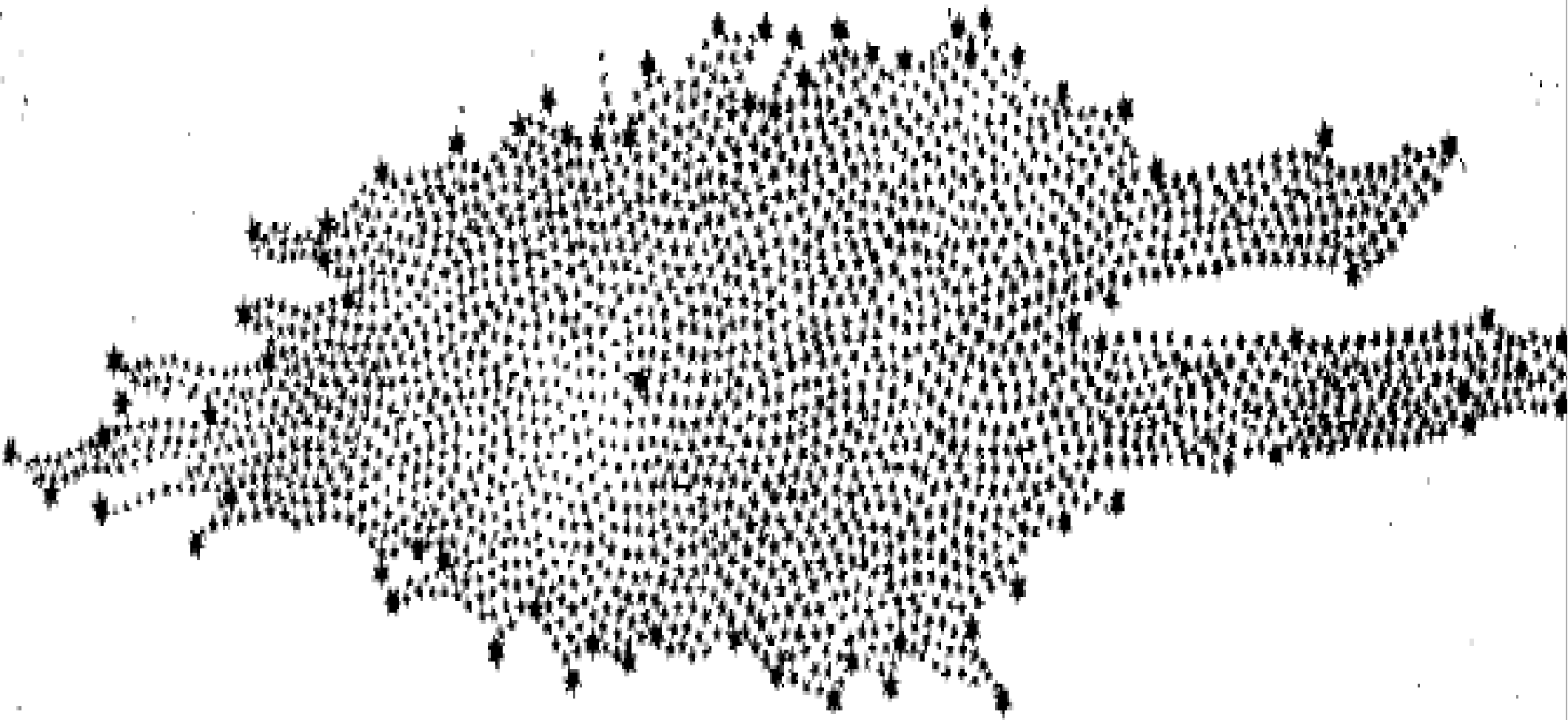


Earth – Moon

How the nail of an astronaut grow in time

~10 μas/yr

First Map of the Milky Way
1785



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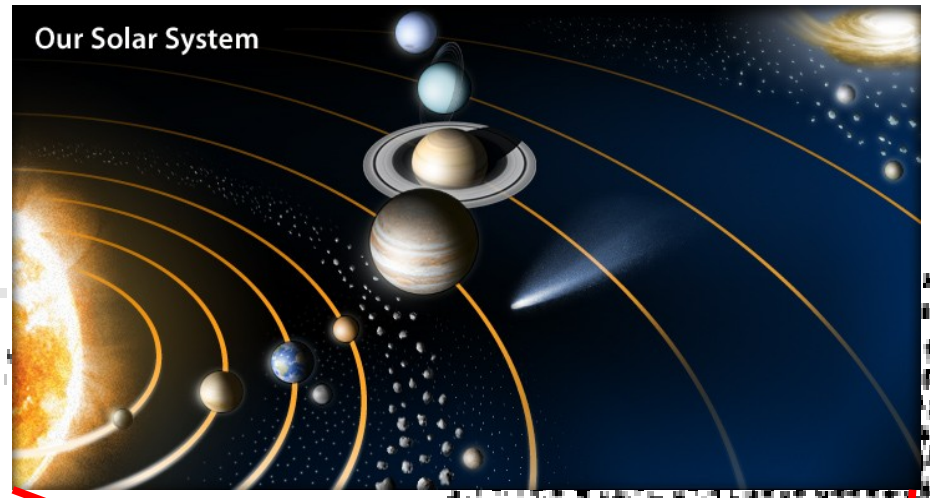
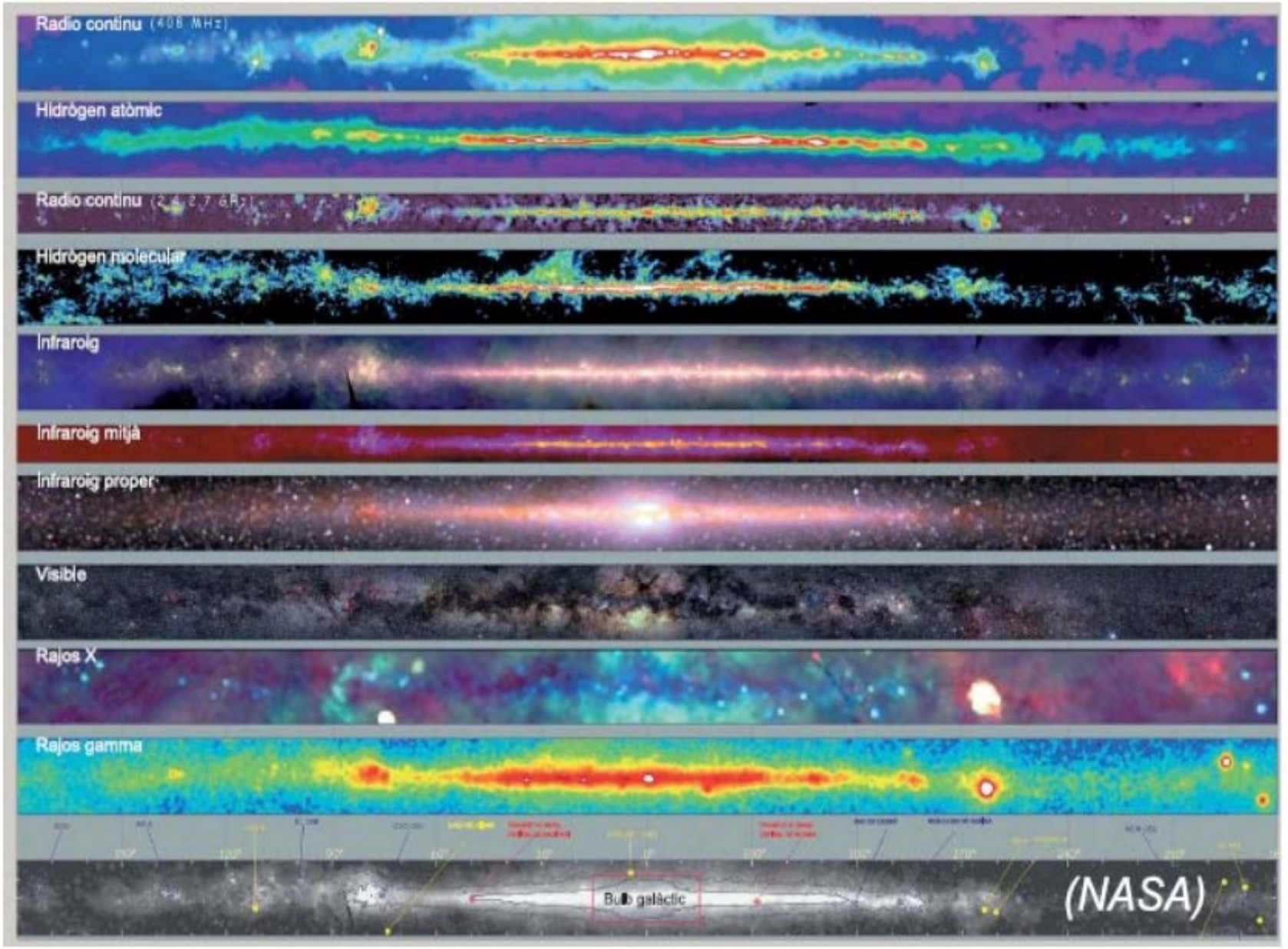
1785



The observations



The Milky Way at different wavelengths, Gaia in the optical

http://model.obs-besancon.fr/

Model forms

Description

References

Disclaimer

Changes log

last modification: July 5, 2013, 9:46 CEST

modele[at]obs-besancon.fr

Model of stellar population synthesis of the Galaxy

Warning :

On **July 4th, 2013,**, the Besançon model of the Galaxy was moved to a new machine; this should be transparent for model users.
Notice, that the possibility to download the results through http protocol has been suppressed.
In case of problems or questions, do not hesitate to contact us.

Information :

Since Tuesday April 12th 2011, on-the-fly help is displayed when mouse is over the "question mark" signs in the model query form
From Friday July 24th 2009 on, simulations are forced to stop when output file size exceeds 2 Gbytes or when CPU time exceeds 10 days

This version of the Model of stellar population synthesis of the Galaxy is fully described in the following publication:
A. C. Robin, C. Reylé, S. Derrière and S. Picaud. A synthetic view on structure and evolution of the Milky Way, 2003, *Astron. Astrophys.*, 409:523 **ADS** (*erratum*: 2004, *Astron. Astrophys.*, 416:157)

On December 6, 2004, a new version was enabled that allows to use the CFHT-Megacam photometric system. More informations are available here.

Photometric system: Johnson-Cousins

Form of the model simulation: Catalogue simulation

Kinematics: without kinematics

Display model form

Questions or comments

Model forms

Description

References

Disclaimer

Changes log

last modification: July 5, 2013, 9:46 CEST

modele[at]obs-besancon.fr

Model of stellar population synthesis of the Galaxy

Catalogue simulation with kinematics, Johnson-Cousins photometric system

To get help on parameters and values to supply, click on

Field of view :

- Distance interval (kpc):

  [0.000000 , 50.000000]

  Distance step: mode progressive

  specify step value (in parsecs) if linear mode or Δr/r if logarithmic mode: 0.000

- field:

  small field (defined by the center of the field and its surface) :

  Longitude : 200.00 Latitude : 59.00 Solid angle (deg^2) : 1.000000

  large field (field defined by galactic longitude and latitude):

  Coordinate system: galactic coordinates

  If equatorial coordinates, specify equinox: 2

  Galactic longitude or right ascension (decimal degrees): [200

  Galactic latitude or declination (decimal degrees): [59.

Extinction law

Diffuse extinction:

Model forms

Description

References

Disclaimer

Changes log

last modification: July 5, 2013, 9:46 CEST

modele[at]obs-besancon.fr

Selection on:

- **absolute magnitude** *(-7< < 20)*

  More details are given in Robin et al. (2003) A&A 409, 523.

  : [-7.00 , 20.00]

- **spectral type and subtype**:

(O , B , A , F , G , K , M ,C=AGB-C or OH/IR, DA)

earliest: type	earliest: subtype (0-9)	latest: type	latest: subtype (0-9)
O	0	DA	5

luminosity class:

I.. supergiants
II. bright giants
III giants
IV. subgiants

age and/or populations:

07 -> Disc : 7. - 10 Gyr
08 -> Intermediate Pop.
09 -> Halo
10 -> Bulge

Apparent magnitude passband : V

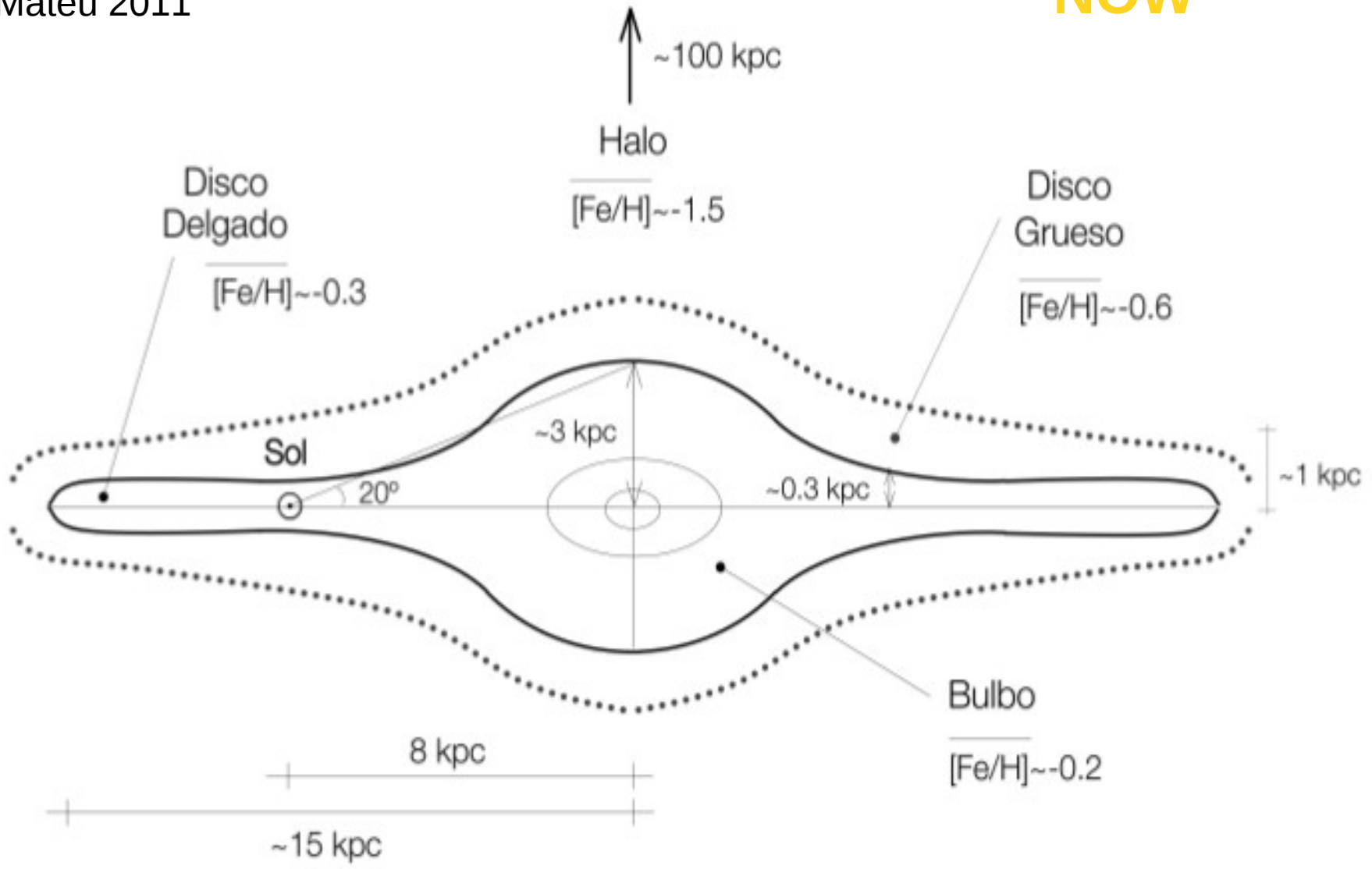
Intervals of apparent magnitude for each passband:

U	-99.00	99.00	B	-99.00	99.00
V	10.00	18.00	R	-99.00	99.00
I	-99.00	99.00	J	-99.00	99.00
H	-99.00	99.00	K	-99.00	99.00
L	-99.00	99.00			

Corresponding colour indices and intervals:

Mateu 2011

NOW

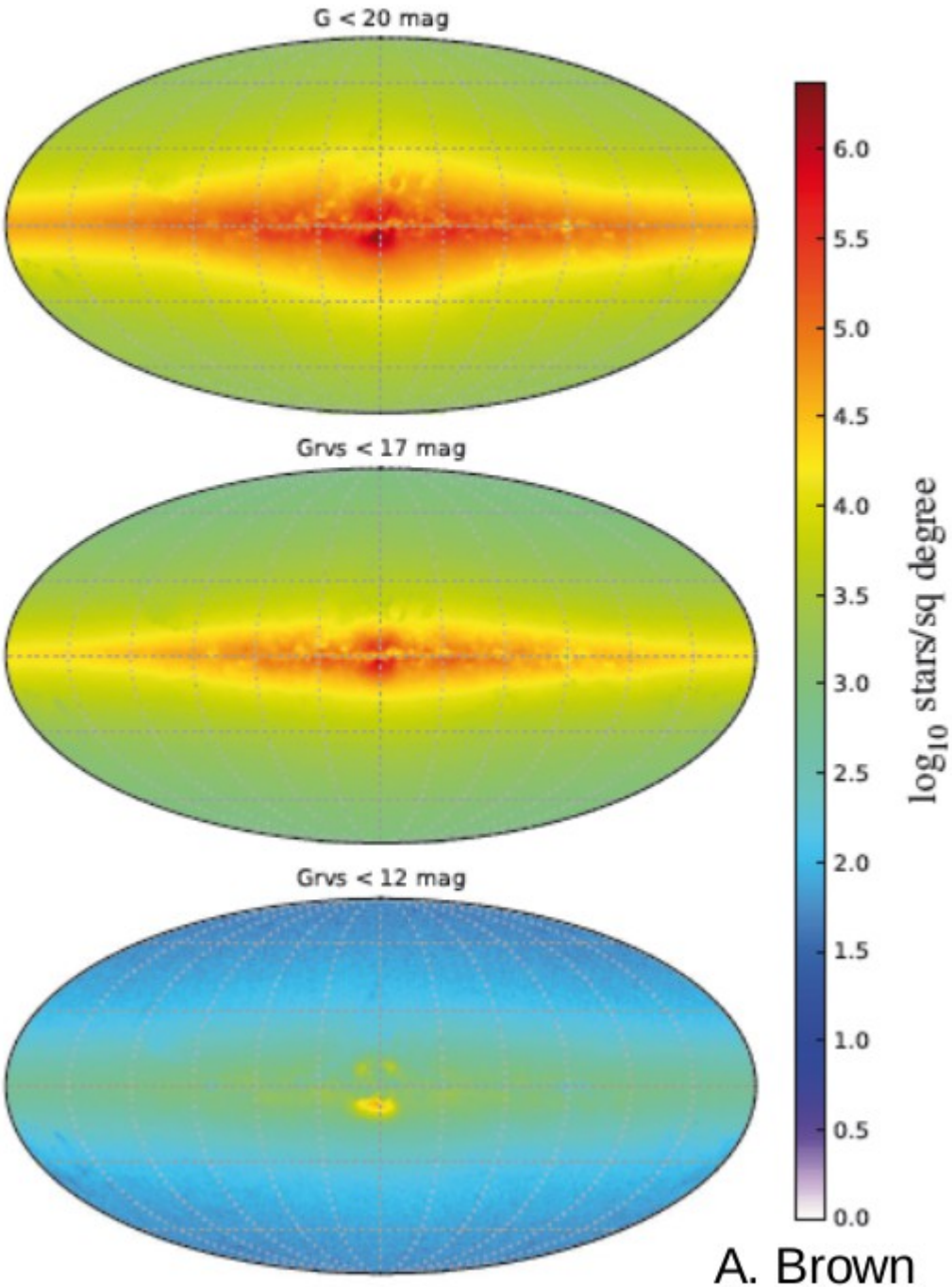


Survey capabilities

- Three simultaneous observing modes
- Complete to $G = 20$ ($V = 20$–22)
- Observing programme: autonomous on-board detection and unbiased
- Quasi-regular time-sampling over 5 years ($\sim$ 70 observations)
- Angular resolution comparable to HST

Number of objects

- 1 billion stars to $G = 20$
- 10^6–10^7 galaxies
- 500 000 quasars
- 3×10^5 solar system bodies
- tens of thousands of exoplanets



A. Brown

Survey capabilities

- Three simultaneous observing modes
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- Observing programme: autonomou on-board detection and unbiased
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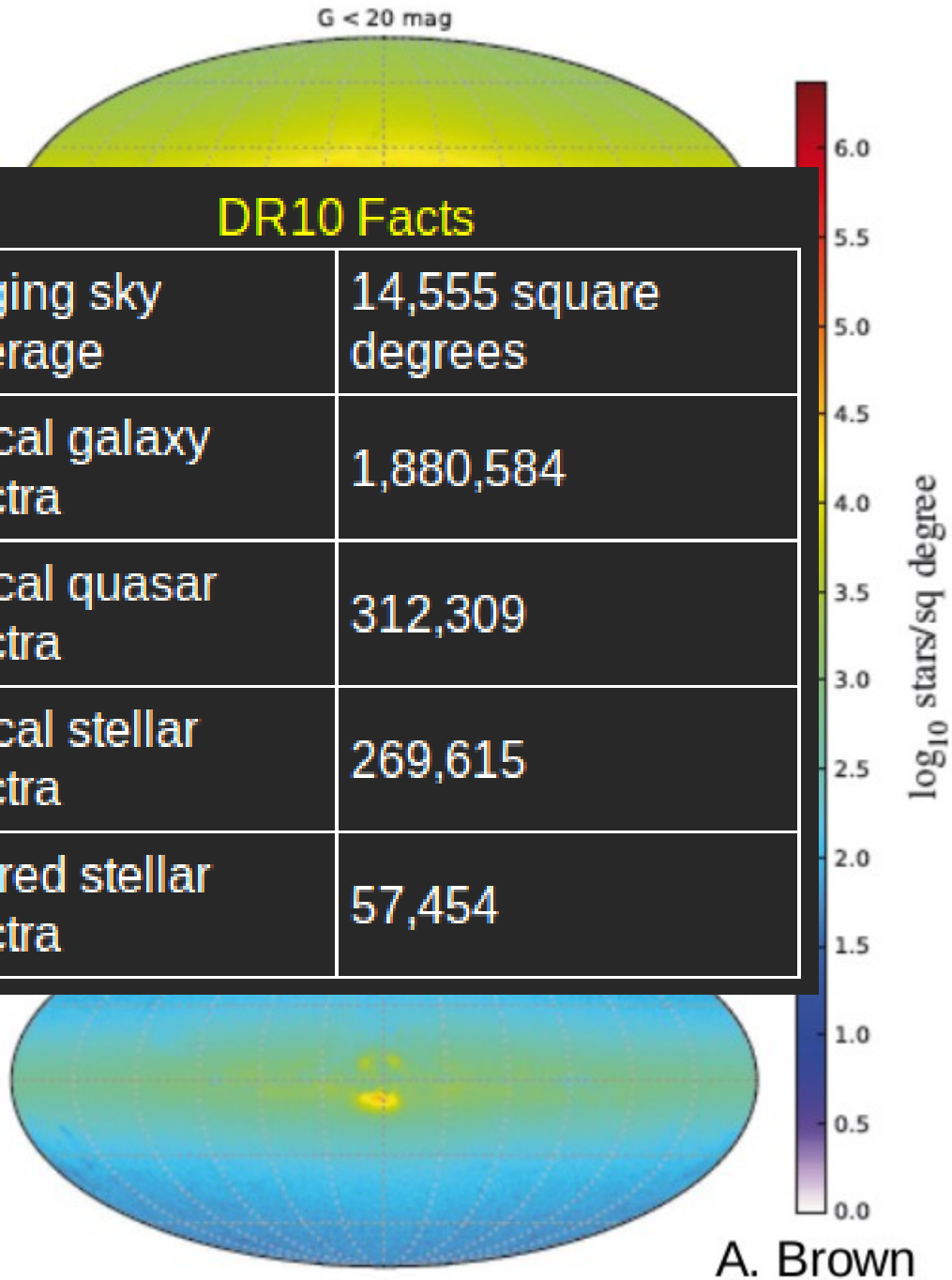
- 500 000 quasars
- 3×10^5 solar system bodies
- tens of thousands of exoplanets

Simulated Gaia sky — Robin et al., arXiv:1202.0132

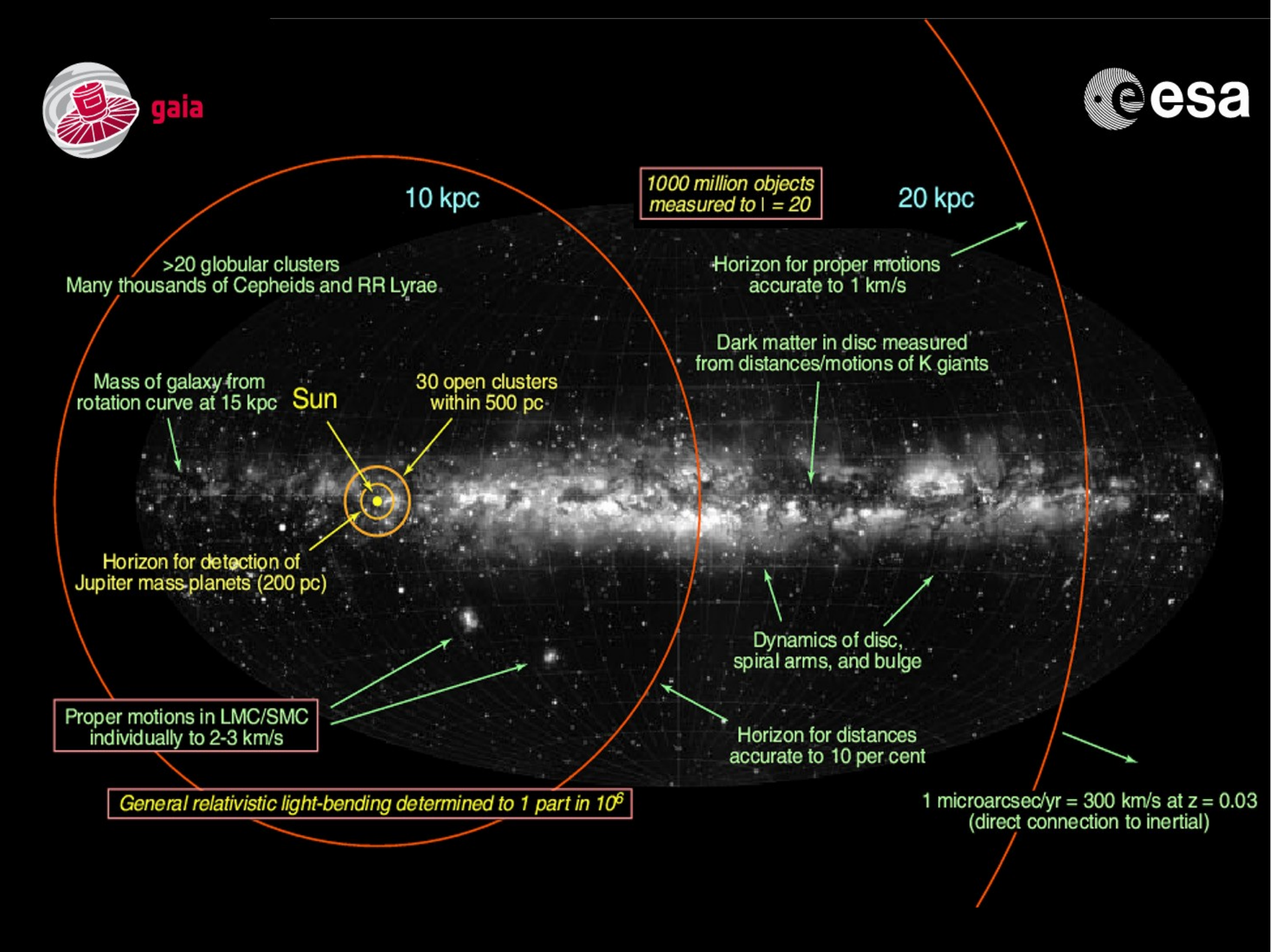


DR10 Facts	
Imaging sky coverage	14,555 square degrees
Optical galaxy spectra	1,880,584
Optical quasar spectra	312,309
Optical stellar spectra	269,615
Infrared stellar spectra	57,454

A. Brown

Our Galaxy

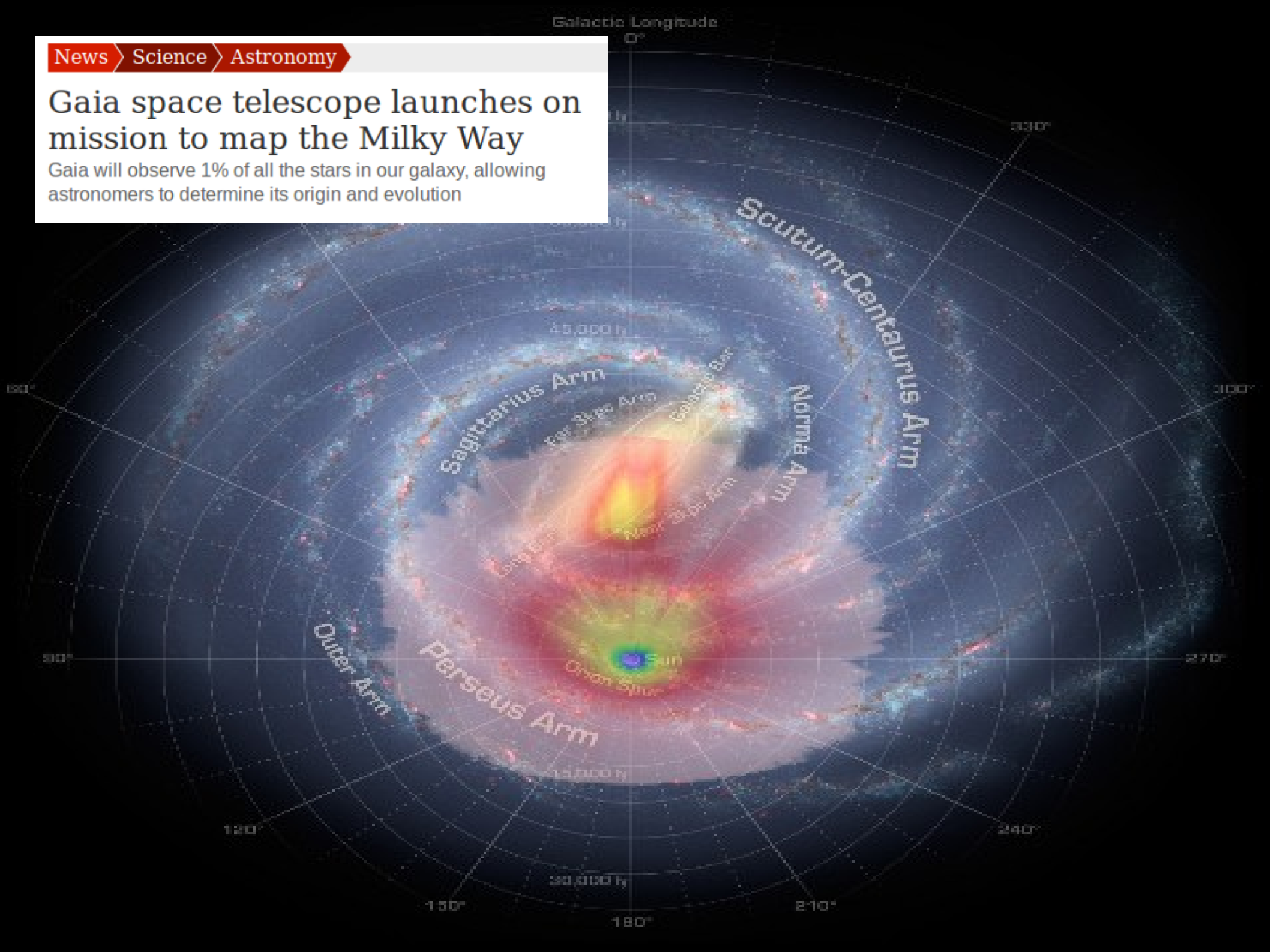
As we cannot see our own Galaxy from outside, there are still a lot of unknowns about its structure. With Gaia we will solve many of these unknowns. How many spiral arms our Galaxy have? two or four? How the stars move when they cross these spiral arms? How the Galaxy was formed? The motion of the visible matter in the Galaxy reveals important information about the non-visible mass. Gaia give us more details about this dark matter.

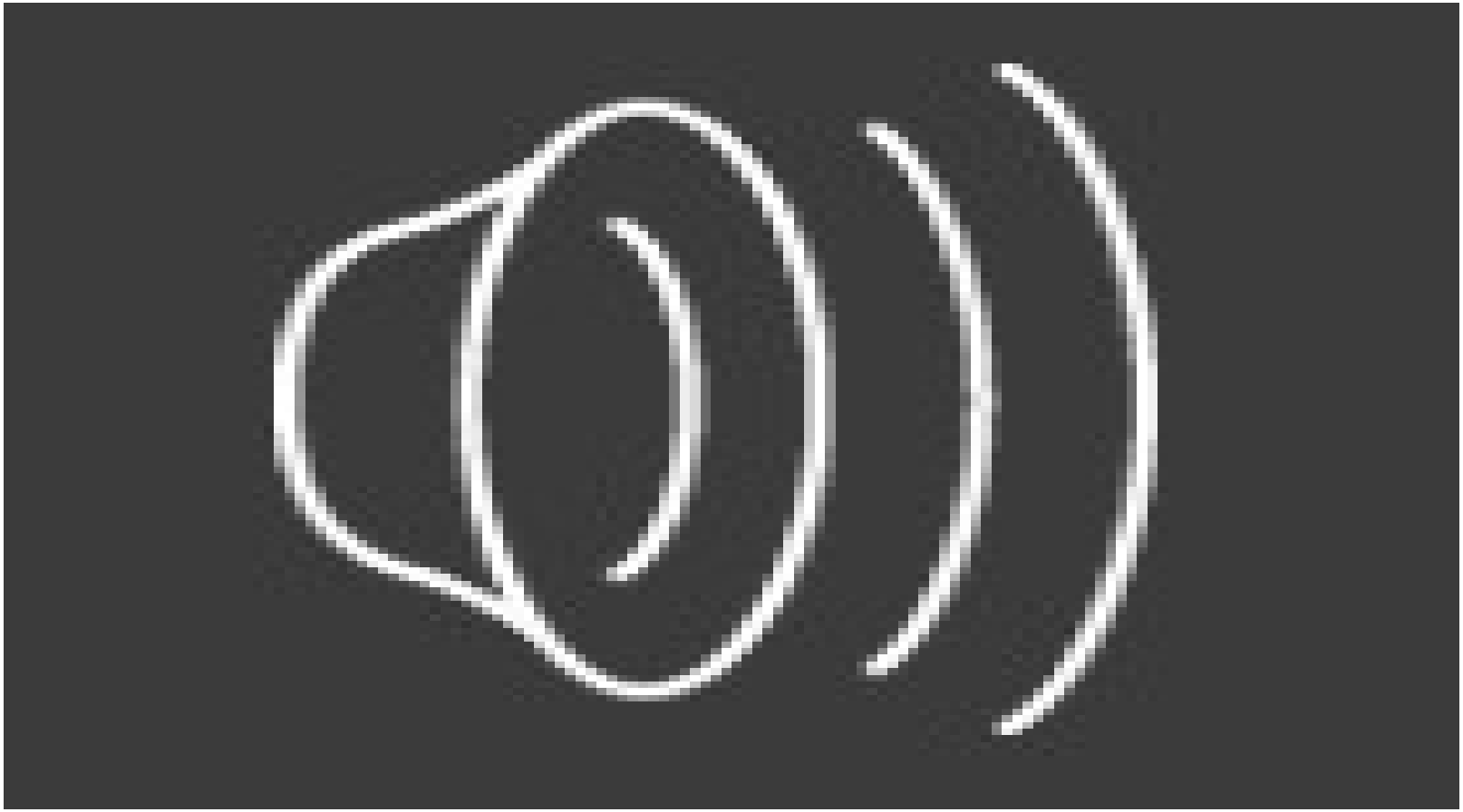

gaia
esa
10 kpc
1000 million objects measured to I = 20
20 kpc
>20 globular clusters
Many thousands of Cepheids and RR Lyrae
Horizon for proper motions accurate to 1 km/s
Dark matter in disc measured from distances/motions of K giants
Mass of galaxy from rotation curve at 15 kpc
Sun
30 open clusters within 500 pc
Horizon for detection of Jupiter mass planets (200 pc)
Dynamics of disc, spiral arms, and bulge
Proper motions in LMC/SMC individually to 2-3 km/s
Horizon for distances accurate to 10 per cent
General relativistic light-bending determined to 1 part in 10^6
1 microarcsec/yr = 300 km/s at z = 0.03
(direct connection to inertial)

News › Science › Astronomy

Gaia space telescope launches on mission to map the Milky Way

Gaia will observe 1% of all the stars in our galaxy, allowing astronomers to determine its origin and evolution





First release (Launch + 22 months): Positions and magnitudes of the 90 percent of the sky with acceptable precisions. In particular the stars observed in common with Hipparcos mission will also be delivered in order to allow the comparison with the data of 1989-1993.

Second release (Launch + 28 months): Integrated BP/RP photometry, mean radial velocities for those objects with constant radial velocity and astrophysical parameters derived with good accuracy are delivered.

Third release (Launch + 40 months): Orbital solutions of binary systems. BP/RP/RVS spectra delivered for those objects with good astrophysical parameters determined.

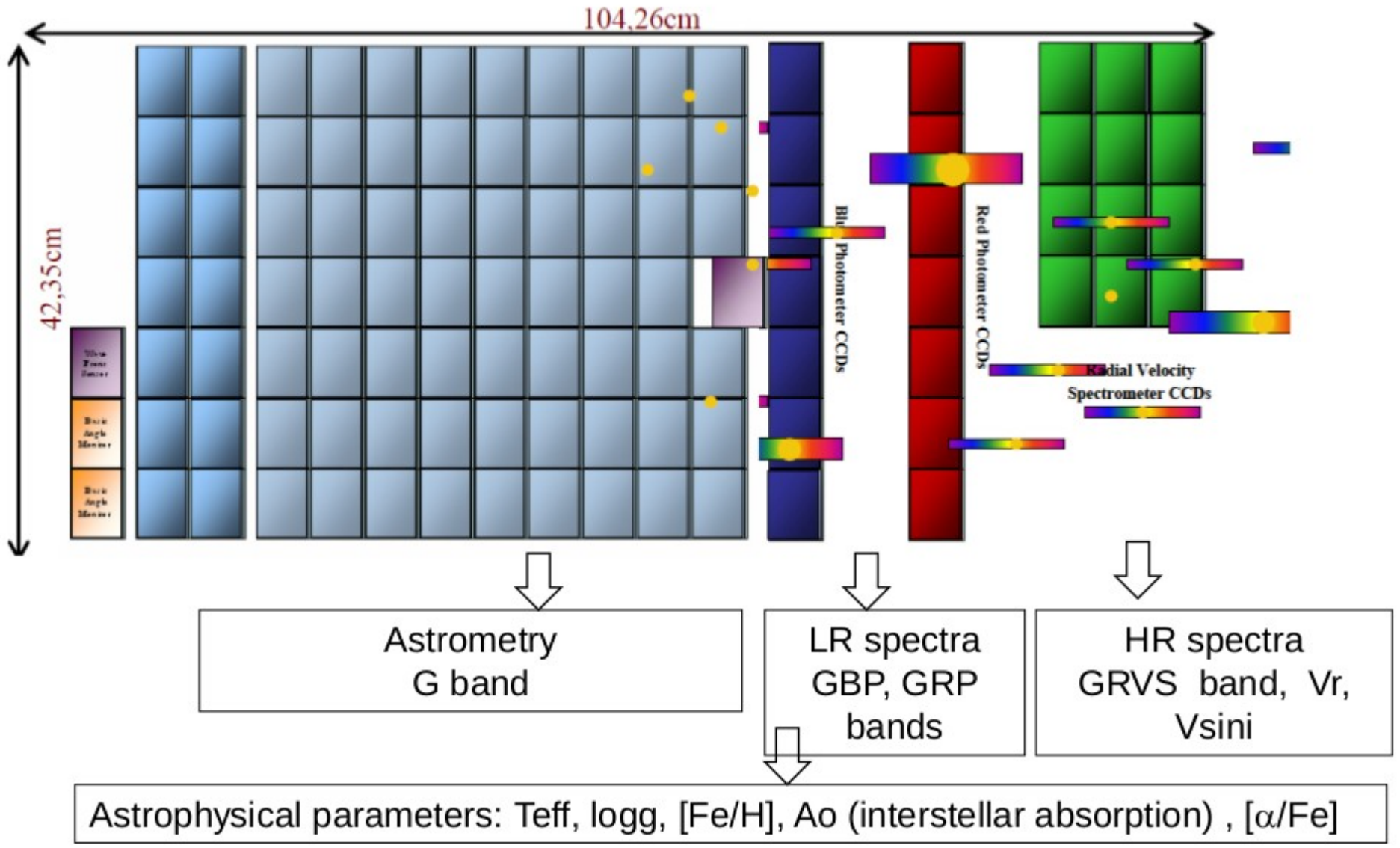
Fourth release (Launch + 65 months): Variable stars classification with epoch photometry, orbital solutions for Solar System objects and non-single objects catalogue.

Final release (End of mission + 3 years): The catalogue will be consisting of:

- Full astrometric, photometric, and radial-velocity catalogues.
- All available variable-star and non-single-star solutions.
- Source classifications (probabilities) plus multiple astrophysical parameters (derived from BP/RP, RVS, and astrometry) for stars, unresolved binaries, galaxies, and quasars. Some parameters may not be available for faint(er) stars.
- A list of exoplanets.
- All epoch and transit data for all sources.
- All ground-based observations made for data-processing purposes

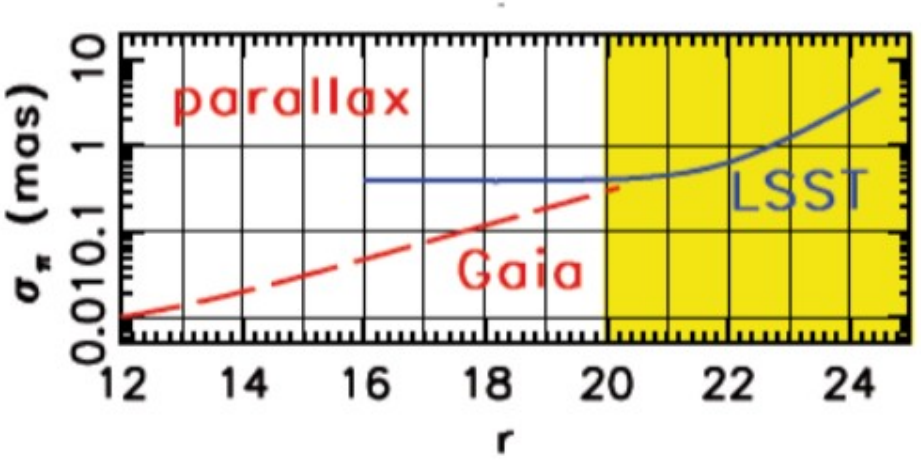
106 CCDs ~ 938 millones de pixels

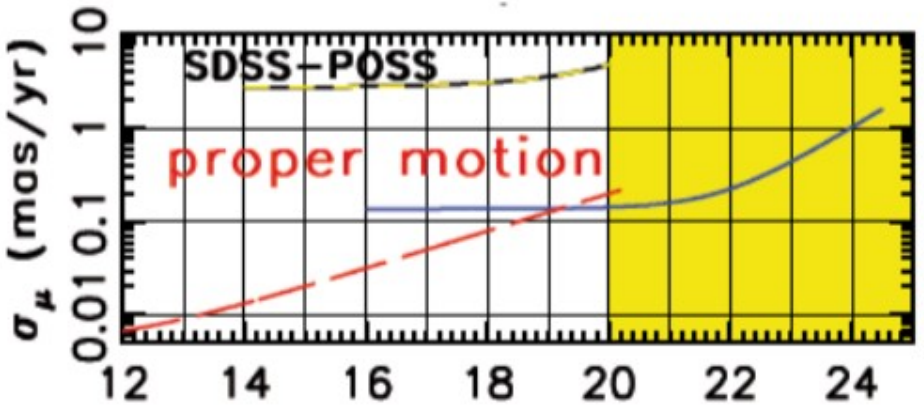
Gaia focal plane



LSST and Gaia: complementary for studying the Milky Way

Gaia will provide calibration checks to astrometric LSST data
LSST will extend the Gaia survey four magnitudes deeper.





Other Gaia discoveries

Besides the billion stars, Gaia is also observing and discovering other type of objects. Gaia will discover at the end of the mission about 200000 white dwarfs, 50000 brown dwarfs, 30000 extrasolar planets, 200 microlensing events, 200000 asteroids (about a thousand of them with orbits close to Earth, potentially dangerous), 100000 novae and supernovae explosions, 1-10 million of resolved galaxies, 500000 quasars, ...

GOG: Gaia Object Generator

[Fe/H] without GAIA error (Real data)

A gamma distribution is used for each star with alpha (α) and beta (β) parameters calculated respect to the Sun placed at (x,y,z) = (-8.5, 0, 0) kpc.

$$[Fe/H] = \alpha * R_R + \beta$$

The Galactic metallicity gradient, W. Rolleston, S. Smartt, P. Dufton and R. Ryans.

$$\alpha = d[Fe/H] / dR_{GAL} = -0.07$$

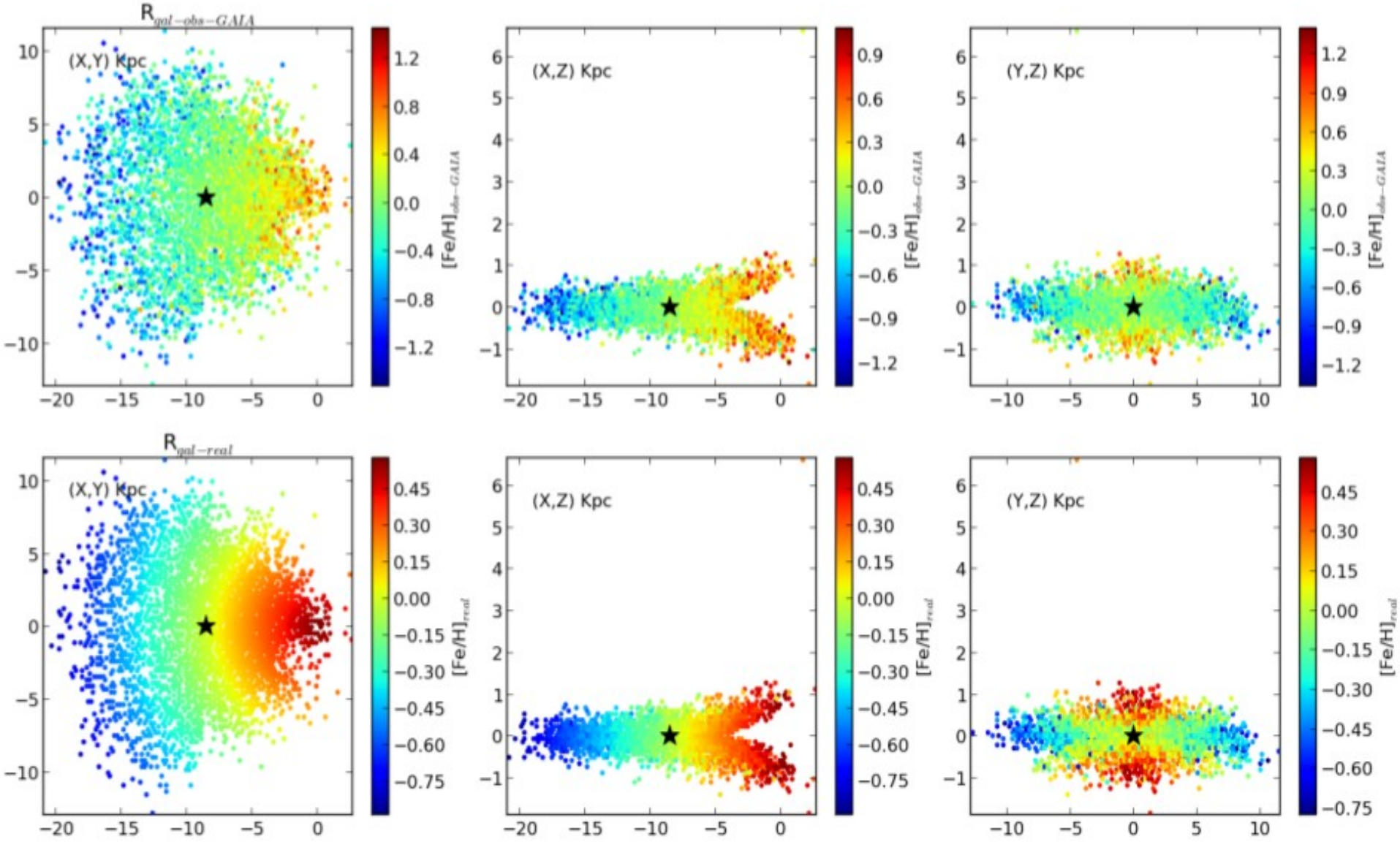
$$[Fe/H]_{SUN} = 0 = -0.07 * 8.5 + \beta$$

$$\beta = 0.595$$

$$[Fe/H] = -0.07 * R_R + 0.595$$

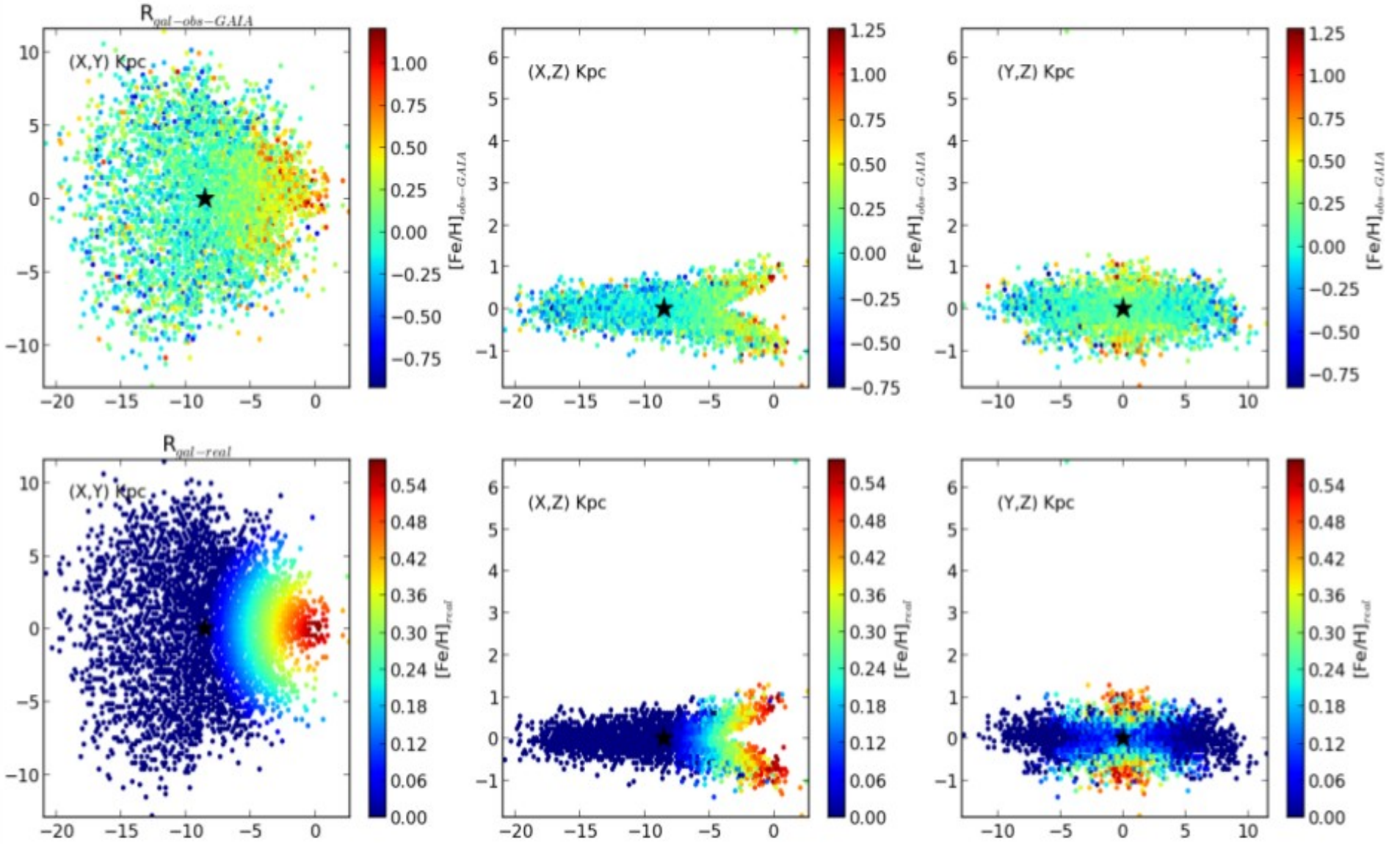
Fernández et al. (2014), in preparation

Metallicities Distribution (Negative slope)



Fernández et al. (2014), in preparation

Metallicity Distribution (negative and const. slope)

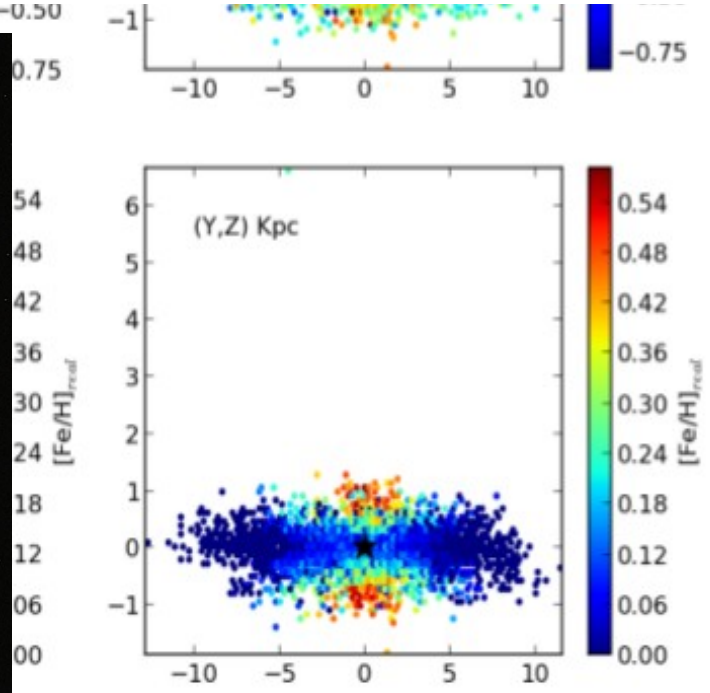


Fernández et al. (2014), in preparation

Metallicity Distribution (negative and const. slope)

3D kinematics through the X-shaped Milky Way bulge ⋆

S. Vásquez[1,2,3], M. Zoccali[1,3], V. Hill[4], A. Renzini[5,6], O. A. González[2,3], E. Gardner[7], Victor P. Debattista[8], A. C. Robin[7], M. Rejkuba[9], M. Baffico[1], M. Monelli[10,11], V. Motta[12], and D. Minniti[1,3,13,14]



Fernández et al. (2014), in preparation

Conclusions

The metallicity is truncated near the galactic centre probably due to the galactic bar.

The metallicity dispersion tends to broaden at higher magnitudes, this is probably due to the population of the galactic centre ([Fe/H]>0) and anti-galactic centre ([Fe/H]).

The observed data is consistent with the simulations of GOG.

We found that as the galaxy evolves in the SPH/N-body code the slope of the metallicity decrease.

We found no significant difference between the original metallicity and the one seen by GAIA.

The metallicity does no change when errors are taking into account, but the dispersion increases when errors are taken into account.


Thanks for your attention!!!