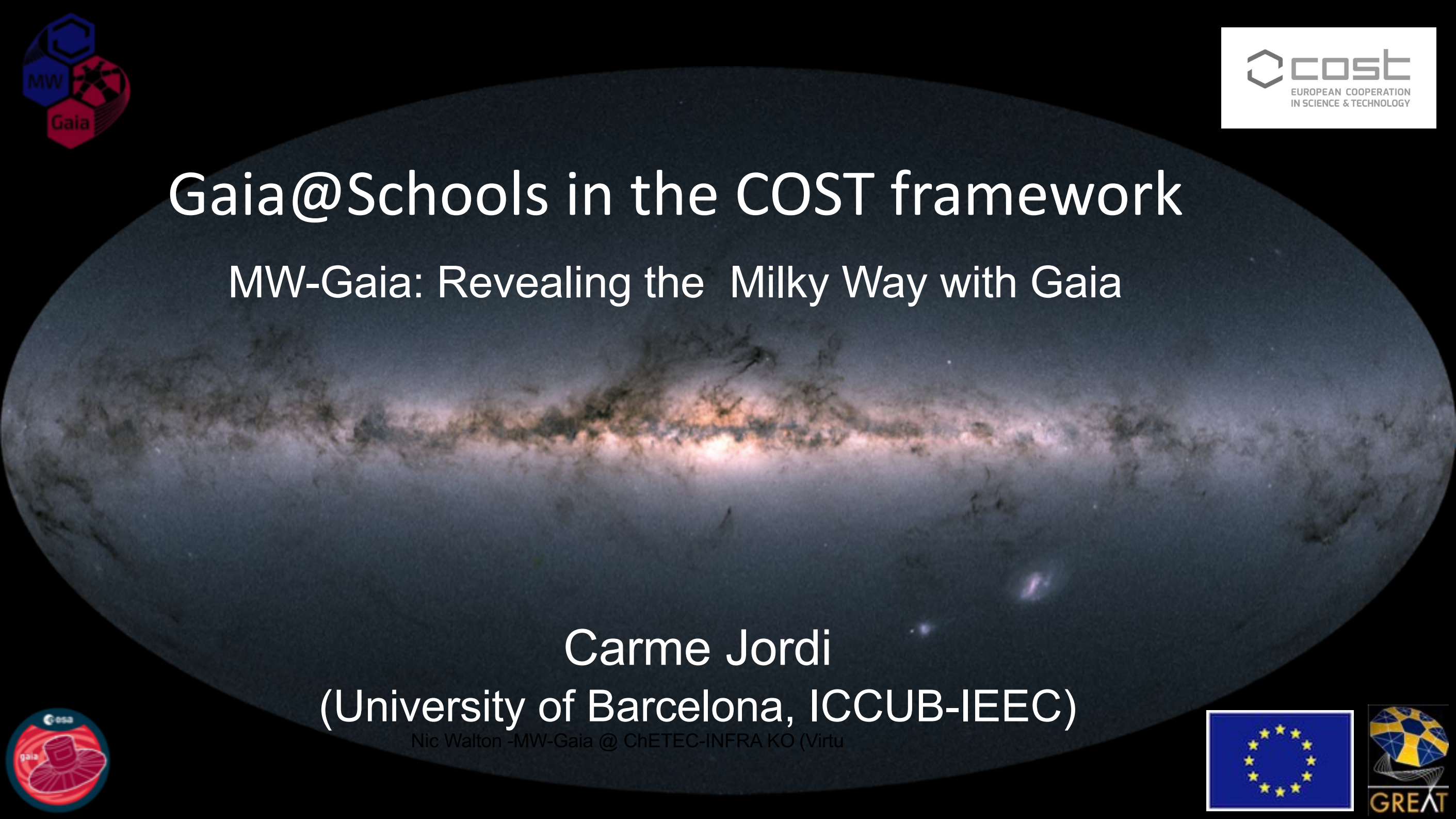




# Gaia@Schools in the COST framework

## MW-Gaia: Revealing the Milky Way with Gaia

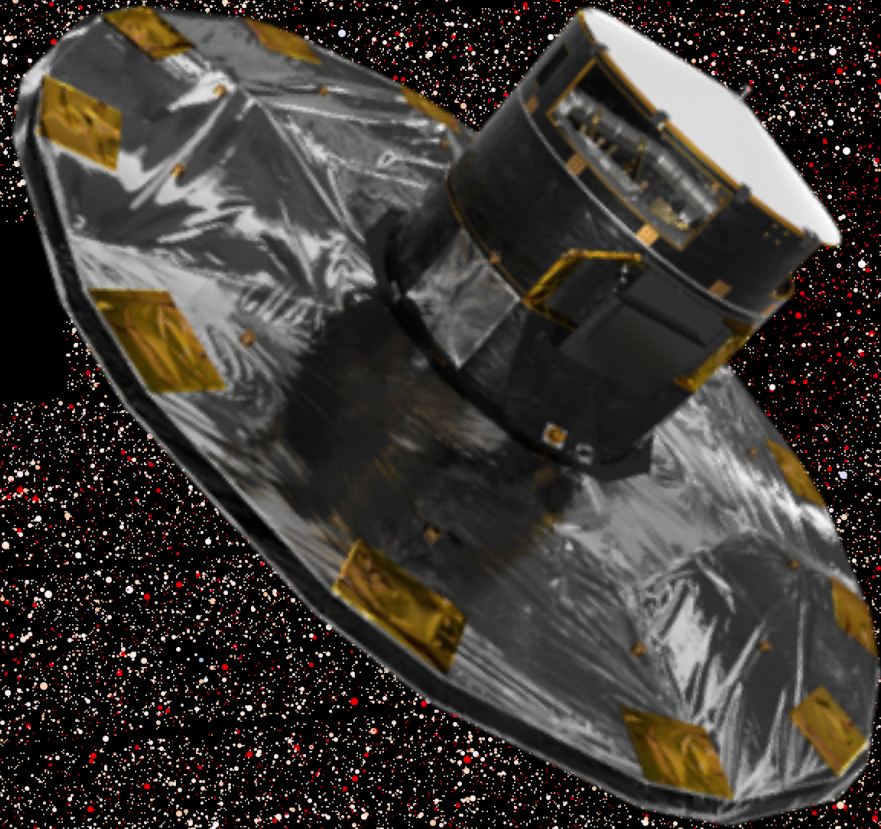


Carme Jordi

(University of Barcelona, ICCUB-IEEC)

Nic Walton -MW-Gaia @ ChETEC-INFRA KO (Virtu





**70 million transits per day**

**2503 days in science operations**

**93 TB of science data gathered**

**177 billion transits observed**



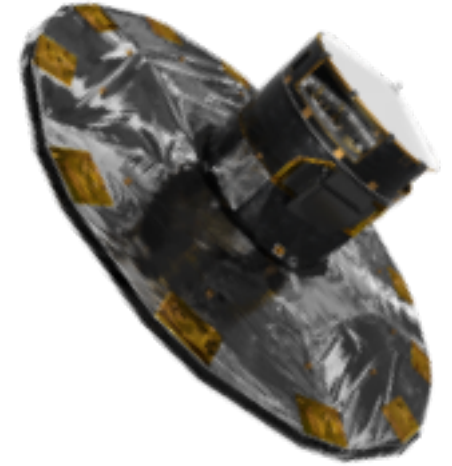
*Credits: ESA/Gaia/DPAC*





# A long history of success

- First ideas in 1997
- Launch 19-Dec-2013
- Science operations 25-Jul-2014
- DR1 (14 months) 14-Sep-2016
- DR2 (22 months) 25-Apr-2018
- End of nominal mission 16-Jul-2019
- **EDR3 (34 months) 3-Des-2020**
- First mission extension end-2020
- **DR3 (EDR3 + new products): H1-2022**
- **Second mission extension end 2022**
- DR4 (66 months, nominal mission) TBD
- Third mission extension 2025 ?
- Final catalogue TBD



Credits: ESA/Gaia

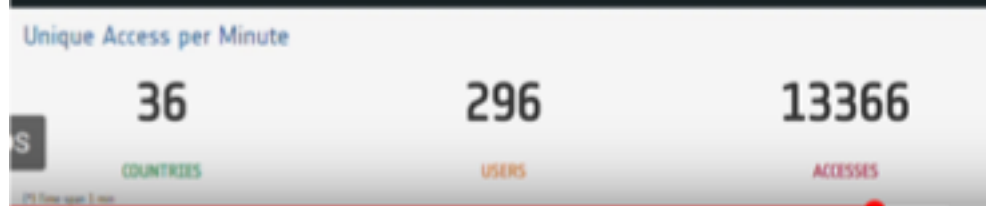
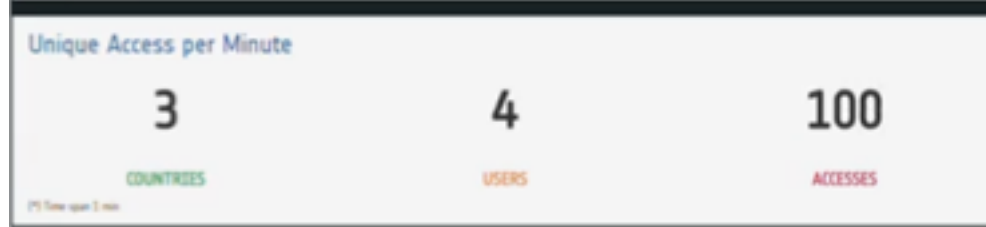




# Gaia archive: a worldwide used facility

Archive Users (different IP Addresses) downloading data per month





3 Des 2020

before 12:00 CET

at 12:05 CET



# Big Science, Big Data Challenge



**1 811 709 771**  
stellar positions

**1 806 254 432**  
brightness  
in white light

**1 542 033 472**  
brightness  
in blue light

**1 540 770 489**  
colour

**1 467 744 818**  
parallax and  
proper motions

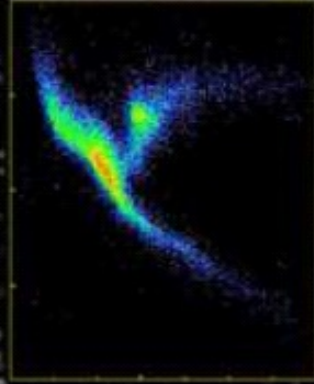
**1 614 173**  
extragalactic  
sources

**1 554 997 939**  
brightness  
in red light



# Gaia: a Big Science

Gaia



Star Formation  
History of the  
Milky Way

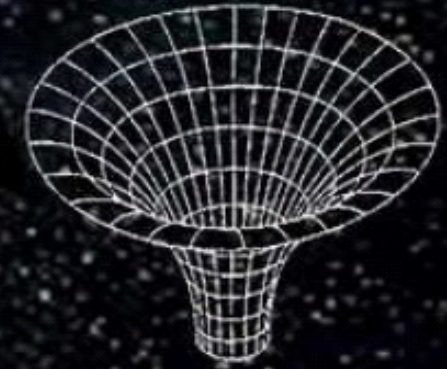
Galactic  
Structure



Stellar  
Astrophysics

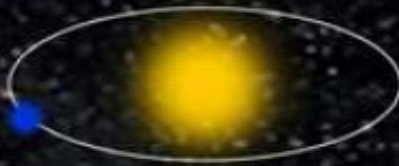


Binaries and  
Brown Dwarfs

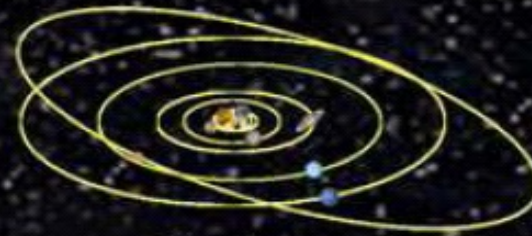


Fundamental  
Physics

Extrasolar  
Planets



Solar  
System

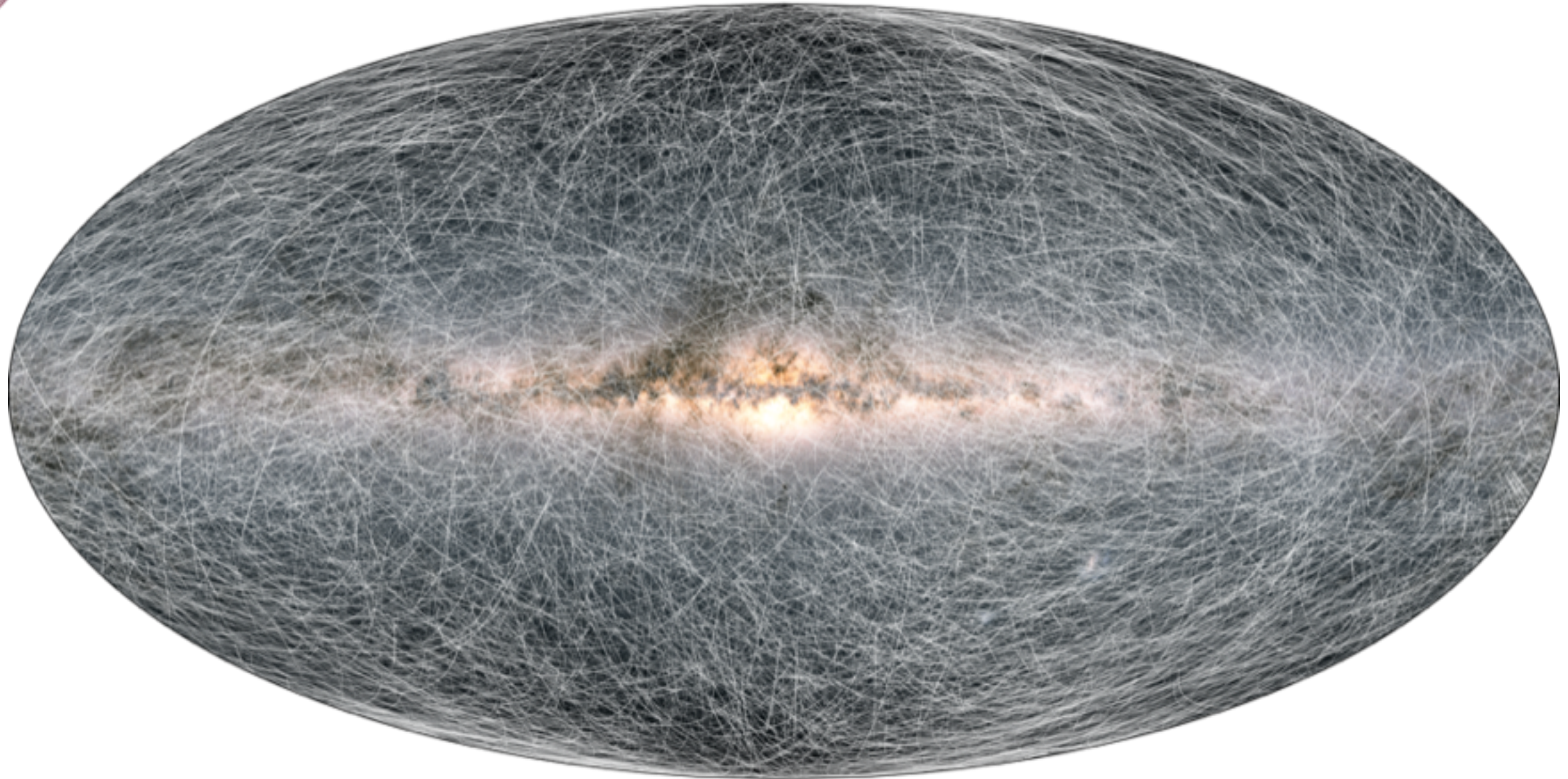


Reference  
Frame





# The displacement of stars on the sky 400,000 years into the future



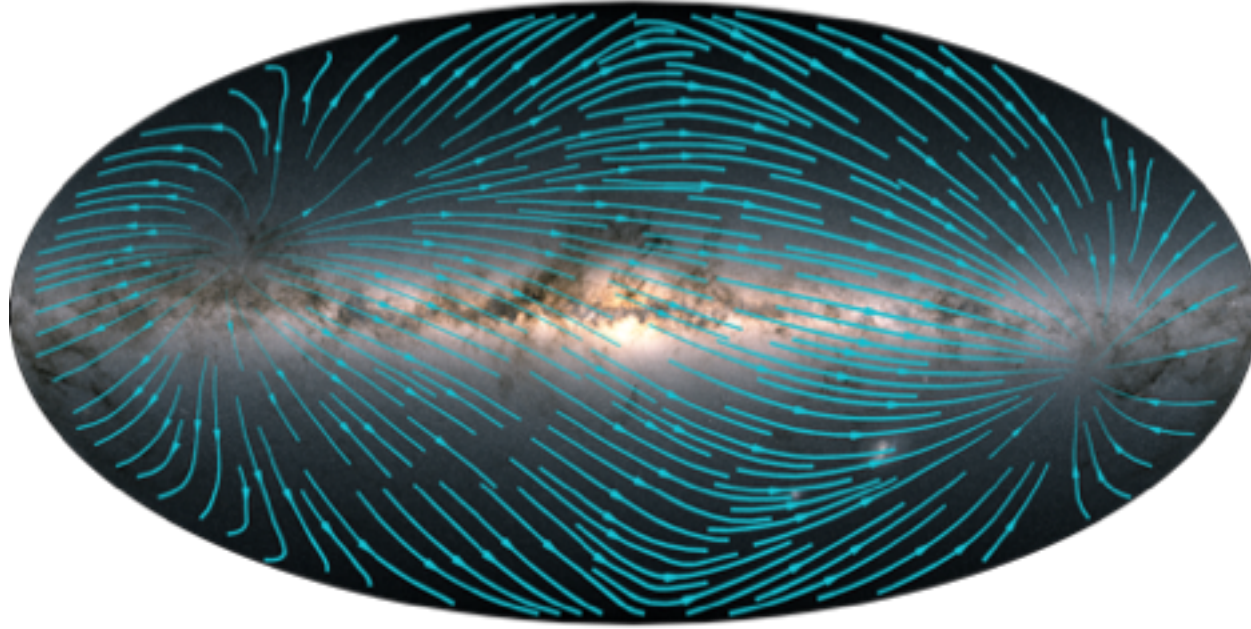
2 June 2021

Carme Jordi

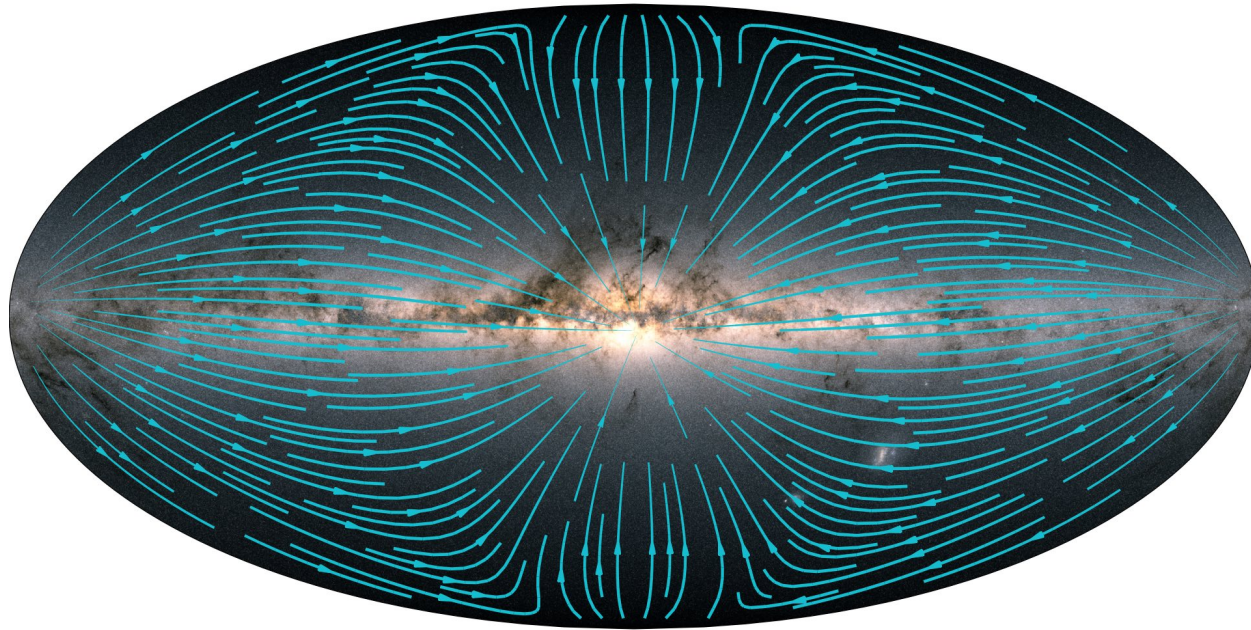
MW-Gaia: Gaia@Schools (Virtual)







The average motion across the sky for stars located at 1000 parsecs from the Sun.



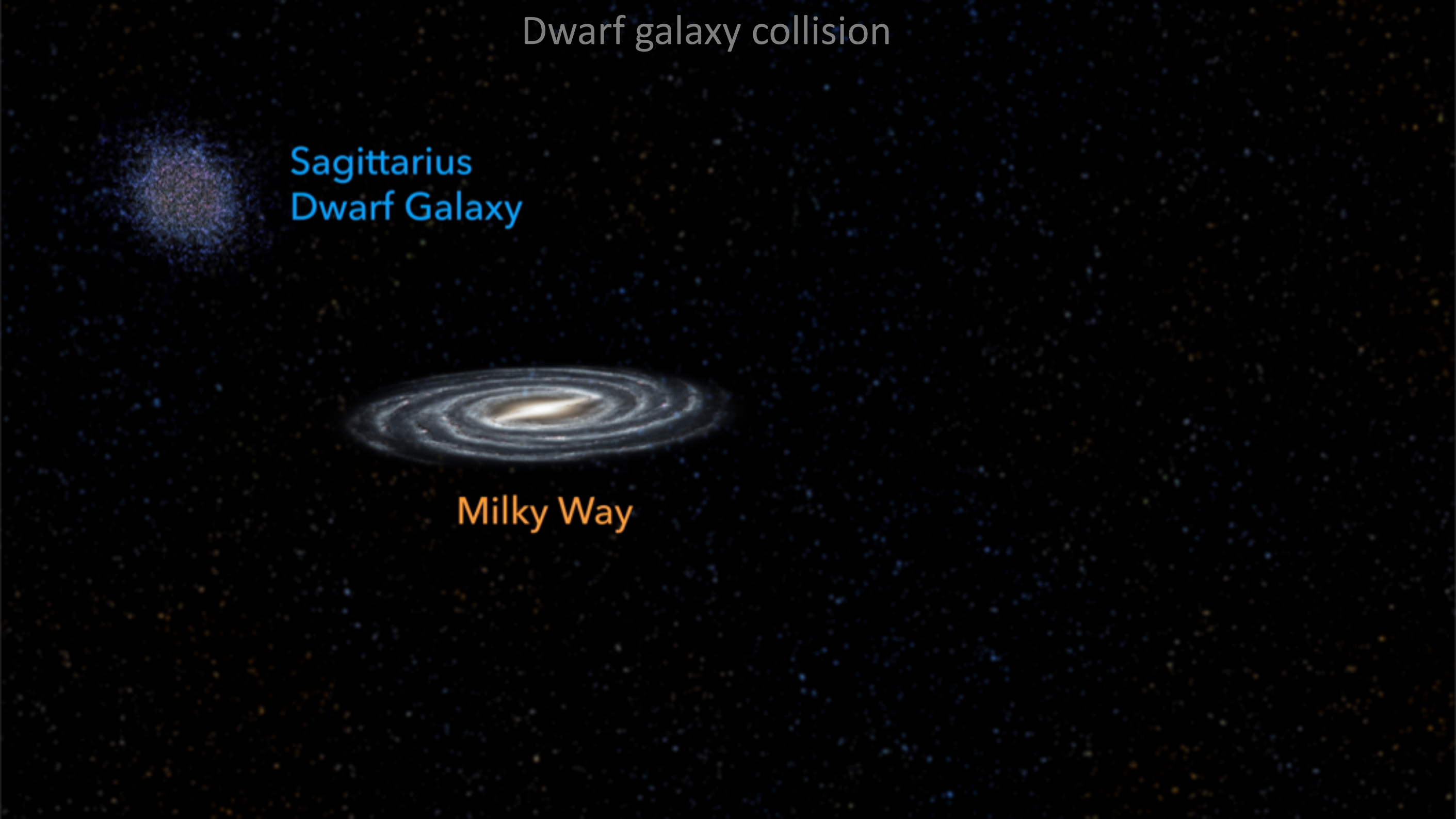
Apparent motion of distant quasars caused by the acceleration of the Sun.



# Dwarf galaxy collision

Sagittarius  
Dwarf Galaxy

Milky Way





# Archaeology

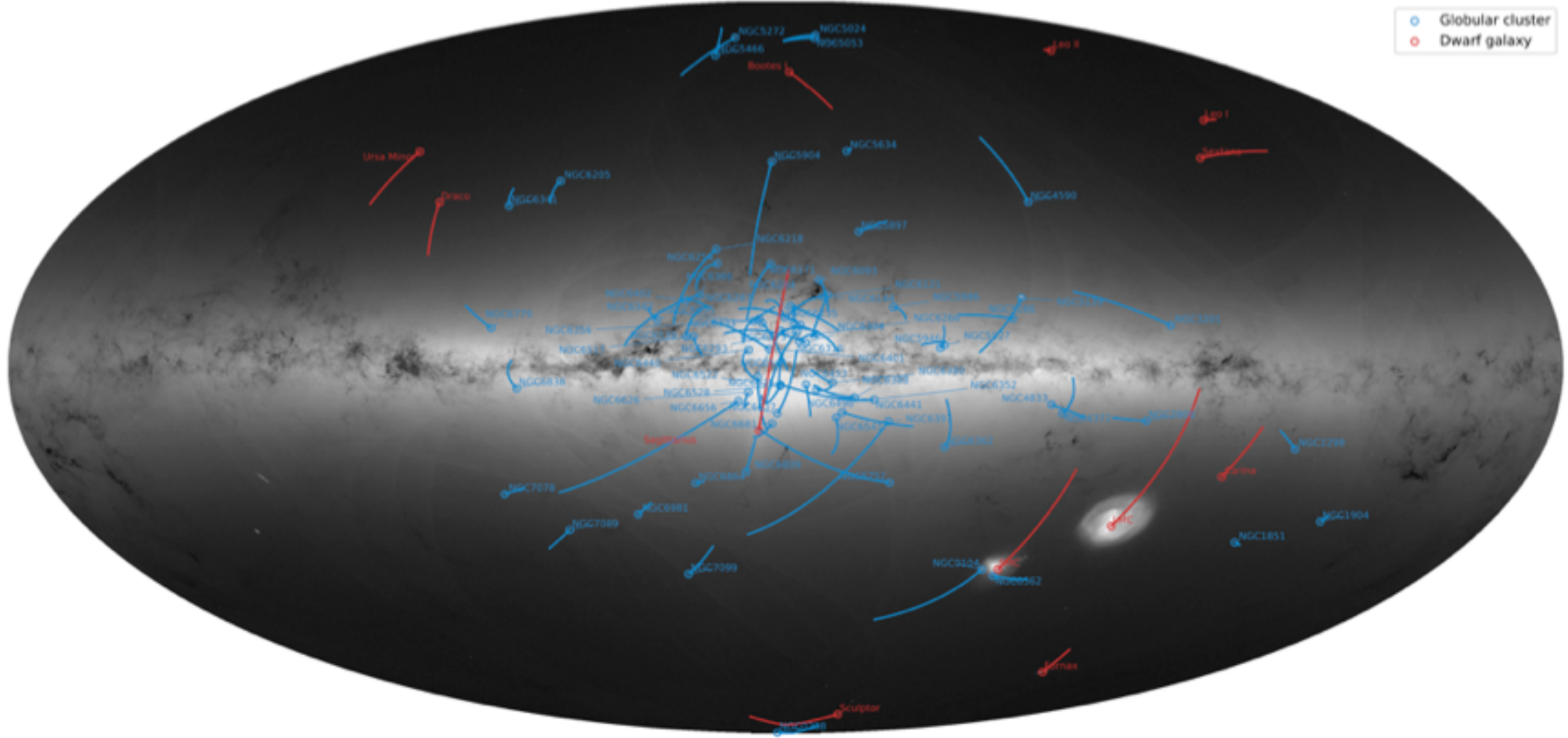
Reading the motion of  
the stars

Perturbation of orbits  
by collisions





# Estimating the mass of the Galaxy



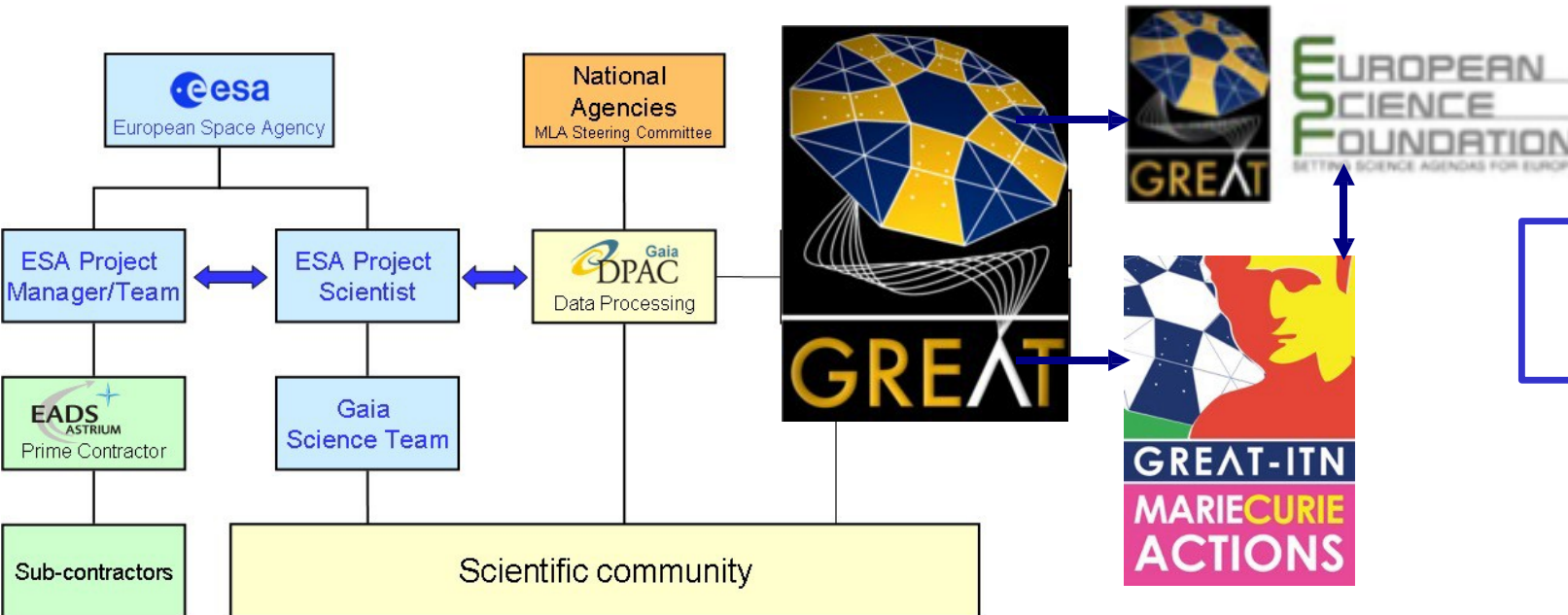


# Gaia Research for European Astronomy Training

## GREAT 2010-2015

See <http://www.great-esf.eu>

### Some history:



Workshops & Exchanges

Student Training  
17 ESR/PhDs

Outputs: science teams, science case for new instruments, case for new networks

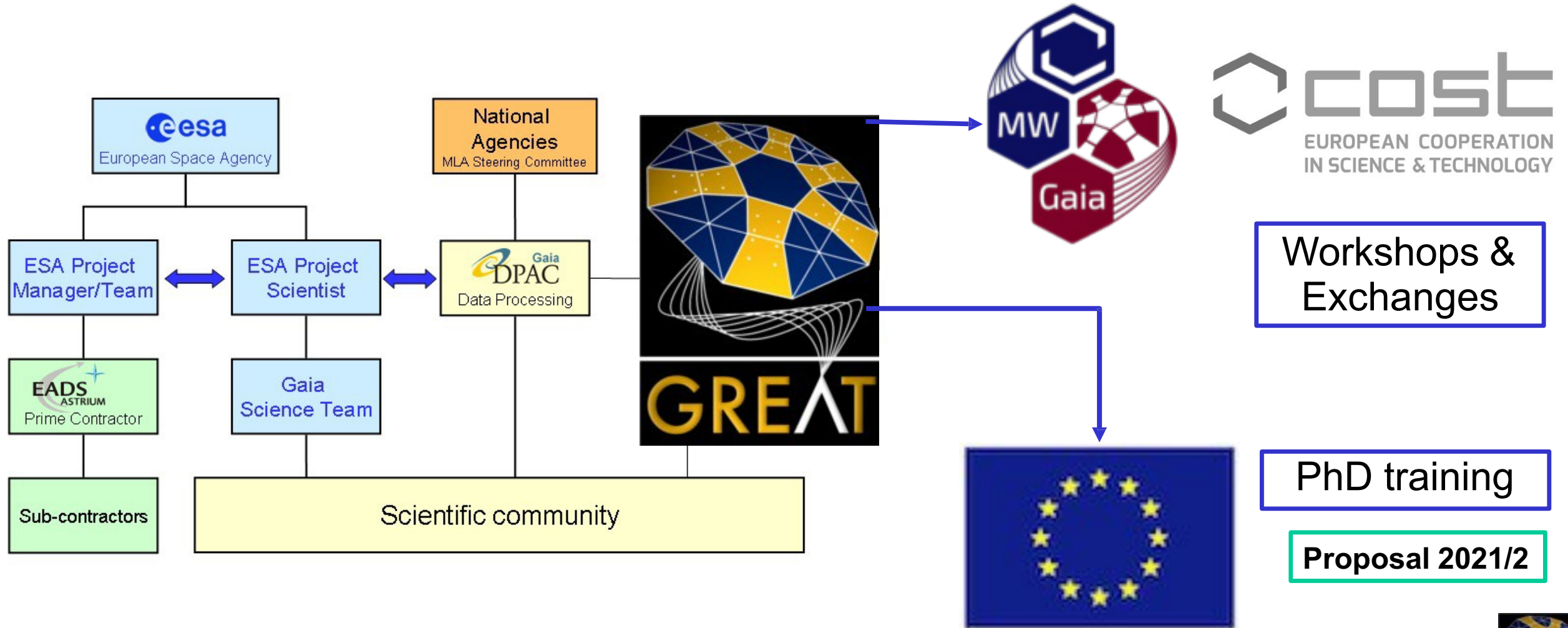
over 2000 scientists attending ~60 events





# GREAT 2019-2023

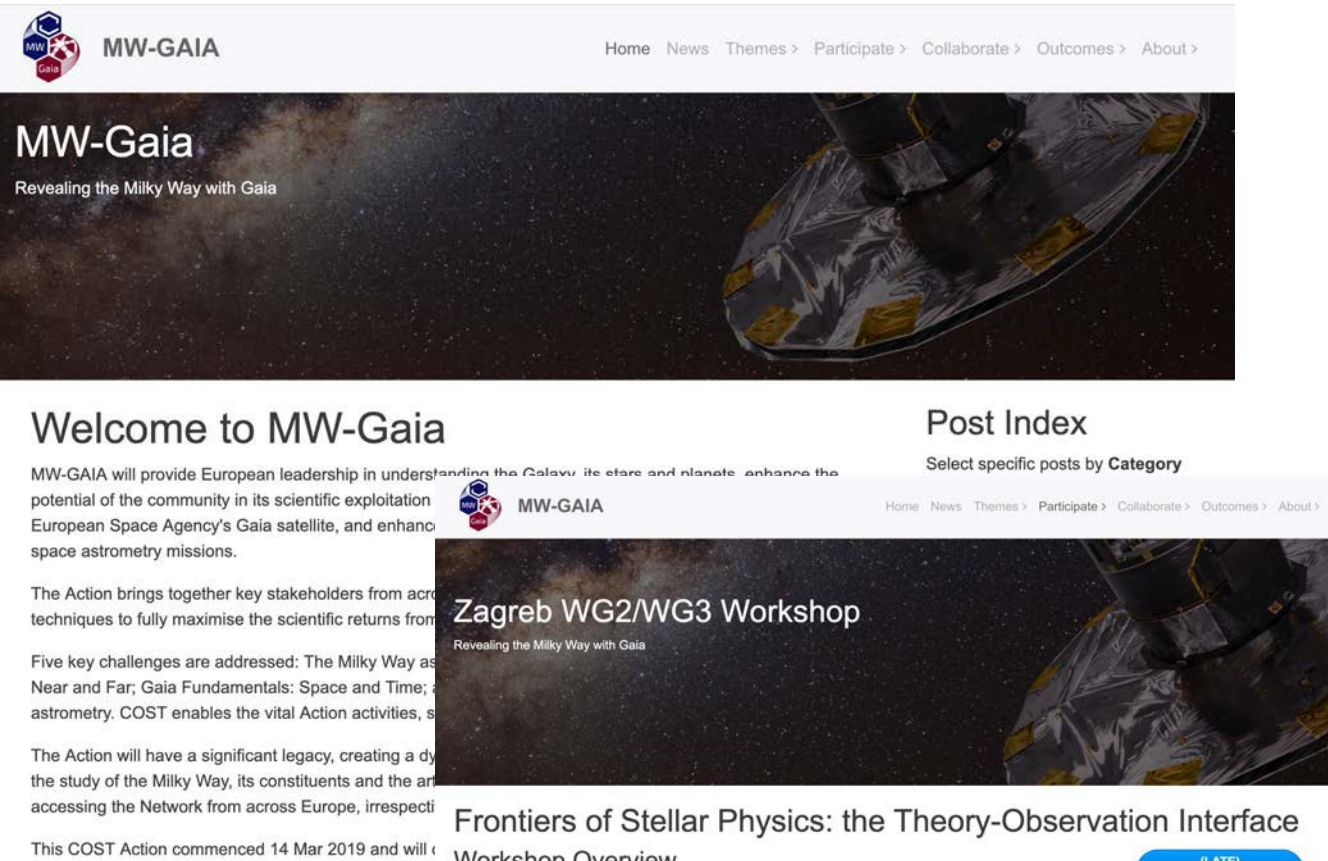
See <http://www.mw-gaia.org> and <http://www.great-esf.eu>





# MW-Gaia: <http://www.mw-gaia.org>

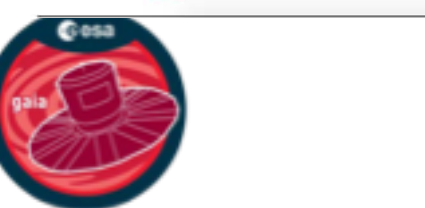
## March 2019 to March (September?) 2023



The screenshot shows the MW-Gaia website homepage. At the top left is the MW-Gaia logo. To its right is the text 'MW-GAIA'. Further right is a navigation menu with links: Home, News, Themes >, Participate >, Collaborate >, Outcomes >, About >. Below the navigation is a large banner image of the Gaia satellite in space. On the left side of the banner, the text reads 'MW-Gaia' and 'Revealing the Milky Way with Gaia'. Below the banner, there is a 'Welcome to MW-Gaia' section with introductory text. To the right of the welcome text is a 'Post Index' section with the heading 'Select specific posts by Category'. Below the post index is a featured article titled 'Zagreb WG2/WG3 Workshop' with a sub-heading 'Revealing the Milky Way with Gaia'. Below the workshop article is another article titled 'Frontiers of Stellar Physics: the Theory-Observation Interface Workshop Overview'. To the right of the workshop article is a blue button that says '(LATE) REGISTRATION PAGE'. Below the workshop article is a circular image of a group of people standing in front of a building. To the right of the circular image is a 'News' section with the text '20200117: new programme and location details added'. Below the news section is a 'Deadline' section with the text 'Registration and Abstract Submission Deadline: Sun 8 Dec 2019.' Below the deadline section is a 'Key Dates' section with a list of dates: 'Deadline for funding support applications: Sun 8 Dec 2019', 'Registration Deadline: Sun 8 Dec 2019', 'Feedback to those requesting financial assistance: Mon 16 Dec 2019.', and 'Publication of Programme:'. At the bottom left of the screenshot is a 'NEWS' section with the MW-Gaia logo and the text 'NEWS'. At the bottom right of the screenshot is a 'GREAT' logo.

- The MW-Gaia COST Action has participants from 29 (over 38) COST countries and participation from groups in Armenia, Canada, China, Lebanon, Russia, South Africa, Ukraine, USA

- Networks a significant proportion of the science community leading studies of the Milky Way including those responsible for ESA's Gaia mission



(LATE) REGISTRATION PAGE

News

20200117: new programme and location details added

Deadline

Registration and Abstract Submission Deadline: Sun 8 Dec 2019.

Key Dates

- Deadline for funding support applications: Sun 8 Dec 2019
- Registration Deadline: Sun 8 Dec 2019
- Feedback to those requesting financial assistance: Mon 16 Dec 2019.
- Publication of Programme:





# Benefit of the MW-Gaia COST Network

## Lead not follow, raise profile of Gaia related science & technology

- Increased science visibility and exposure of Gaia key science
  - Build connections across all of Europe (including central and eastern)
- Opportunities for (especially early stage) researcher networking and 'raising awareness' of their science
  - Training that supplements 'traditional' national PhD research
- Development of further competitive proposals to enable research in key science areas
- Influence instrumentation projects deriving from network initiatives
- Support development of future major space missions (e.g. ESA voyage 2050 programme) → position industry participation in eventual build phase







# MW:Gaia: Working Groups

MW-Gaia is organised into five working groups (WG):

- [WG1: The Milky Way as a Galaxy:](#)
- [WG2: The Life and Death of Stars:](#)
- [WG3: Planetary Systems Near and Far:](#)
- [WG4: Gaia Fundamentals: Space and Time:](#)
- [WG5: Impact, Inclusiveness and Outreach:](#)

Each WG has an organizer, with participants able to signup to the WG mailing list

Each WG is responsible for organizing workshops and training events in its topic area → **get involved, sign up to the mailing lists**





# MW:Gaia: Working Group Leads

(contact details via the [\[www\]](#) click through)

Action Chair: Nicholas Walton (Cambridge: UK) [\[www\]](#)

Action vice-Chair: Carme Jordi (Barcelona: ES) [\[www\]](#)

WG1 Lead: Despina Hatzidimitriou (Athens: GR) [\[www\]](#)

WG2 Lead: Gisella Clementini (Bologna: IT) [\[www\]](#)

WG3 Lead: Joris De Ridder (Leuven: BE) [\[www\]](#)

WG4 Lead: Sonia Anton (Aveiro: PT) [\[www\]](#)

WG5 Lead: Šarūnas Mikolaitis (Vilnius: LT) [\[www\]](#)

Exchange Visit (STSM) Coordinator: Karri Muinonen (Helsinki: FI) [\[www\]](#)

Country Inclusion Coordinator (TA): Ivanka Stateva (Sofia: BG) [\[www\]](#)

Science Communications (SCM): Anthony Brown (Leiden: NL) [\[www\]](#)

Inclusion and Training (ITM): Corinne Charbonnel (Geneva: CH) [\[www\]](#)





# MW-Gaia: WG5

## Impact, Inclusiveness and Outreach

**Objective:** Develop and implement the Action Research Coordination Framework plans, Training Plan, Impact and Inclusion Plan, Outreach and Dissemination Plan. Organise interaction with industry, with schools. Deliver the final Action deliverables and closing conference.

**Tasks: WGT5a:** Deliver Action Impact, primarily through the generation of a science roadmap/case for sub- $\mu$ as astrometry in delivering the next advances in our understanding of the MW (under the leadership of the Action Core Group)

**WGT5b:** Ensure the effective implementation of inclusiveness policies (e.g. location, gender, age) and the Action Inclusion and Impact plan.

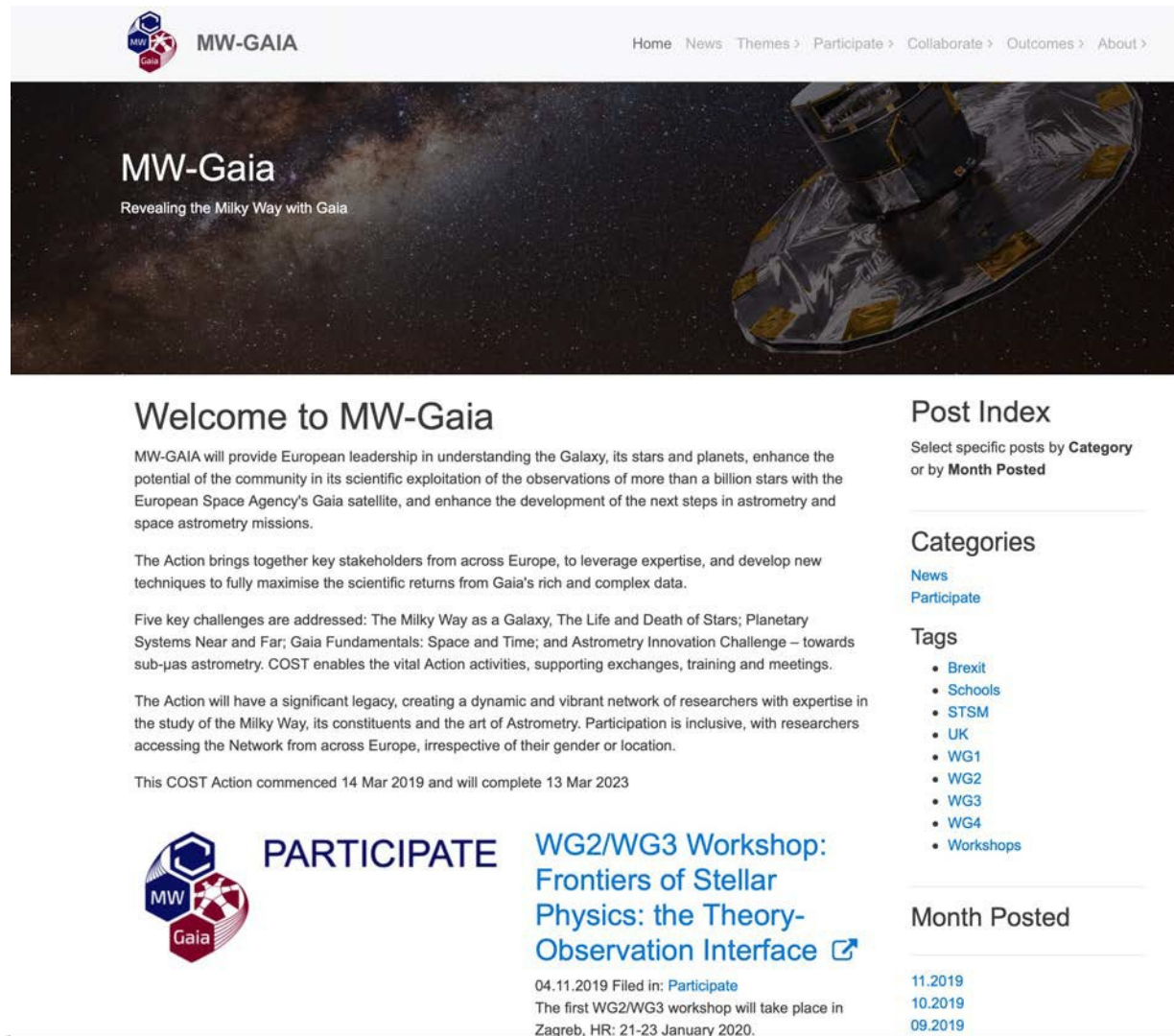
**WG5Tc:** Coordination of the Action outreach and dissemination activities.

**WGT5d:** Training for the next generation of astrometry experts, with a priority focus on including ECIs from ITCs in training activities.



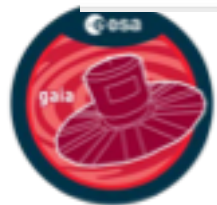


# MW-Gaia: <http://www.mw-gaia.org>



The screenshot shows the MW-Gaia website homepage. At the top left is the MW-Gaia logo. To its right is the text 'MW-GAIA' and a navigation menu with links: Home, News, Themes, Participate, Collaborate, Outcomes, About. Below the navigation is a large banner image of the Gaia satellite in space, with the text 'MW-Gaia' and 'Revealing the Milky Way with Gaia'. The main content area is divided into two columns. The left column has a heading 'Welcome to MW-Gaia' followed by a paragraph about the project's goals, a paragraph about the Action's purpose, a list of five key challenges, a paragraph about the project's legacy, and a note that the COST Action commenced on 14 Mar 2019 and will complete on 13 Mar 2023. The right column has a heading 'Post Index' with a sub-heading 'Select specific posts by Category or by Month Posted', a 'Categories' section with links for 'News' and 'Participate', a 'Tags' section with a list of tags including 'Brexit', 'Schools', 'STSM', 'UK', 'WG1', 'WG2', 'WG3', 'WG4', and 'Workshops', and a 'Month Posted' section with a list of dates: '11.2019', '10.2019', and '09.2019'. At the bottom of the main content area, there is a 'PARTICIPATE' section with a sub-heading 'WG2/WG3 Workshop: Frontiers of Stellar Physics: the Theory-Observation Interface' and a brief description of the workshop.

- The MW-Gaia COST Action now well underway (in spite of covid-19)
- Check the website for details of network activities
- Workshops, schools
- Open calls for exchange visits, grant for conferences





Brought to you by the GENIUS project

EN • FR • DE • IT • ES • CA • SL • JA • MK • HR • EL • EU • PT

Choose your community!

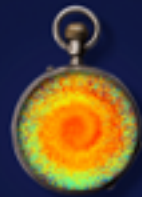
NEWS

## GAIA MEMORY GAME

You want to train your memory? Gaia mission can help you with that while having fun!!



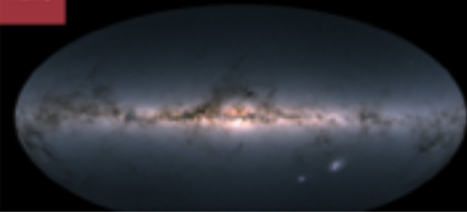
NEWS



### Gaia detects a shake in the Milky Way

Gaia data help to discover substructures which were unknown so far in the Milky Way.

NEWS



### Gaia creates richest star map of our Galaxy – and beyond

ESA's Gaia mission has produced the richest star catalogue to date, including high-precision measurements of nearly 1.7 billion stars

TWITTER

Gaiaverse

Follow

ESAGaia

RT @ESAGaia: #GaiaDR2 will be made possible by #OPAC (https://t.co/UmEhKLUZ) and our ESA Gaia teams, all still working hard on getting th...

esascience

RT @esascience: Save the date: Three months from today, on 25 April 2018, @ESAGaia will release its long-awaited map of positions, distance...

rdrimmel

RT @rdrimmel: The upcoming #Triton #occultation is brought to you thanks to @ESAGaia. (#GaiaMission #GaiaDR2 antipeta.) https://t.co/3AKR...

rdrimmel

RT @rdrimmel: #Triton #occultation, as seen by

RESOURCES



ACCESS TO GAIA ARCHIVE

GO TO THE OFFICIAL GAIA MISSION WEBSITE

BLOG

Latest Post

### Gaia-GOSA, an interactive tool for ground-based observations

Gaia-Groundbased Observation Service for Asteroids (Gaia-GOSA), a tool that let users behave as team members of the Gaia mission.

29 Sep 2015 Toni Santana-Ries

<https://gaiaverse.eu/>





## Contents of Gaia DR3

Data Product	No. of sources	Comments
Astrometry	1.8 billion	Same as Gaia EDR3
G/BP/RP photometry	1.8 billion	Same as Gaia EDR3
Radial velocities	~30 million	$G_{RVS} \lesssim 14$
Photometric variability: classification, characterization, light curves	7+ million	Includes eclipsing, (MS) pulsating, transients, spotted, flaring, evolved pulsators, and quasars
Source Classification and astrophysical parameters	$\gtrsim 300$ million	based on the BP/RP/RVS spectra, magnitude limit TBD
<i>Mean</i> BP/RP/RVS spectra	TBD subset	





## Contents of Gaia DR3

Data Product	No. of sources	Comments
Solar system objects epoch astrometry/photometry	$\geq 100,000$	including orbit solutions
Solar system objects mean BP/RP reflectance spectra	$\sim 5000$	
Catalogue of astrometric, spectroscopic, eclipsing non-single stars	TBD	Combined solutions where possible
QSO host and galaxy morphological characterization	TBD	Based on input list
G/BP/RP photometry light curves for all sources in $5.5^\circ$ radius field centred on M31	$\sim 1.1$ million	Includes variable and non-variable sources





# Contents of Gaia DR3

## Astrometric non-single star solution types

- acceleration, 7 and 9 parameters
- orbital solutions, 12 parameters
- stochastic solutions
  - ▶ single star source model or basic binary star model does not fit
- NOTE: no epoch astrometry or epoch radial velocities will be released as part of Gaia DR3

## Astrophysical parameters based on BP/RP/RVS spectra

- $T_{\text{eff}}$ ,  $\log g$ ,  $A_G$ ,  $E(G_{BP} - G_{RP})$ , metallicity, abundances, distances, radii, masses, activity index
  - ▶ solutions from multiple algorithms will be provided
  - ▶ rotational velocity for bright subset of stars (TBC)
- Extinction map
- Source classification (star, binary, galaxy, . . . )

## Mean BP/RP/RVS spectra

- For subset of sources only
- Tool to handle BP/RP spectra will be provided

## Solar system objects

- Orbits
- Reflectance spectra

## QSO hosts and galaxies

- Morphological characterization

## Light curves for field around M31

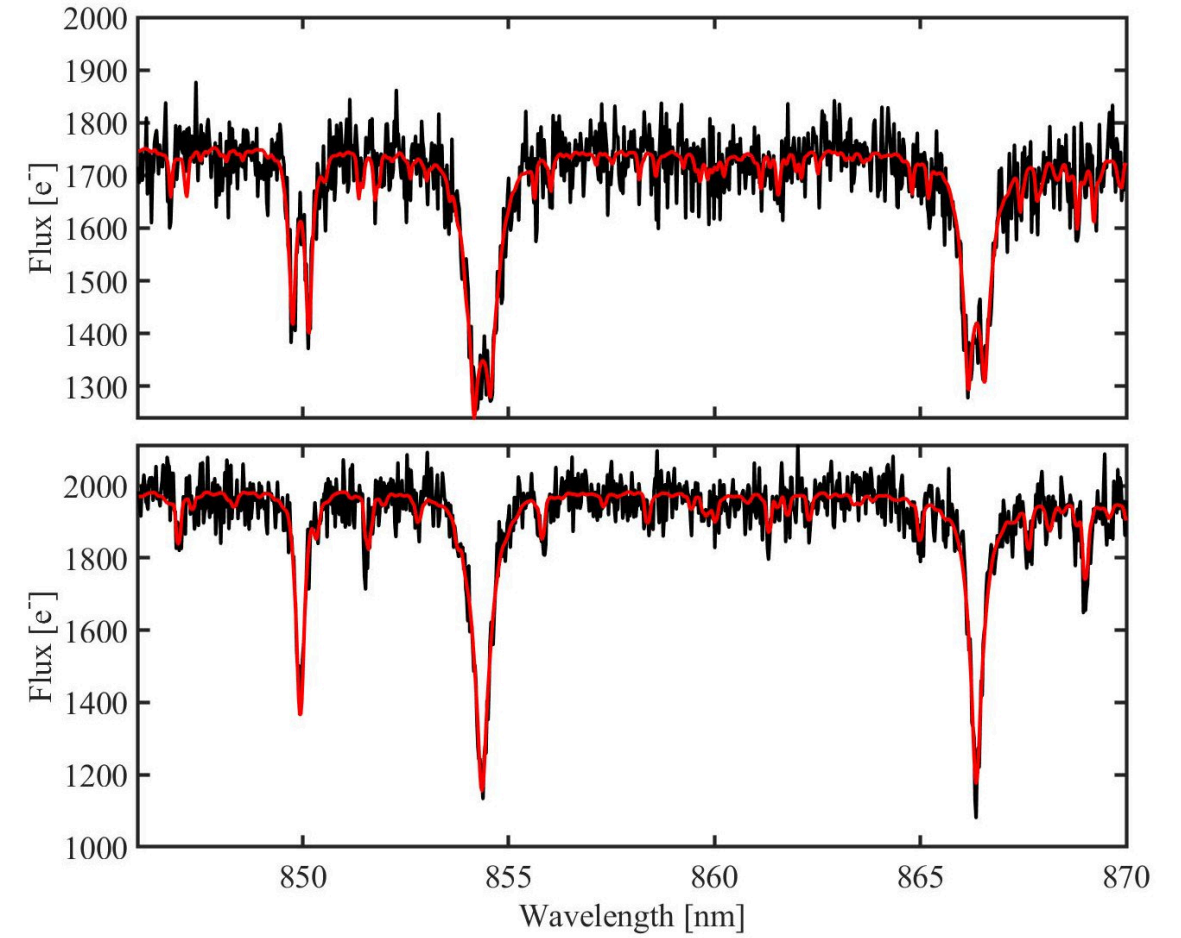
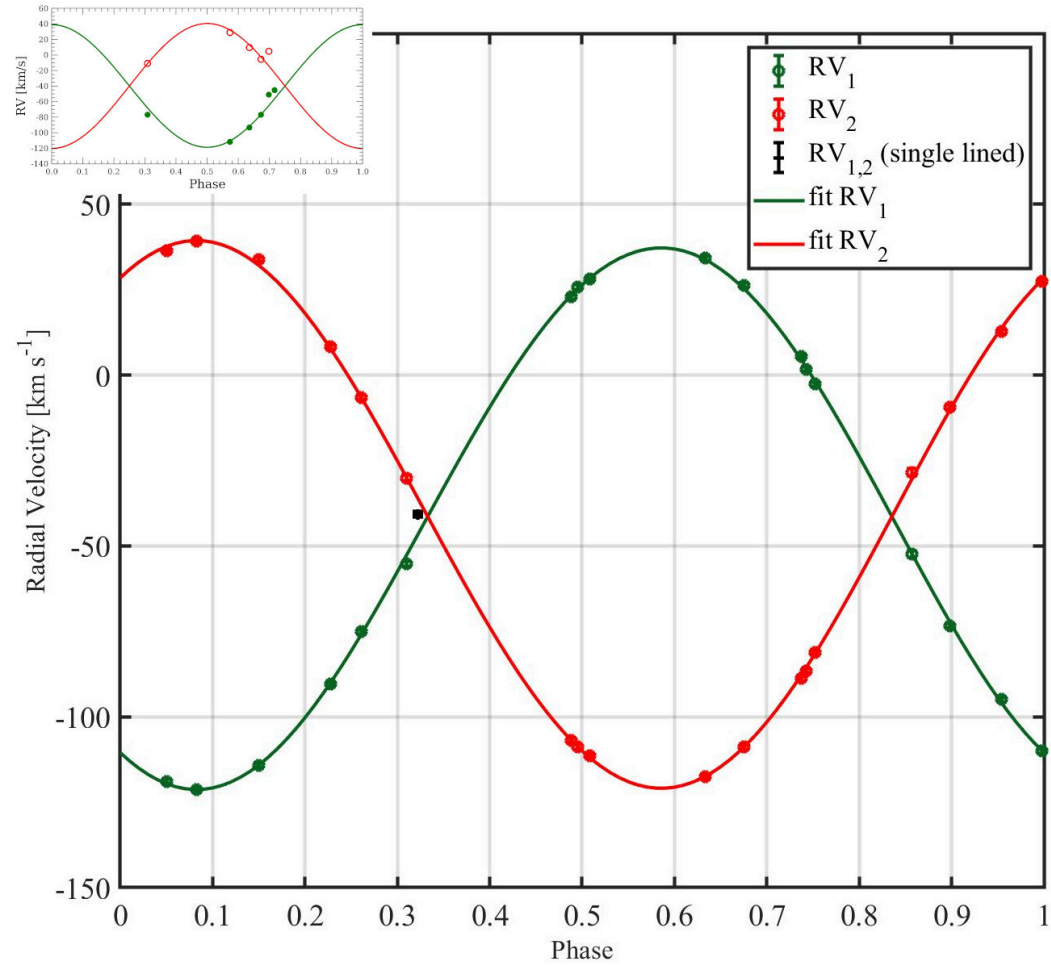
- Preview of Gaia DR4 epoch photometry







# Double lined spectroscopic binary

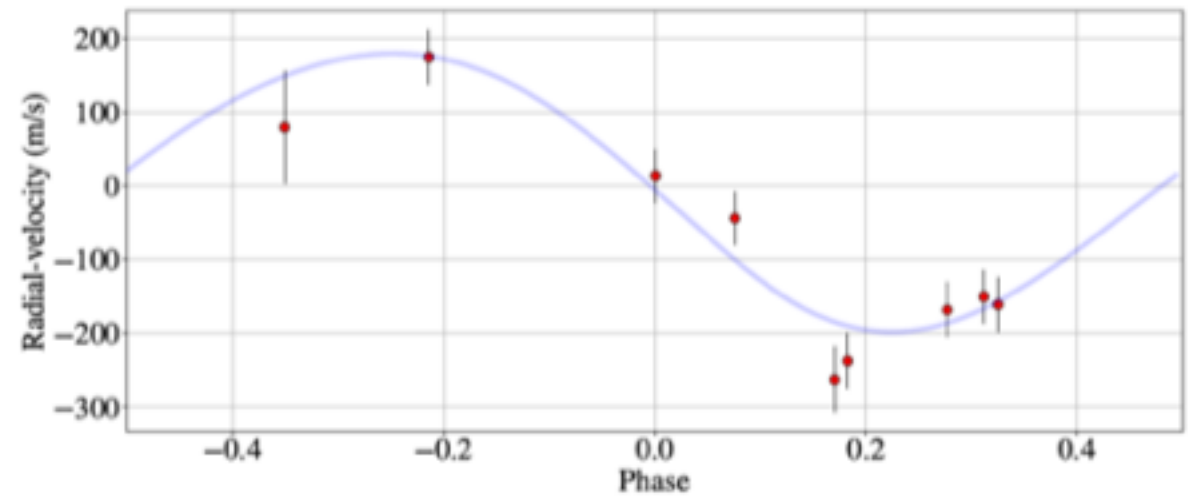
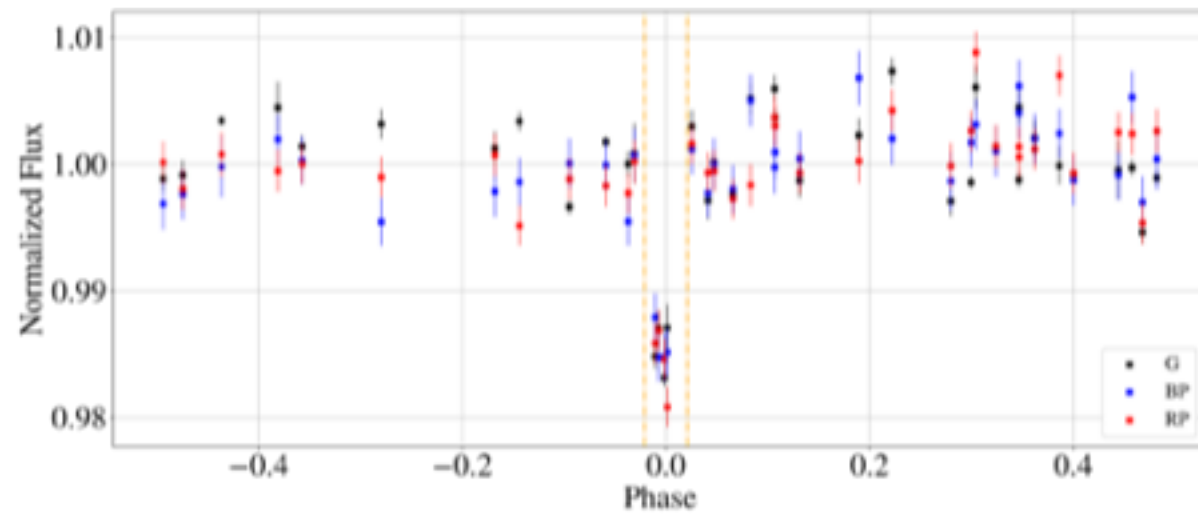
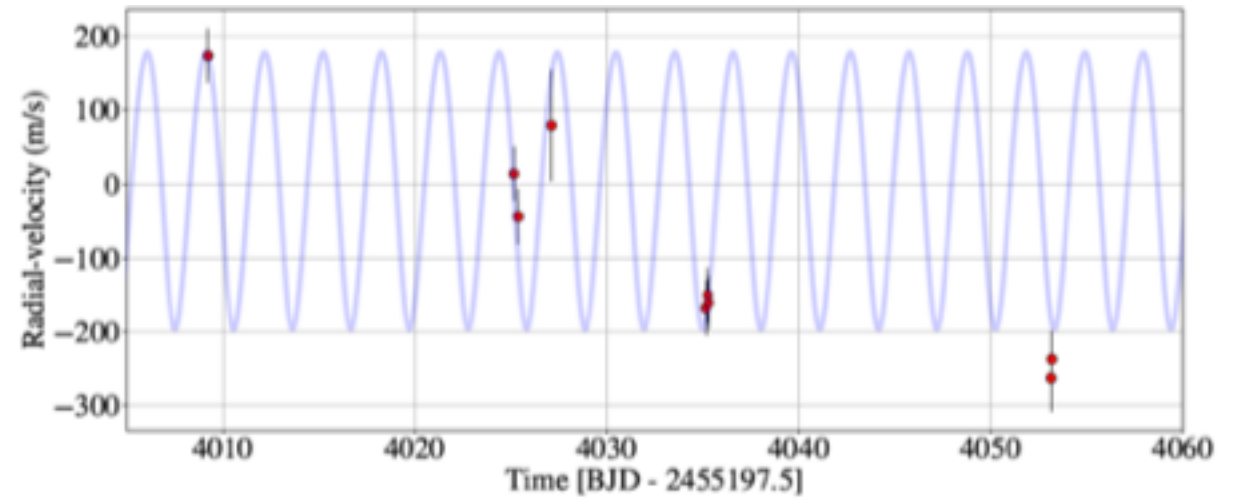
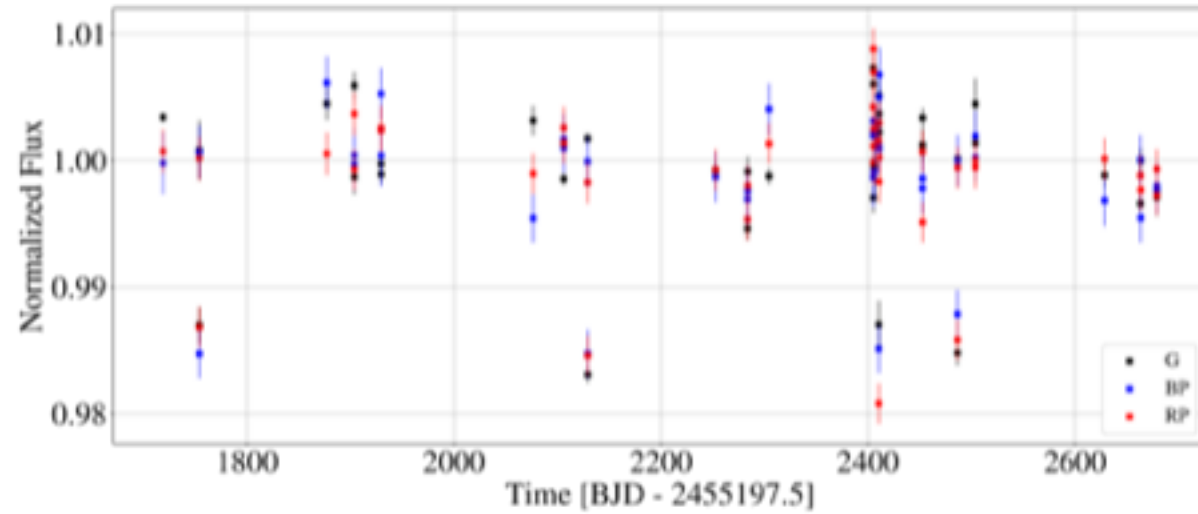


[https://www.cosmos.esa.int/web/gaia/iow\\_20210427](https://www.cosmos.esa.int/web/gaia/iow_20210427)





# First Transiting Exoplanet by Gaia

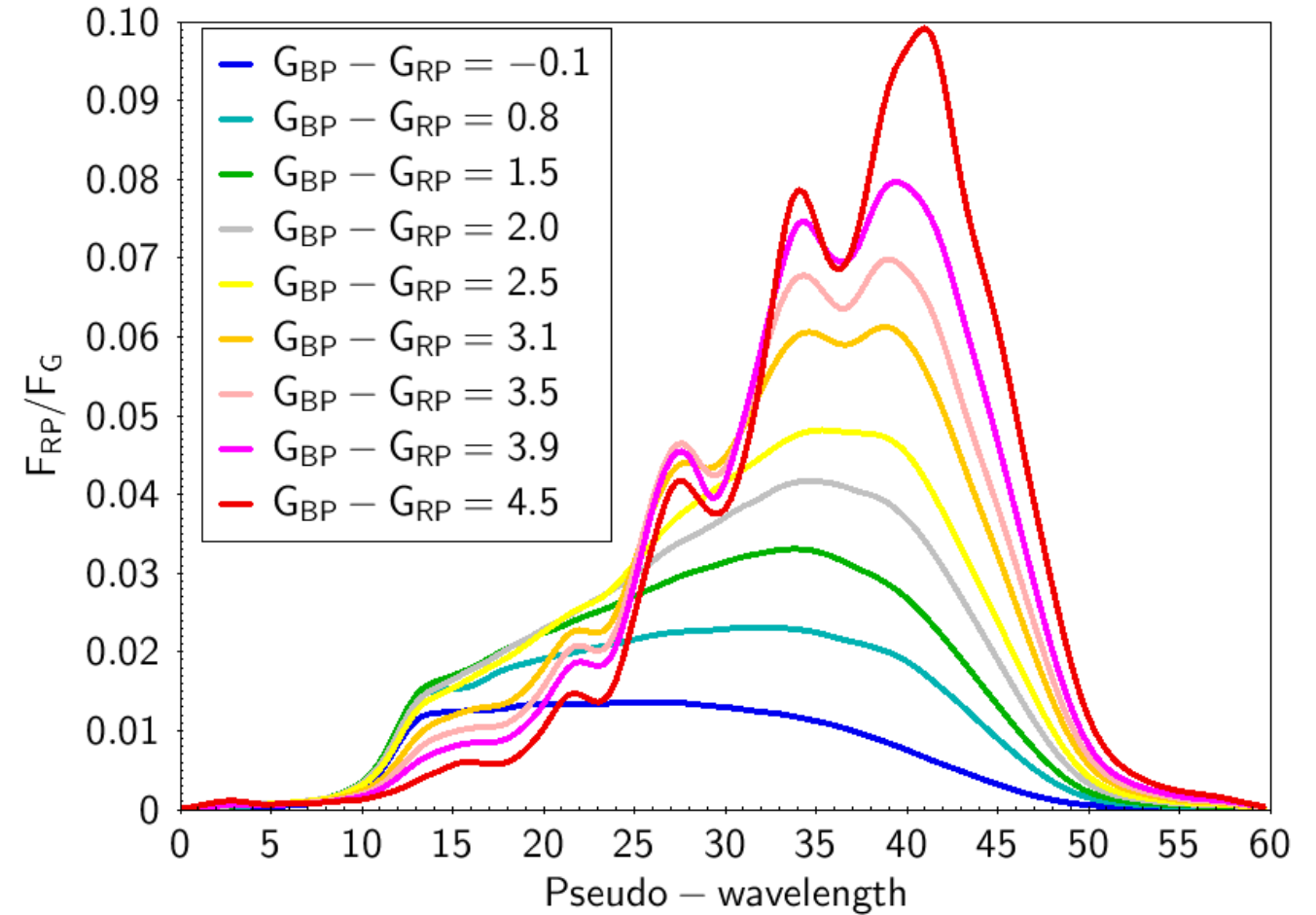
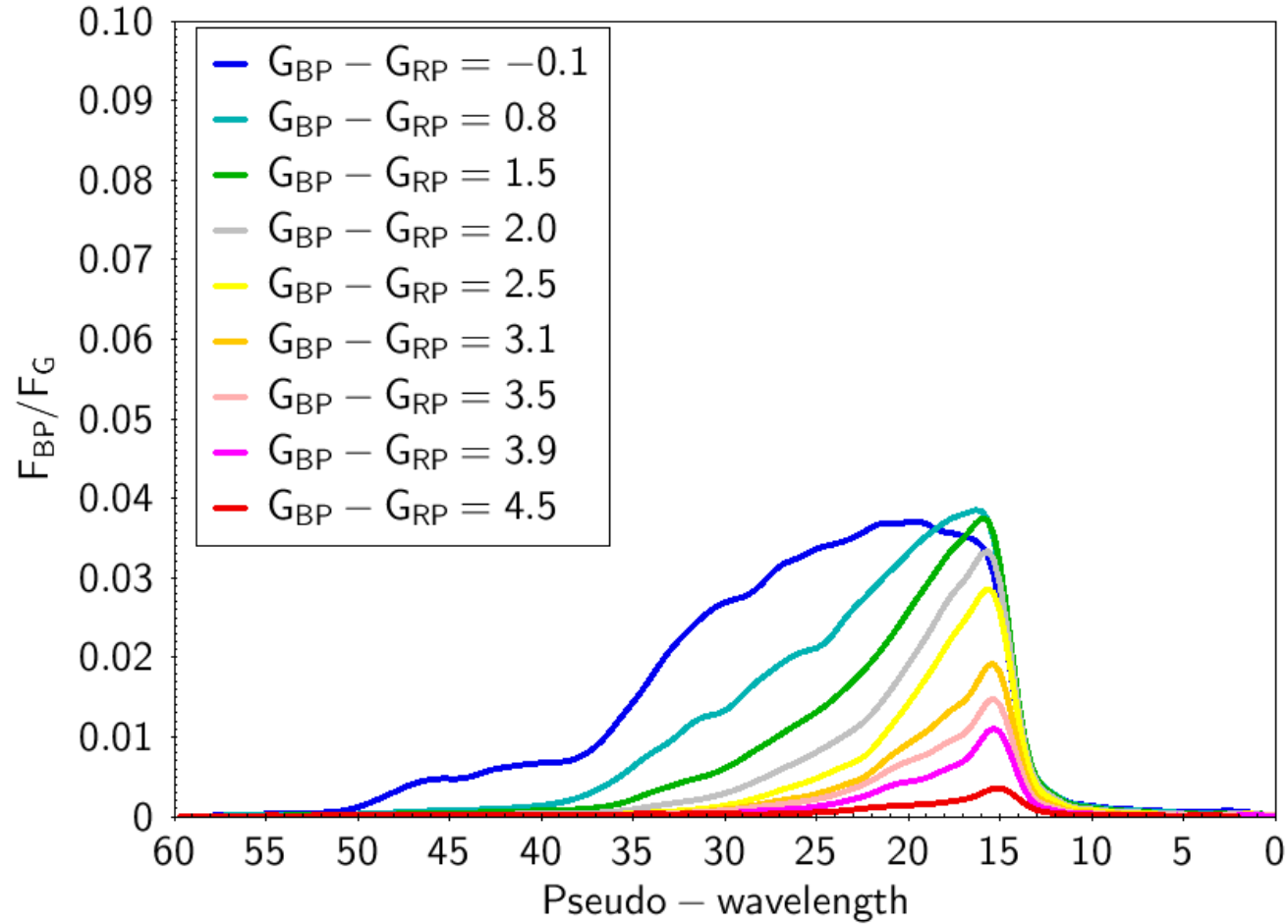


[https://www.cosmos.esa.int/web/gaia/iow\\_20210330](https://www.cosmos.esa.int/web/gaia/iow_20210330)





# First calibrated XP spectra



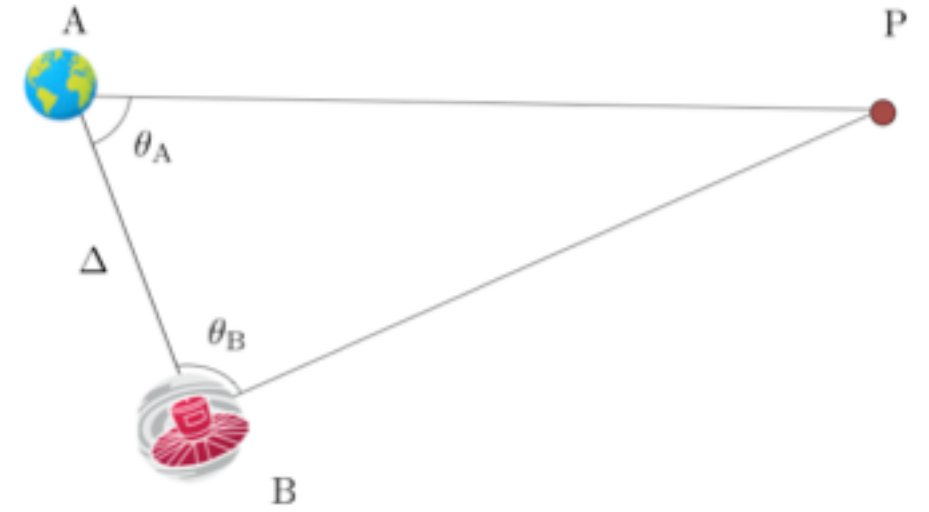
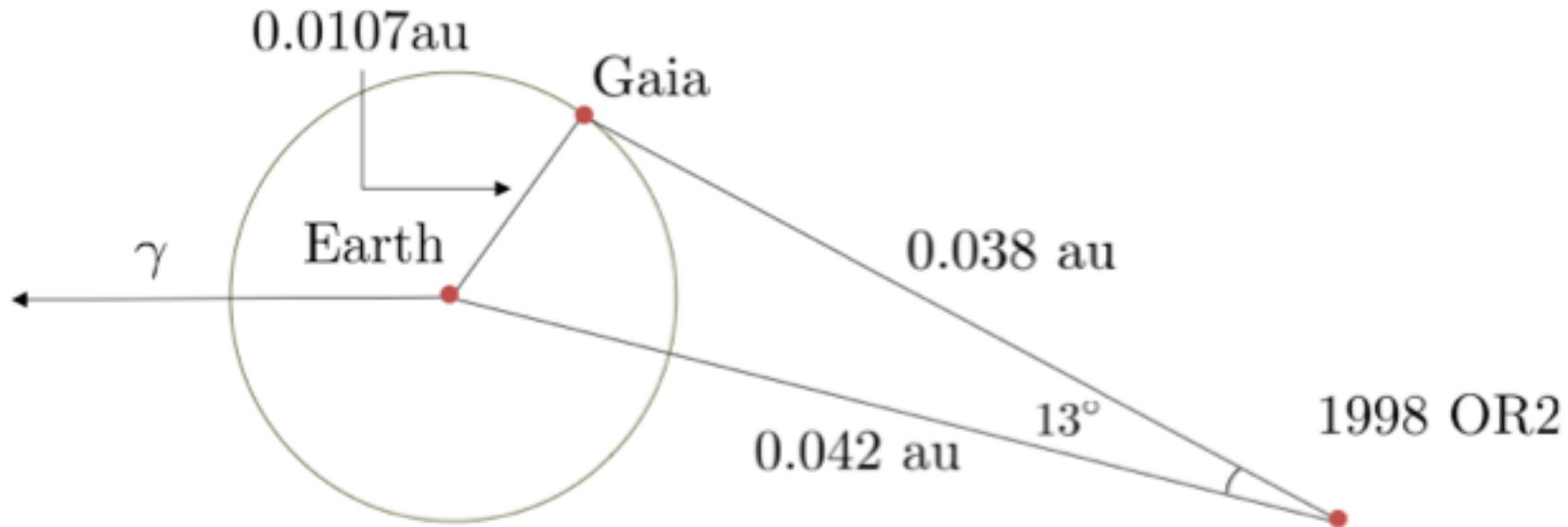
[https://www.cosmos.esa.int/web/gaia/iow\\_20200812](https://www.cosmos.esa.int/web/gaia/iow_20200812)





# Gaia and the size of the Solar system

Geometric configuration during the Gaia observation of 1998 OR2 on 28 April 2020



[The Solar Parallax with Gaia / GAIA-C4-TN-OCA-FM-061](#)





**GREAT/MW-Gaia Plenary 14 @ EAS 2021:**

**=> register for Gaia Symposium S15 at**

**<https://eas.unige.ch/EAS2021/registration.jsp>**

Credit: ESA/Gaia/DPAC



**MW-Gaia: <http://www.mw-gaia.org>**

