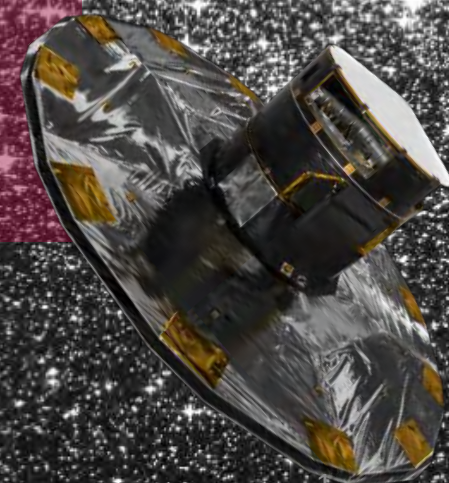


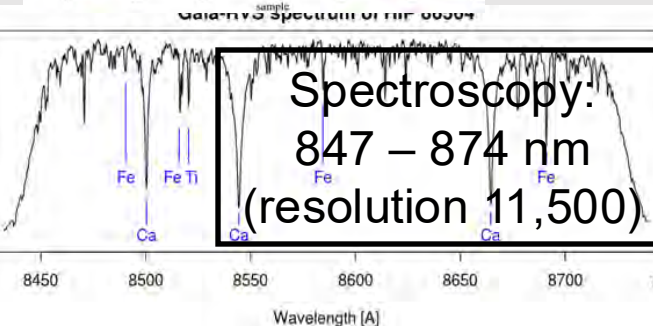
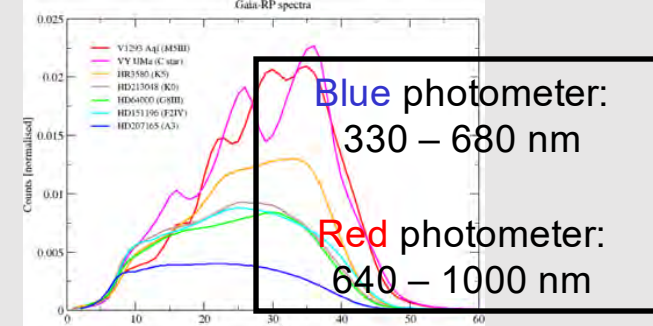
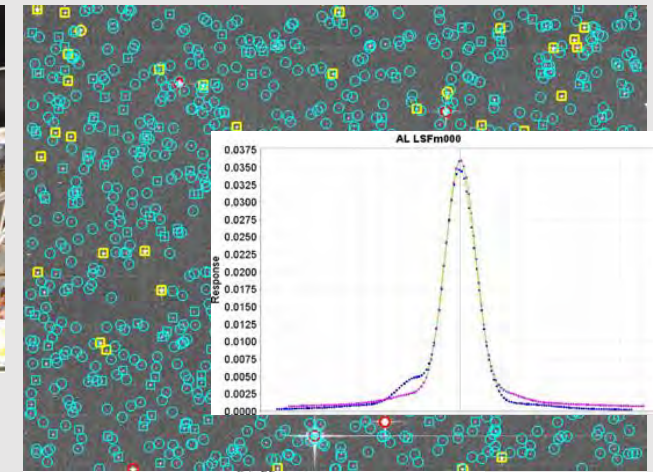
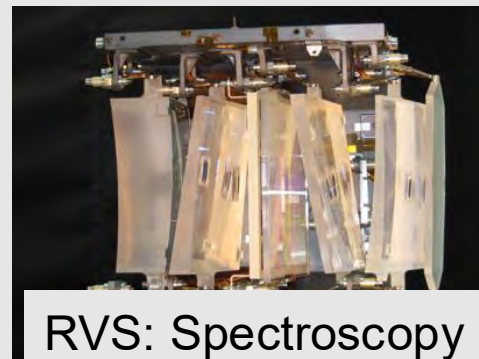
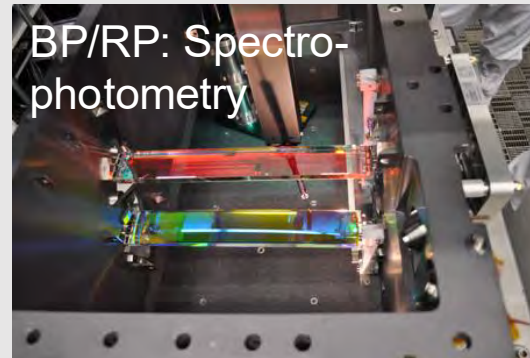
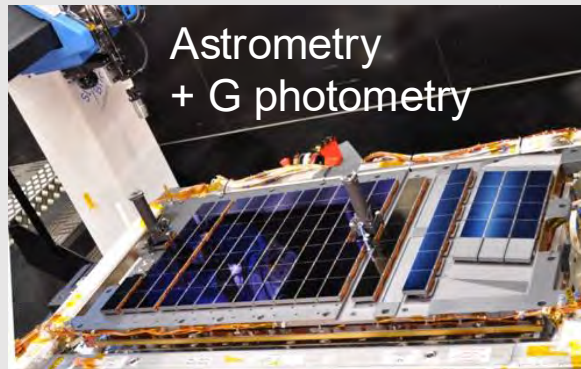
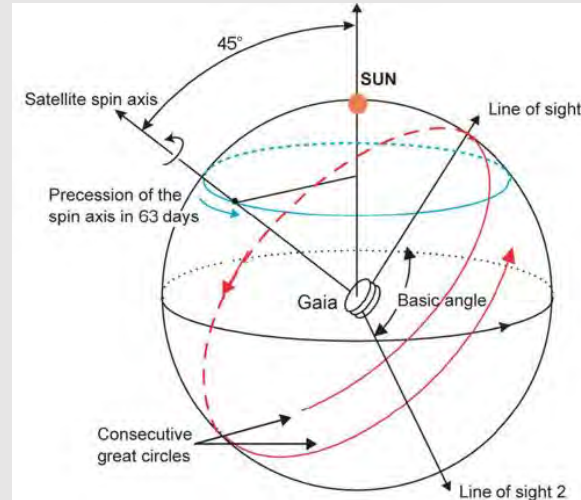
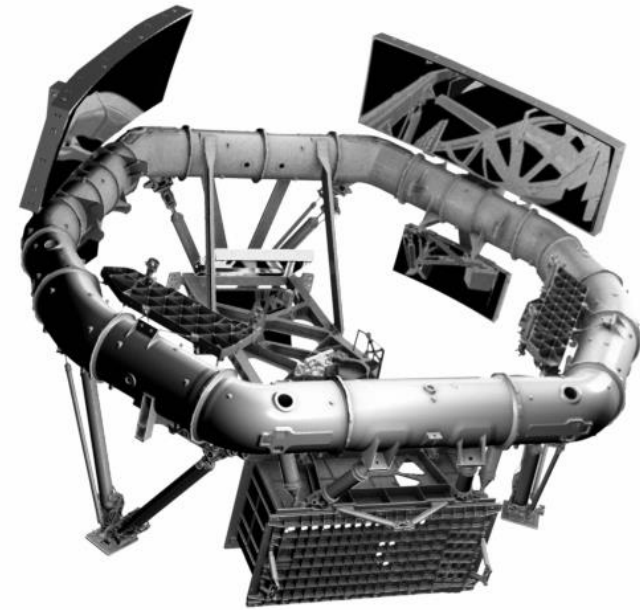


Gaia: Mission and Status

Nicholas Walton
Institute of Astronomy
University of Cambridge



The Gaia Payload Instruments



- Astrometry and spectrophotometry for > 2 billion objects (~1.8 billion in Data Release 3)
- Radial velocities for > 100 million objects
- Survey complete to $G=20.7$ ($V=20-22$)
- Observing programme autonomous with onboard detection and unbiased
- Quasi regular time sampling (~ 70 obs in 5 yrs)
- Launched Dec 2013
- 10+ years of operation at L2: final data release ~2030

In flight operations ended 15 Jan 2025

SKY-SCANNING COMPLETE FOR ESA'S MILKY WAY MAPPER GAIA

From 24 July 2014 to 15 January 2025, Gaia made more than three trillion observations of two billion stars and other objects, which revolutionised the view of our home galaxy and cosmic neighbourhood.

3 TRILLION
Observations

2 BILLION
Stars & other objects observed

938 MILLION
Camera pixels on board

15 300
Spacecraft 'pirouettes'

55 KG
Cold nitrogen gas consumed

580 MILLION
Accesses of Gaia catalogue so far

3827
Days in science operations

50 000 HOURS
Ground station time used

13 000
Refereed scientific publications so far

2.8 MILLION
Commands sent to spacecraft

142 TB
Downlinked data (compressed)

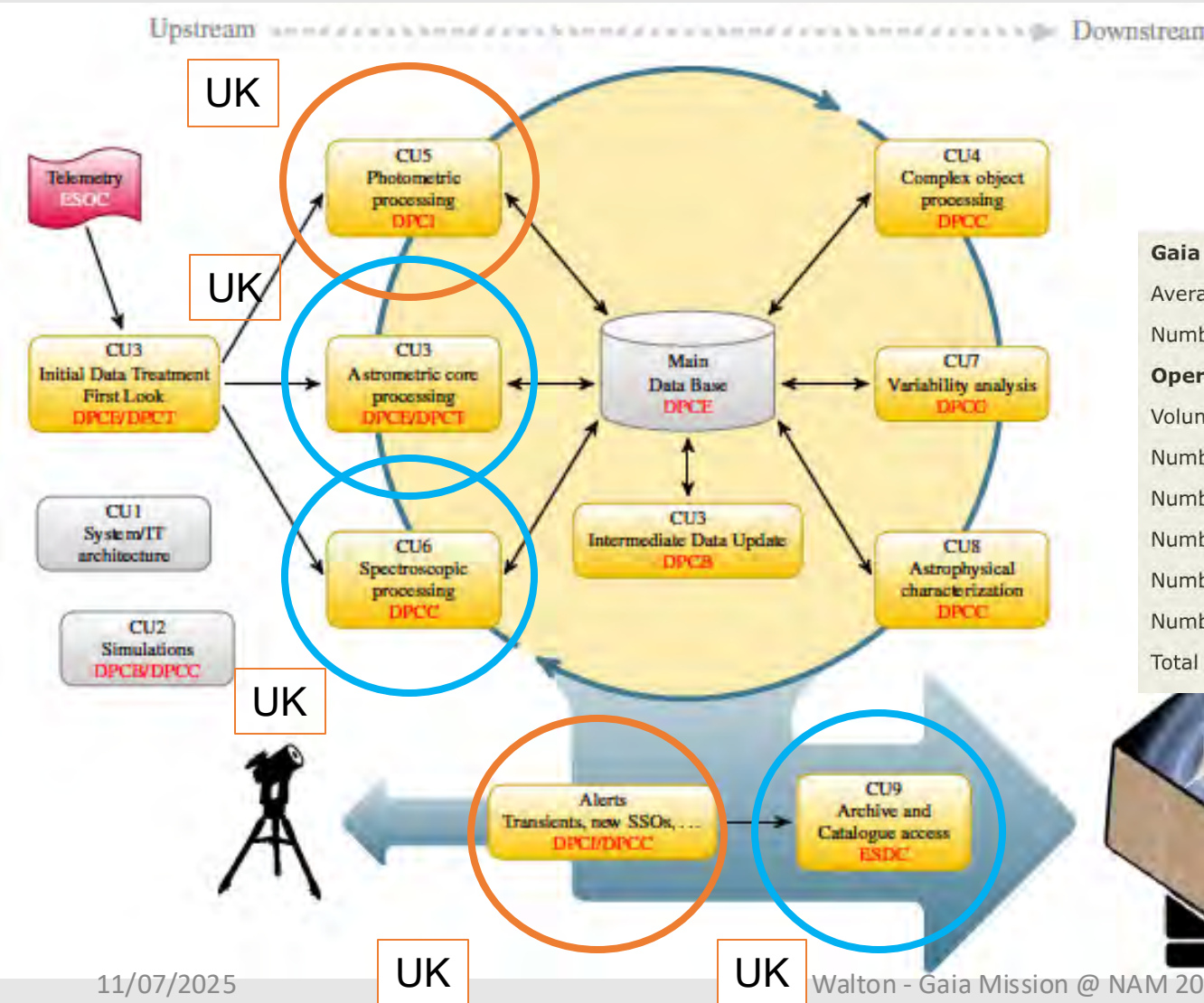
500 TB
Volume of data release 4
(5.5 years of observations)



Gaia: Processing is complex

a pan European effort

Gaia:UK at www.gaia.ac.uk



Significant UK involvement:
Cambridge Gaia Data Processing Centre
Lead Photometric processing and Flux alerts
Contribute to pre-processing, RVS, archive

Gaia science observation phase	
Average distance of Gaia space telescope from Earth (in km)	1,510,000
Number of days in science operations (25 July 2014 - 15 January 2025)	3827
Operational data collected	
Volume of science data collected (in GB)	141,064
Number of object transits through the focal plane	267,356,167,925
Number of astrometric CCD measurements	2,635,367,940,969
Number of photometric CCD measurements	530,852,459,518
Number of object transits through the RVS instrument	17,476,697,079
Number of spectroscopic CCD measurements	52,066,956,051
Total number of CCD measurements (astrometric + photometric + spectroscopic)	3,218,287,356,538

3.2 Trillion observations
made during the 3827
days of inflight operations!

The People Behind Gaia Data Releases

Gaia UK responsible for the processing and analysis of the photometric data, the spectrophotometric data, photometric science alerts and with essential contributions to the spectroscopic data

GAIA DATA PROCESSING AND ANALYSIS CONSORTIUM



Austria
Belgium
Croatia
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary

Italy
Poland
Portugal
Slovenia
Spain
Sweden
Switzerland
The Netherlands
United Kingdom

With small contributions from:

Brazil, Chile, China, Israel, USA,
Southern Observatory



Gaia
AC

DPAC8 @ Cambridge
Excited to bring Gaia
DR4/5 to the World



The Gaia Team in the UK: Bringing Gaia data to the community



Cambridge, Edinburgh, University College London, Leicester, Bristol

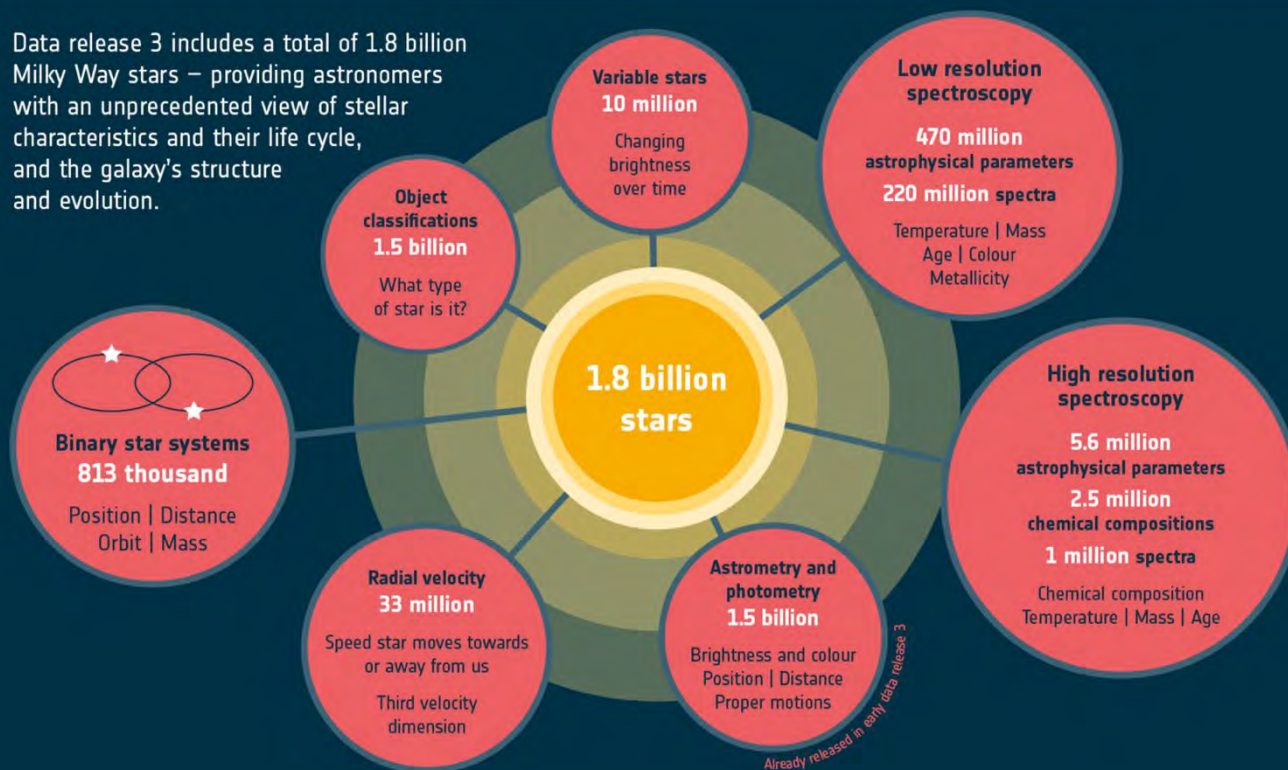
Gaia: Currently at Release Gaia DR3

Gaia data leads to insight across astrophysics



MILKY WAY STARS

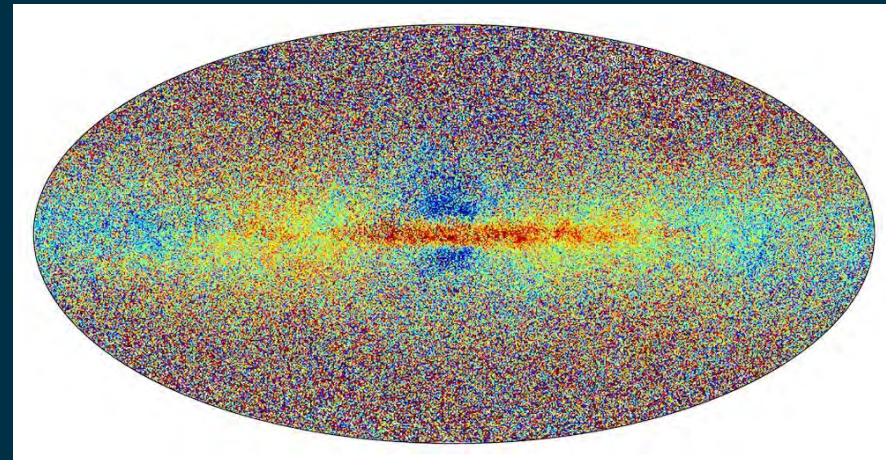
Data release 3 includes a total of 1.8 billion Milky Way stars – providing astronomers with an unprecedented view of stellar characteristics and their life cycle, and the galaxy's structure and evolution.



Over 3.2 Trillion observations

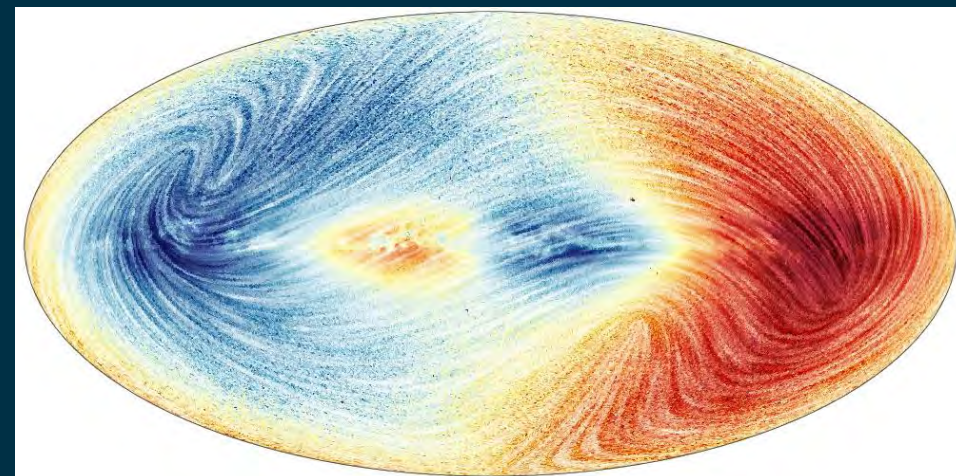


Gaia EDR3/ DR3: with larger to come



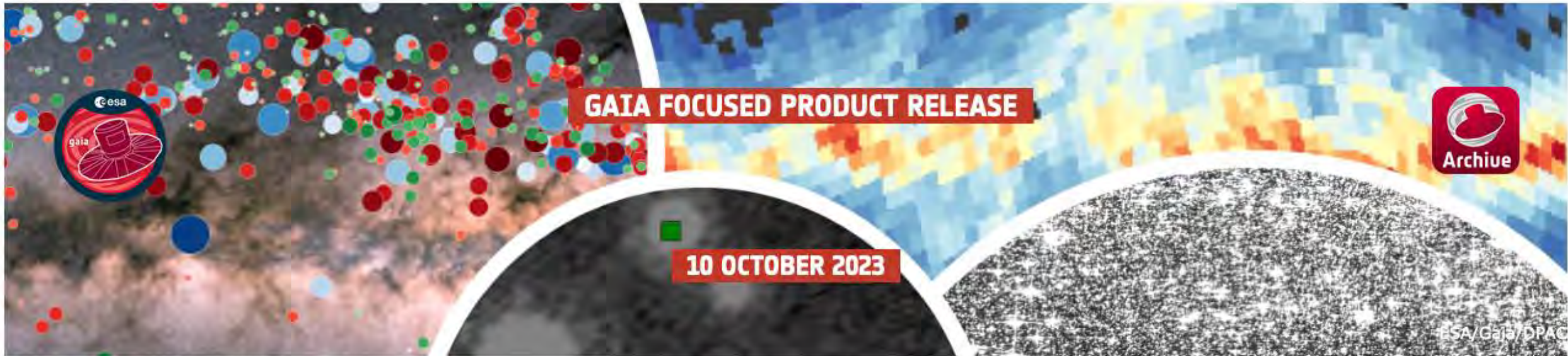
Credit: ESA/ Gaia/ DPAC

Stellar abundances



Stellar velocities

Credit: ESA/
Gaia/ DPAC



GAIA FPR CONTENTS

Information on the contents of Gaia's Focused Product Release.

GAIA FPR PAPERS

The papers describing the data processing and verifying the science performance of Gaia's Focused Product Release.

GAIA FPR DOCUMENTATION

Data release documentation for Gaia FPR. The [Gaia FPR data model](#) is contained inside. Also published as [PDF](#).

GAIA FPR DATA RELEASE EVENTS

Overview of the Gaia events for the Focused Product Release.

PYTHON ACCESS

Gaia data can be accessed using Python

TUTORIALS AND HELP

Help is available to guide you through the

GAIA DATA CREDITS


When using Gaia FPR data, please

GAIA FPR KNOWN ISSUES

The known issues for Gaia FPR. If you find an

Sampling Gaia's Science

14,000 peer reviewed papers to date: Gaia is ESA's most productive space science mission




SCIENCE & EXPLORATION

Hubble investigates a magnetar's birthplace

15/04/2025 903 VIEWS 14 LIKES

READ →




ENABLING & SUPPORT

Farewell, Gaia! Spacecraft operations come to an end

27/03/2025 37153 VIEWS 132 LIKES

READ →




SCIENCE & EXPLORATION

Wobbling stars reveal hidden companions in Gaia data

04/02/2025 8914 VIEWS 57 LIKES

READ →

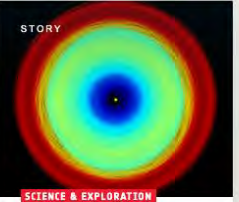


SCIENCE & EXPLORATION

Last starlight for ground-breaking Gaia

15/01/2025 22338 VIEWS 74 LIKES

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SCIENCE & EXPLORATION

Gaia spots possible moons around hundreds of asteroids

08/09/2024 7892 VIEWS 63 LIKES

READ →




ENABLING & SUPPORT

Double trouble: Gaia hit by micrometeoroid and solar storm

17/07/2024 23888 VIEWS 181 LIKES

READ →




SCIENCE & EXPLORATION

Scientists spot hidden companions of bright stars

20/06/2024 3220 VIEWS 15 LIKES

READ →




SCIENCE & EXPLORATION

Gaia: Milky Way's last major collision was surprisingly recent

06/06/2024 8379 VIEWS 47 LIKES

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SCIENCE & EXPLORATION

Sailing among the stars – Gaia's role in discovering distant stars

22/04/2024 2932 VIEWS 17 LIKES

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SCIENCE & EXPLORATION

Sleeping giant surprises Gaia scientists

16/04/2024 33041 VIEWS 69 LIKES

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SCIENCE & EXPLORATION

Gaia unravels the ancient threads of the Milky Way

21/03/2024 15010 VIEWS 58 LIKES

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SCIENCE & EXPLORATION

Gaia's decade of discoveries: unravelling the intricacies of the Milky Way

19/12/2023 15420 VIEWS 128 LIKES

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SCIENCE & EXPLORATION

New Gaia release reveals rare lenses, cluster cores and unknown objects

10/10/2023 24701 VIEWS 95 LIKES

READ →




SCIENCE & EXPLORATION

Wobbling star found in Gaia-Hipparcos data confirmed to host planets

13/04/2023 9753 VIEWS 139 LIKES

READ →




SCIENCE & EXPLORATION

Gaia discovers a new family of black holes

30/03/2023 39349 VIEWS 170 LIKES

READ →




ENABLING & SUPPORT

Amateur astronomers needed: help classify stars with Gaia's data

21/03/2023 15674 VIEWS 240 LIKES

READ →




ENABLING & SUPPORT

Shadow hunters capture Didymos asteroid eclipsing stars

20/10/2022 4548 VIEWS 80 LIKES

READ →

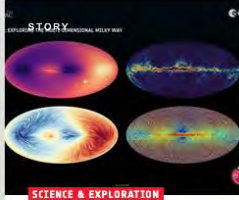


SCIENCE & EXPLORATION

Gaia reveals the past and future of the Sun

11/08/2022 35768 VIEWS 193 LIKES

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SCIENCE & EXPLORATION

Gaia sees strange stars in most detailed Milky Way survey to date

13/06/2022 80791 VIEWS 176 LIKES

READ →




SCIENCE & EXPLORATION

Watch live: first impressions of Gaia data release 3

13/06/2022 80791 VIEWS 176 LIKES

READ →




SCIENCE & EXPLORATION

Jupiter's moon Europa to obscure distant star

13/06/2022 80791 VIEWS 176 LIKES

READ →




SCIENCE & EXPLORATION

Media invitation: new details about our Milky Way in the third Gaia data release

13/06/2022 80791 VIEWS 176 LIKES

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SCIENCE & EXPLORATION

Gaia finds parts of the Milky Way much older than expected

13/06/2022 80791 VIEWS 176 LIKES

READ →




SCIENCE & EXPLORATION

Gaia snaps photo of Webb at L2

13/06/2022 80791 VIEWS 176 LIKES

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SCIENCE & EXPLORATION

Gaia reveals that most Milky Way companion galaxies are new

13/06/2022 80791 VIEWS 176 LIKES

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SCIENCE & EXPLORATION

Is the nearest star cluster to the Sun being destroyed?

24/03/2021 18267 VIEWS 123 LIKES

READ →



SCIENCE & EXPLORATION

Gaia's new data takes us to the Milky Way's anticentre and beyond

03/12/2020 122215 VIEWS 400 LIKES

READ →

See [https://www.esa.int/Science_Exploration/Space_Science/Gaia/\(archive\)/0](https://www.esa.int/Science_Exploration/Space_Science/Gaia/(archive)/0)

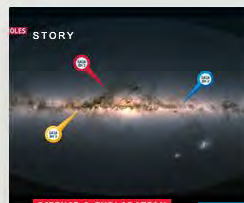
Sampling Gaia's Science



Hubble investigates a magnetar's birthplace

15/04/2025 903 VIEWS 14 LIKES

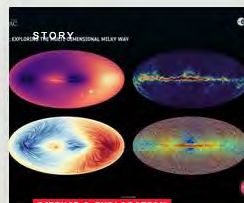
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Sleeping giant surprises Gaia scientists

16/04/2024 33041 VIEWS 69 LIKES

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Gaia sees strange stars in most detailed Milky Way survey t...

13/06/2022 80791 VIEWS 176 LIKES

READ

GAIA: BLACK HOLES

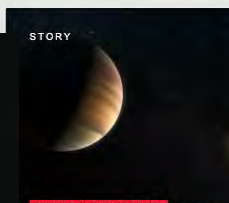


GAIA BH 1

GAIA BH 2

GAIA BH 3

Gaia BH3: 33 solar masses, heaviest black hole of stellar origin



Sailing among the stars - Gaia's role in discovering distant...

22/04/2024 2932 VIEWS 17 LIKES

READ



Gaia reveals the past and future of the Sun

11/08/2022 35768 VIEWS 193 LIKES

READ



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Gaia snaps photo of Webb at L2

Gaia reveals that most Milky Way companion galaxies are new...

Is the nearest star cluster to the Sun being destroyed?

24/03/2021 18267 VIEWS 123 LIKES

READ

See [https://www.esa.int/Science_Exploration/Space_Science/Gaia/\(archive\)/0](https://www.esa.int/Science_Exploration/Space_Science/Gaia/(archive)/0)

Before Gaia



NASA/JPL-Caltech/R. Hurt (SSC/Caltech)

The morphology of the
Milky Way:
We now see that it's
more complex than we
thought!



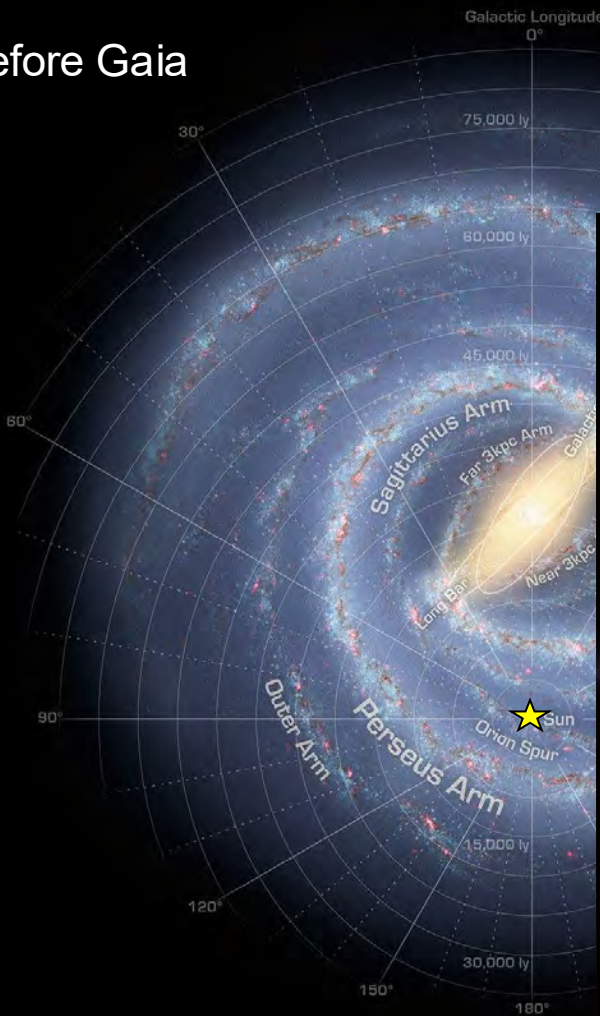
With Gaia



Artistic impression of the Milky Way - face-on, based on the latest Gaia data.
Credits: ESA/Gaia/DPAC, Stefan Payne-Wardenaar - CC BY-SA 3.0 IGO

The morphology of the Milky Way: it's way more complex!

Before Gaia

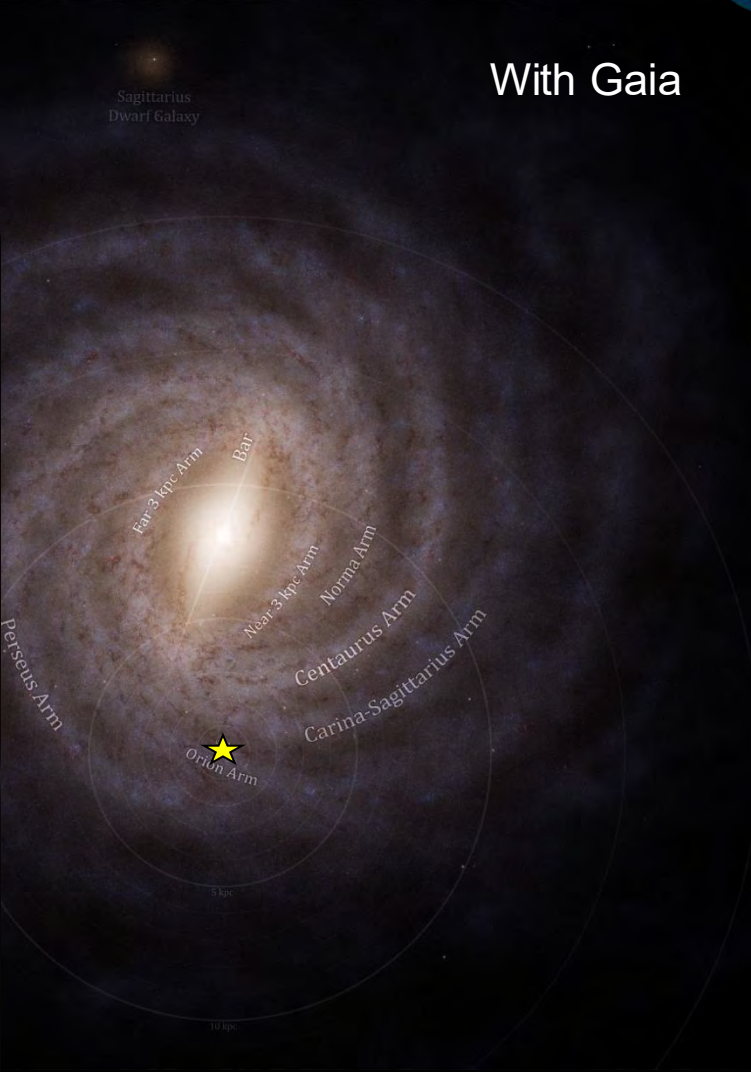


NASA/JPL-Caltech/R. Hurt (SSC/Caltech)



Artistic impression of the Milky Way - edge-on
Credits: ESA/Gaia/DPAC, Stefan Payne-Wardenaar - CC BY-SA 3.0 IGO

With Gaia



Artistic impression of the Milky Way - face-on, based on the latest Gaia data.
Credits: ESA/Gaia/DPAC, Stefan Payne-Wardenaar - CC BY-SA 3.0 IGO

https://www.esa.int/Science_Exploration/Space_Science/Gaia/Gaia_s_decade_of_discoveries_unravelling_the_intricacies_of_our_galaxy

Revealing our Milky Way's Mergers



Credit: V. Belokurov (Cambridge, UK and CCA, New York, US) based on the image by ESO/Juan Carlos Muñoz

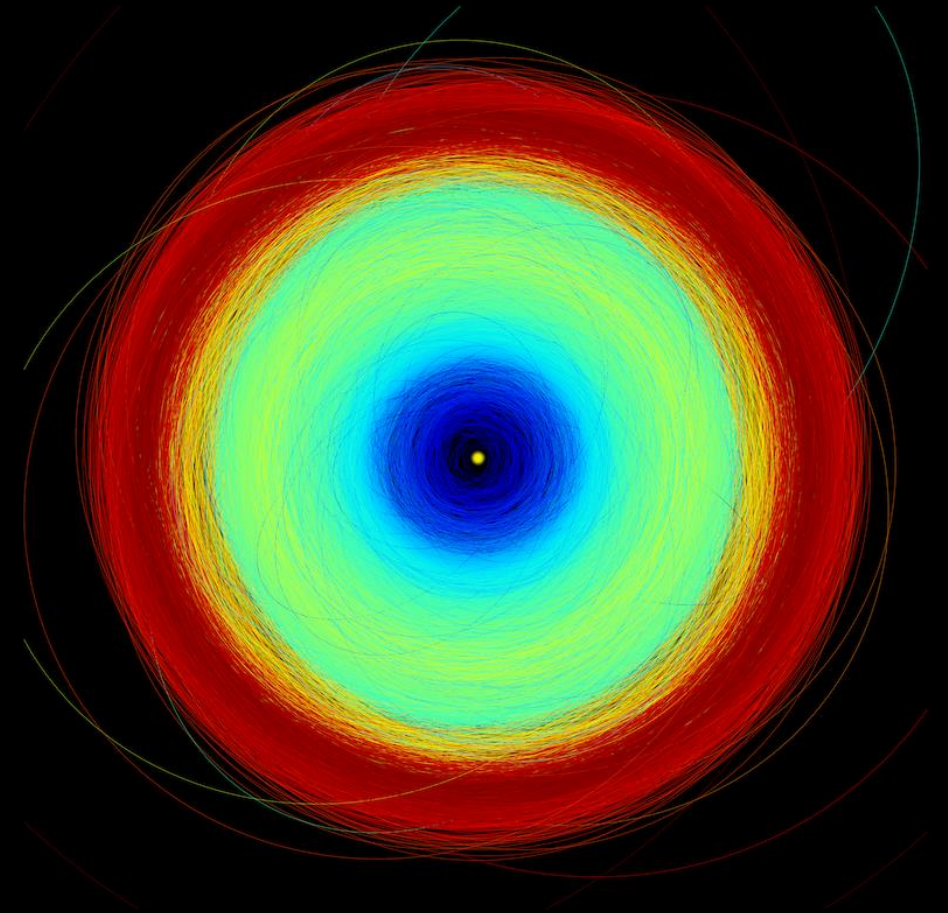
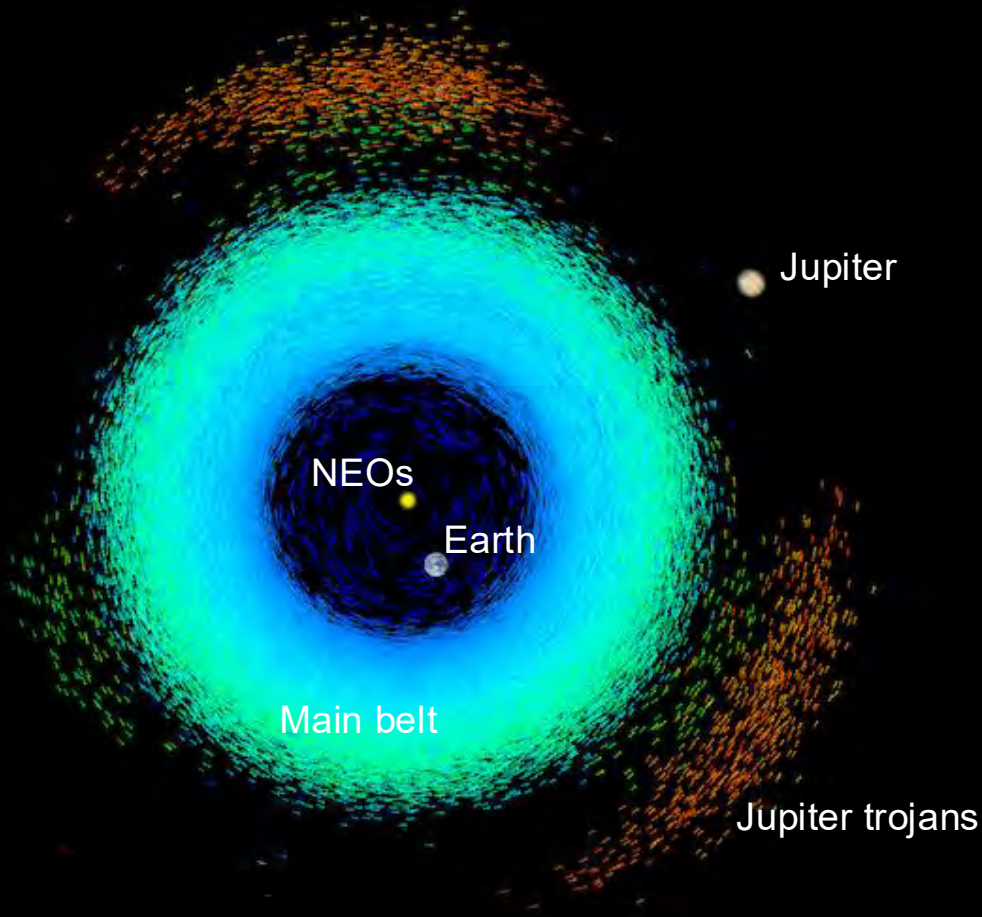


Credit: ESA (artist's impression and composition); Koppelman, Villalobos and Helmi (simulation); NASA/ESA/Hubble (galaxy image)

Gaia and the Solar System



ESA/Gaia/DPAC/P. Tanga



Each asteroid observed by Gaia on 13 June 2022 (DR3 day)
and 10 days of motion

All asteroid orbits in Gaia DR3 out to the Trojans at the
distance of Jupiter

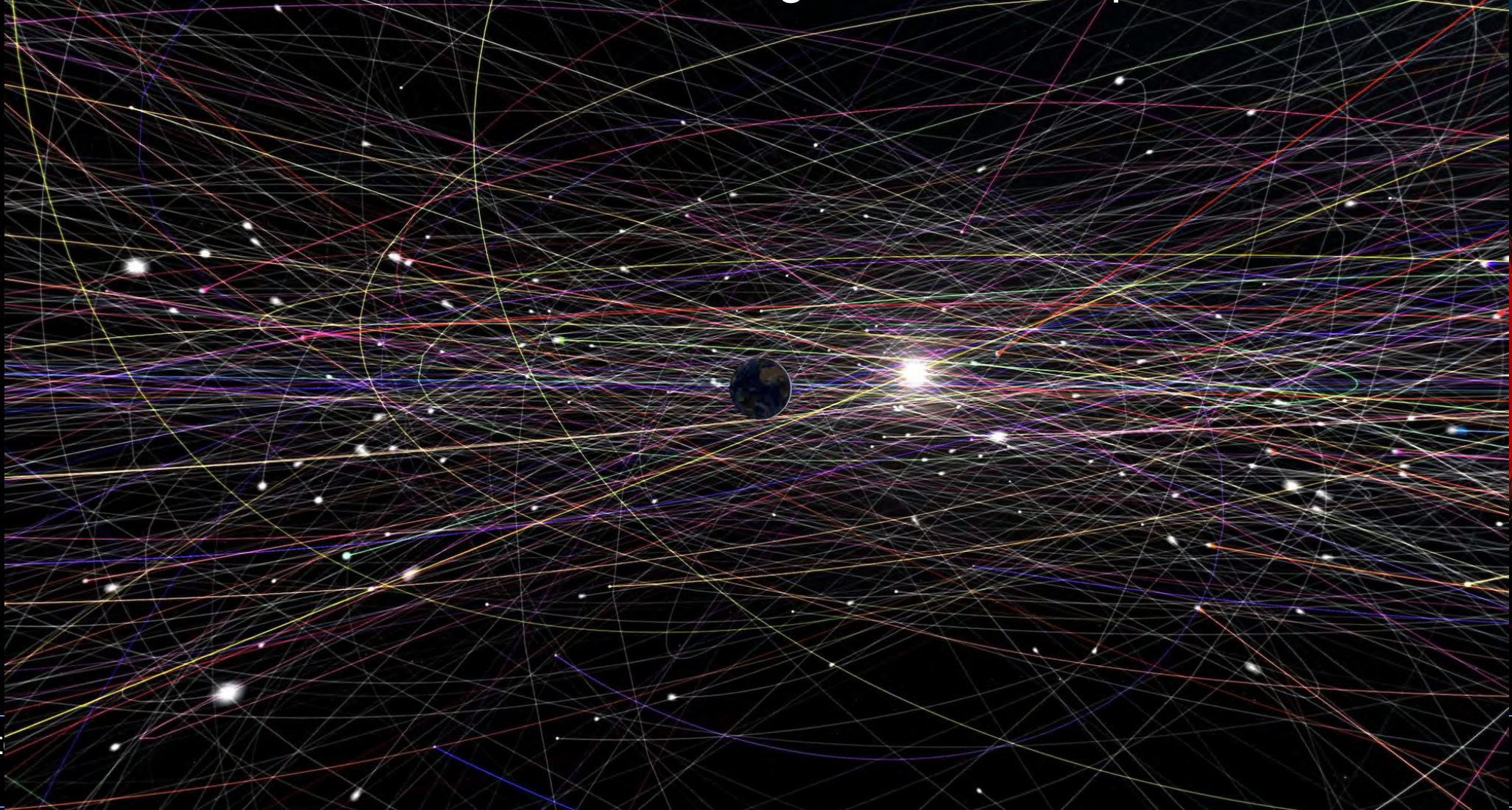
Gaia and the Solar System

Accurate orbits for all asteroids, including for ones that pass close to the Earth

ESA/Gaia/DPAC/P. Tanga



Gaia



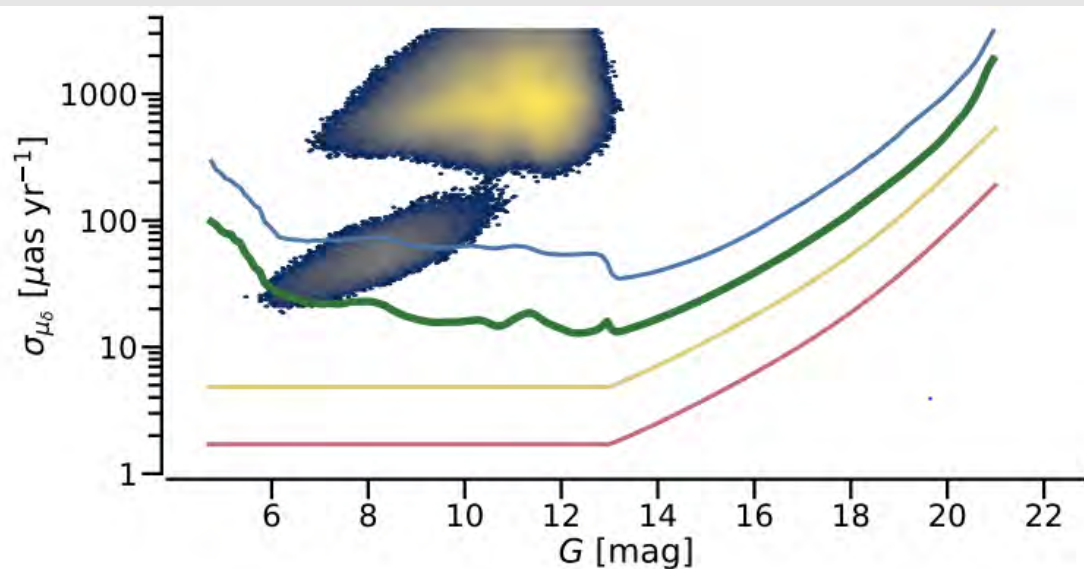
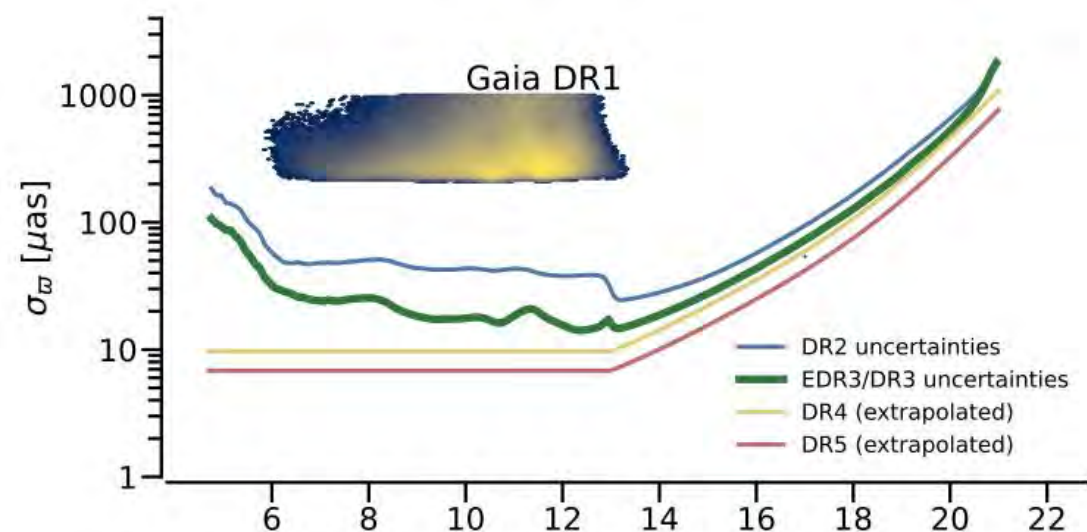
Each ast

at the

Towards Gaia DR4:

- Gaia in-flight operations completed Jan 2025 (no more cold gas propellant)
 - ▶ Nominal mission ended in 2019
 - ▶ Post operations phase until the release of Gaia DR5.
- **Gaia DR4 : December 2026**
- Gaia DR4 is the final release for the nominal mission, 66 months of data
 - ▶ Including a 6 months period of reverse direction of the satellite precession (mitigates degeneracy between AC stellar motion and parallax)
 - ▶ Full Epoch data: astrometry, broad band photometry, radial velocity, BP/RP, RVS
 - ▶ Full astrometric, photometric, and radial-velocity catalogues, variable-stars and non-single-star solutions, classification, exoplanet list, RB/RP and RVS spectra
- Gaia DR5 : will include the extended mission data.

Gaia Performance from DR1 to DR5



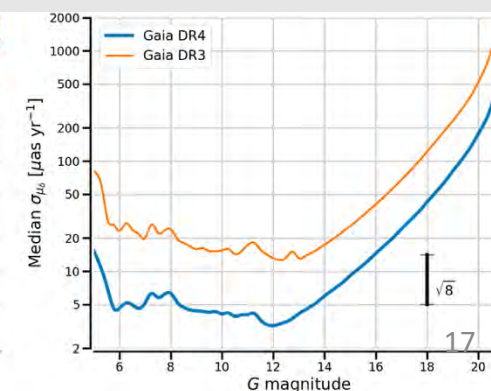
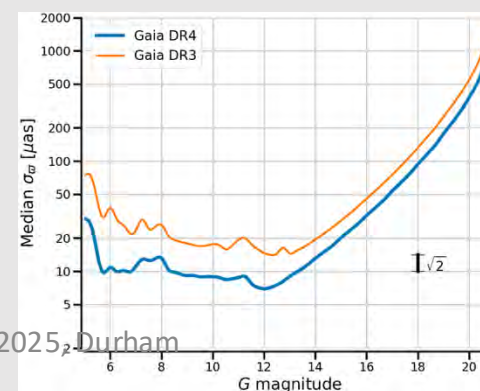
- Basic mission results improve as $t^{-0.5}$

- Positions, parallaxes, photometry and radial velocities \rightarrow factor 1.4 (DR4), 1.9 (DR5)

- Proper motion improves as $t^{-1.5}$

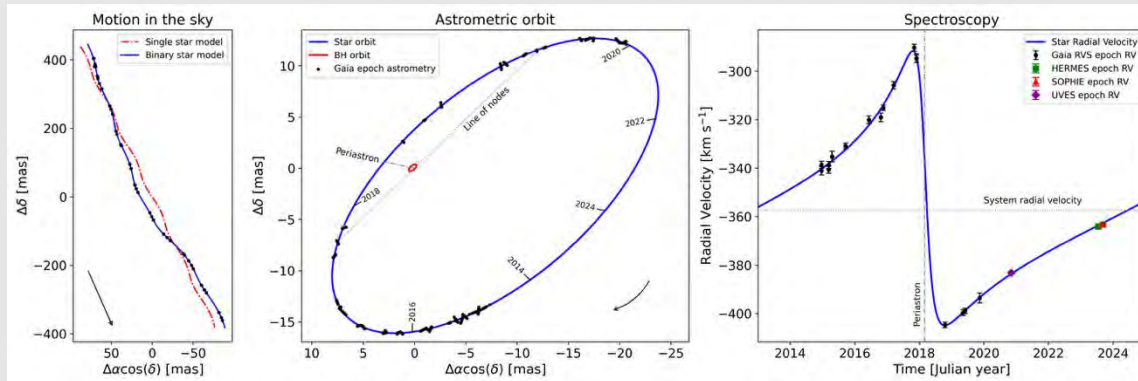
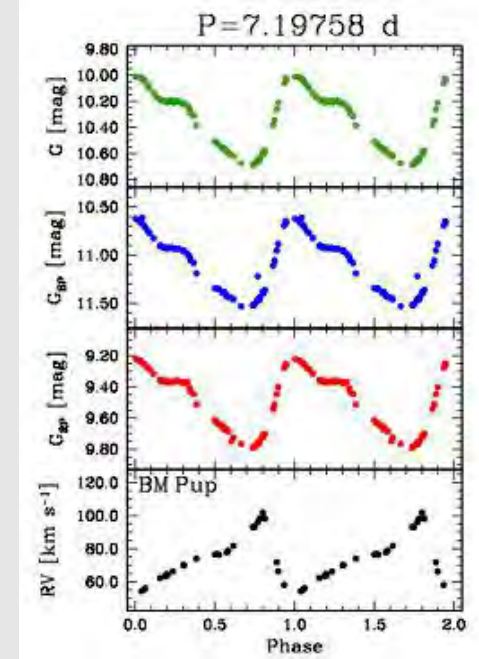
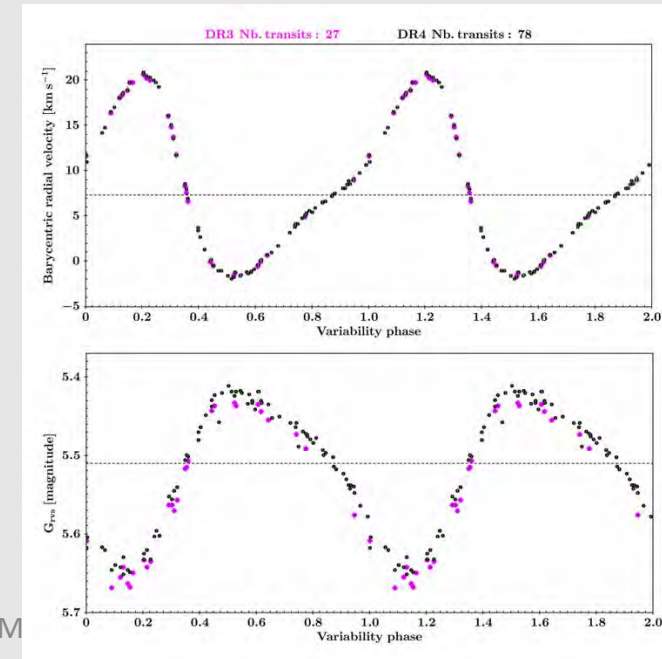
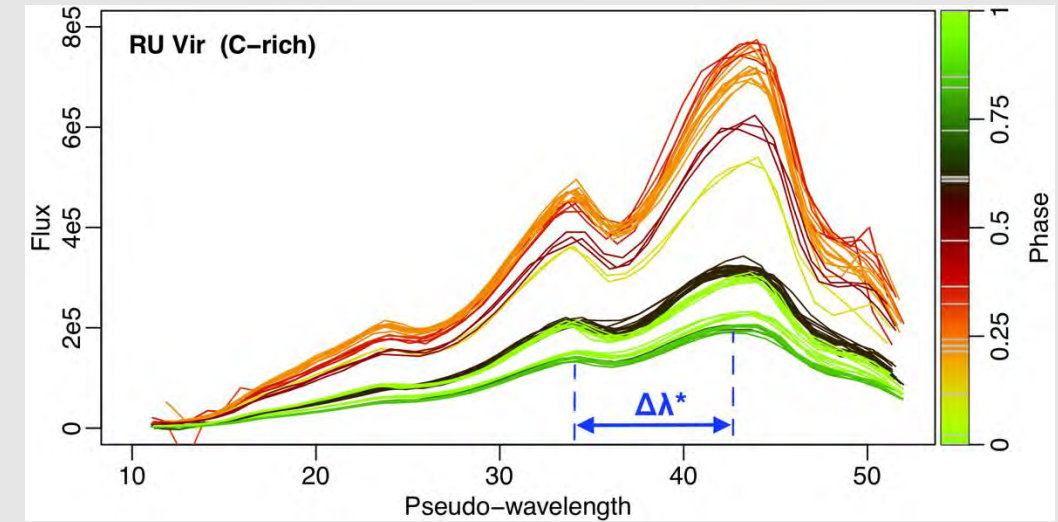
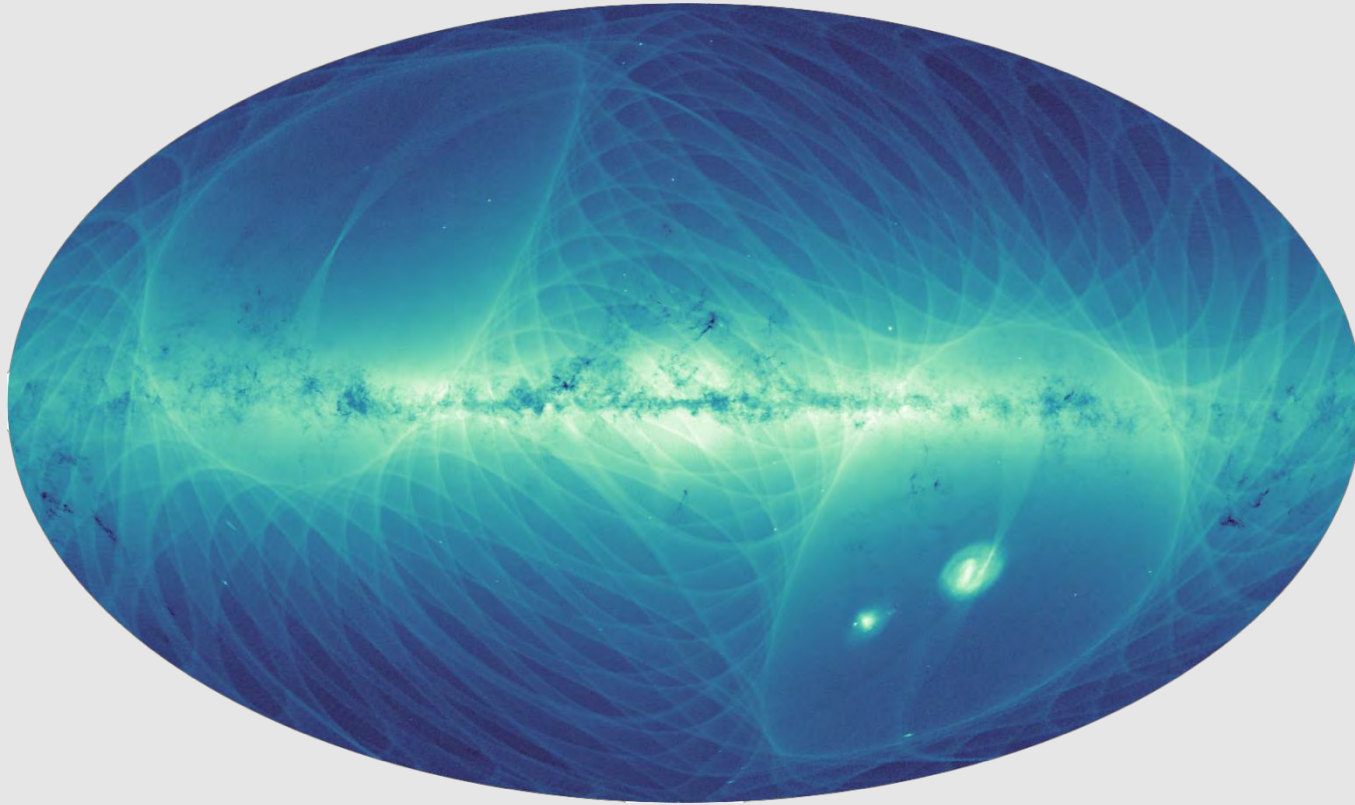
- Rapidly increasing gain in kinematics and dynamics \rightarrow factor 2.7 (DR4), 6.6 (DR5)

- Higher order terms scale more! e.g. improvement in unambiguous determination of orbital period, mass and distance of a perturbing body scales as $t^{-4.5}$



11/07/2025

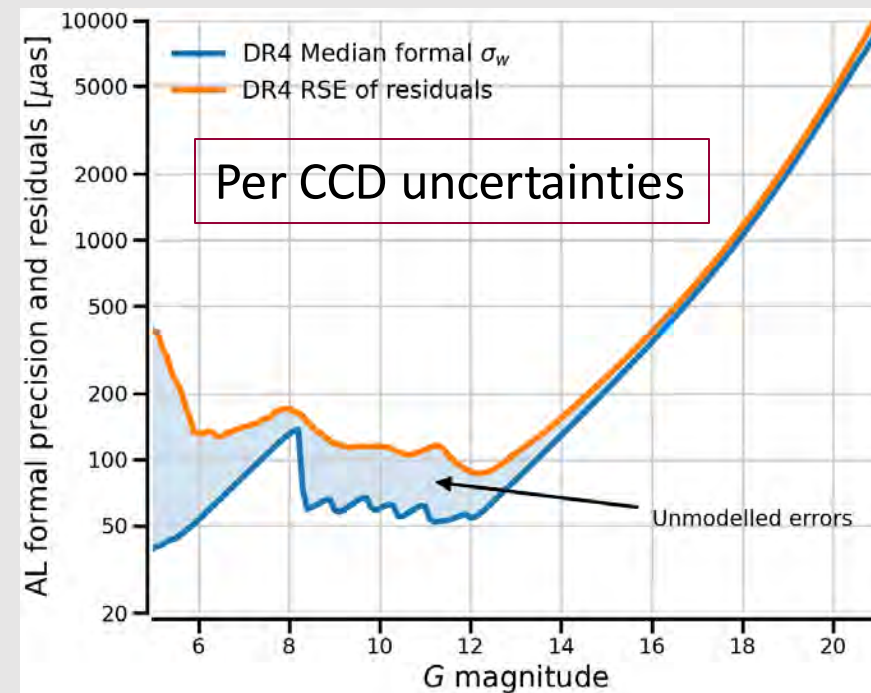
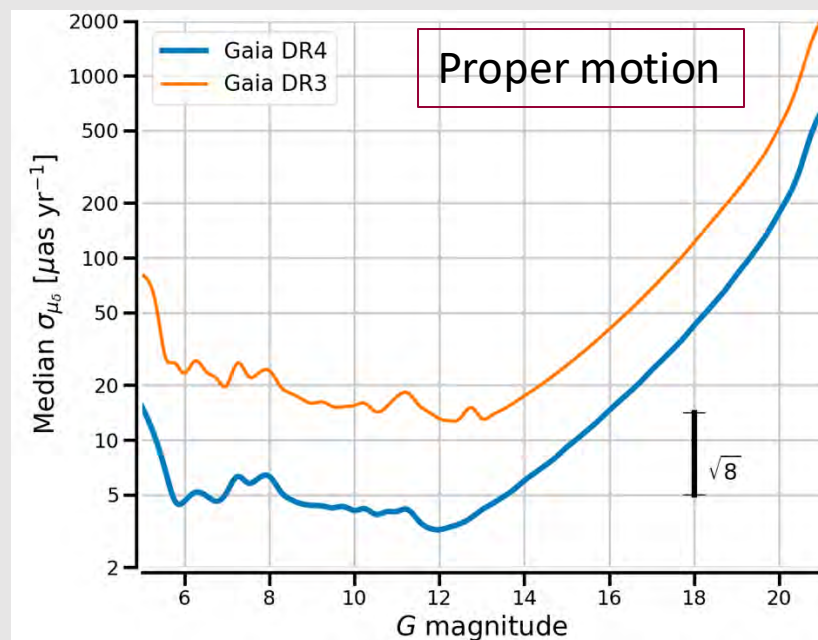
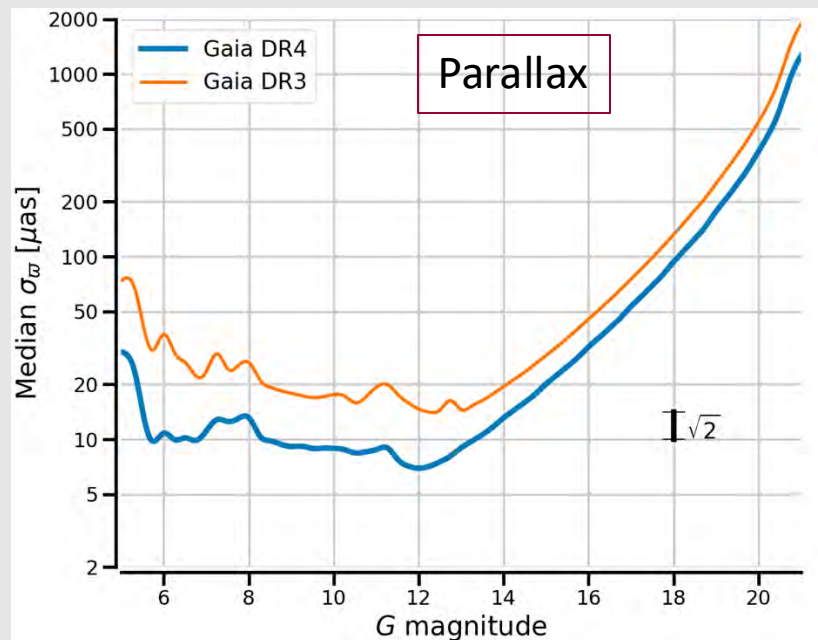
Gaia DR4: Epoch data for 2.5 Billion Sources



Gaia DR4 Astrometric Uncertainties

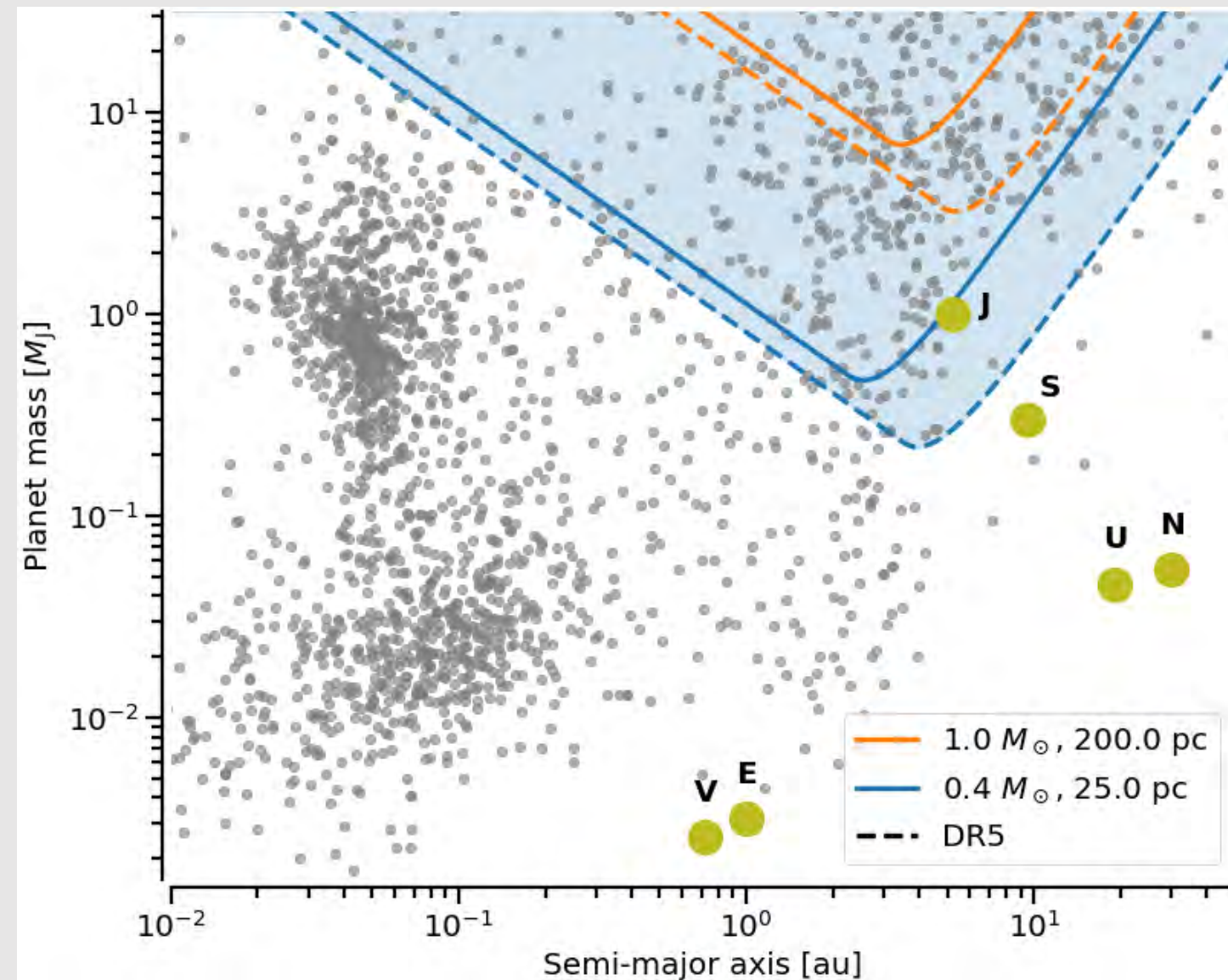
For $G < 13$ the improvement is better than the $\sqrt{2}$ expected

Expected $\sqrt{8}$ improvement for all magnitudes



- Gaia DR4 formal per CCD astrometric uncertainties $\sim 50 \mu\text{as}$ at $G \lesssim 13$ ($\sim 15 \mu\text{as}$ averaged over 9 CCDs)
- But: total uncertainties limited by calibration errors to $\sim 80\text{--}150 \mu\text{as}$ ($30\text{--}50 \mu\text{as}$ averaged over 9 CCDs)

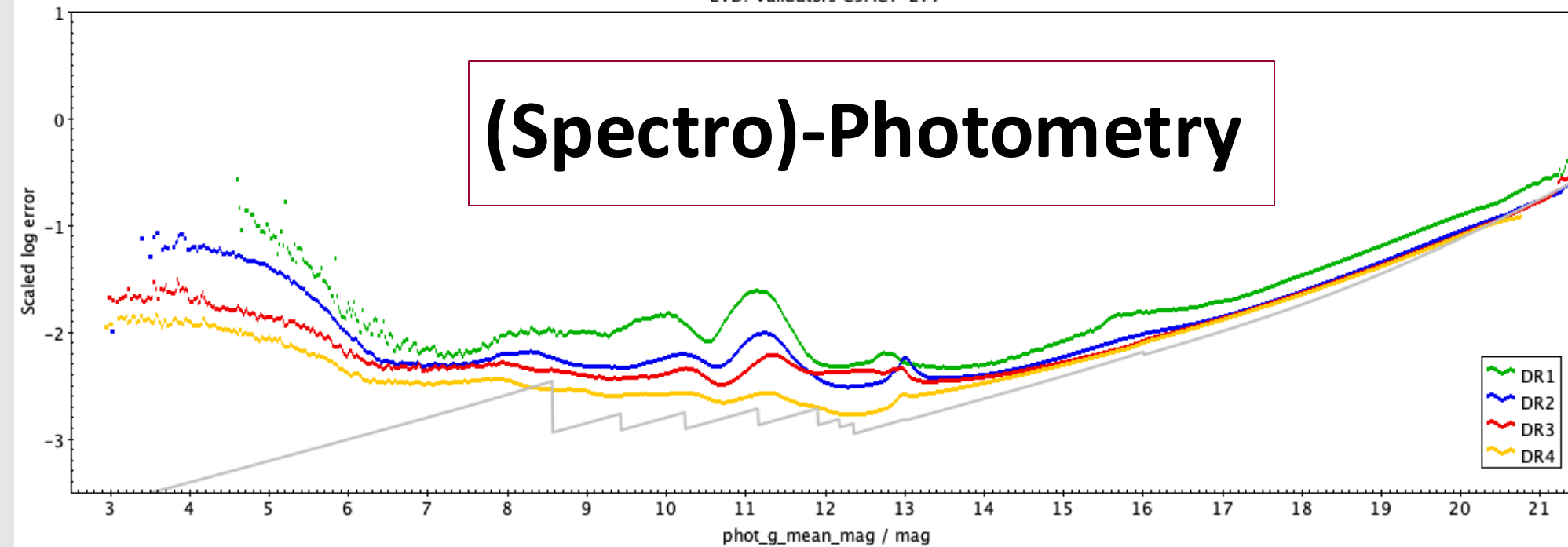
Gaia DR and the Exoplanet Discovery Space



- 10^6 – 10^7 stars, unbiased across spectral type, age, chemical composition of the primary
- Thousands of giant planet ($< 15 M_{Jup}$) discoveries predicted around A to M type stars
- Number could triple for the 10 year observation time span of Gaia DR5
- Possibly $\sim 10^3$ transiting hot Jupiters (see Gaia-1b and Gaia-2b)
- Gaia DR3 exoplanet contents: see Holl et al (2023), Gaia Collaboration, Arenou et al (2023) and the [Gaia exoplanet candidate list](#)

Assuming estimated 50 μ s per epoch uncertainty

(Spectro)-Photometry

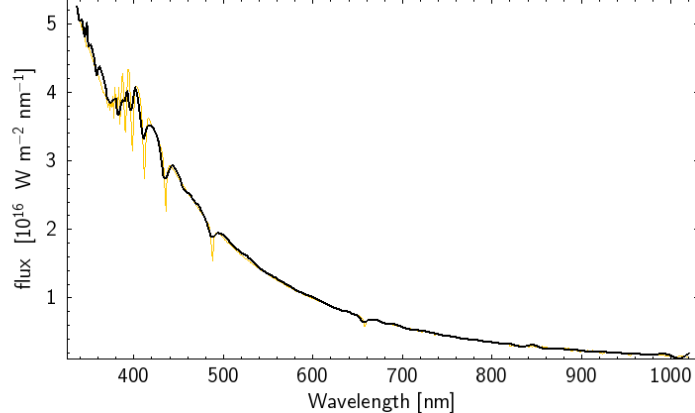


Improvements with each release.
DR4 bright $G < 13$
calibration significantly improved.

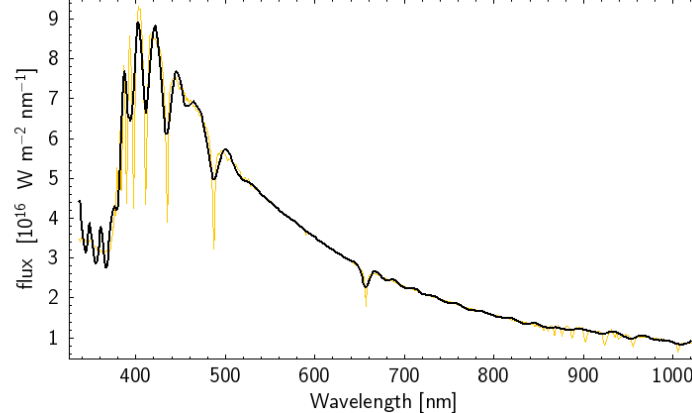
Example XP spectra, fit to spectrophotometric standard stars (yellow ground spectra, black Gaia XP)

Credit: DPAC/ CU5/ DPCI team

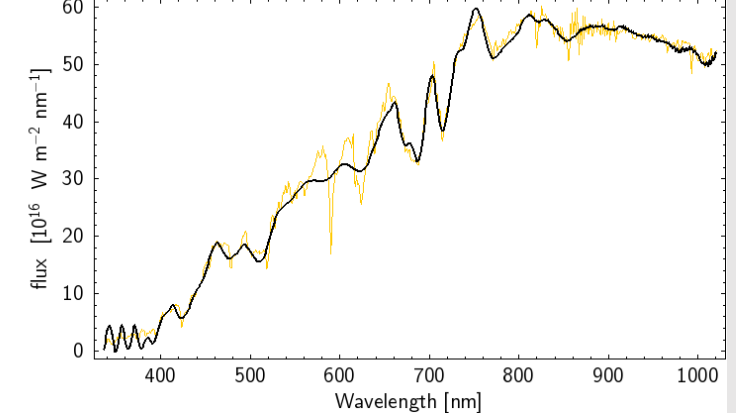
Gaia DR4 3772994667772794112



Gaia DR4 2161093682102883712

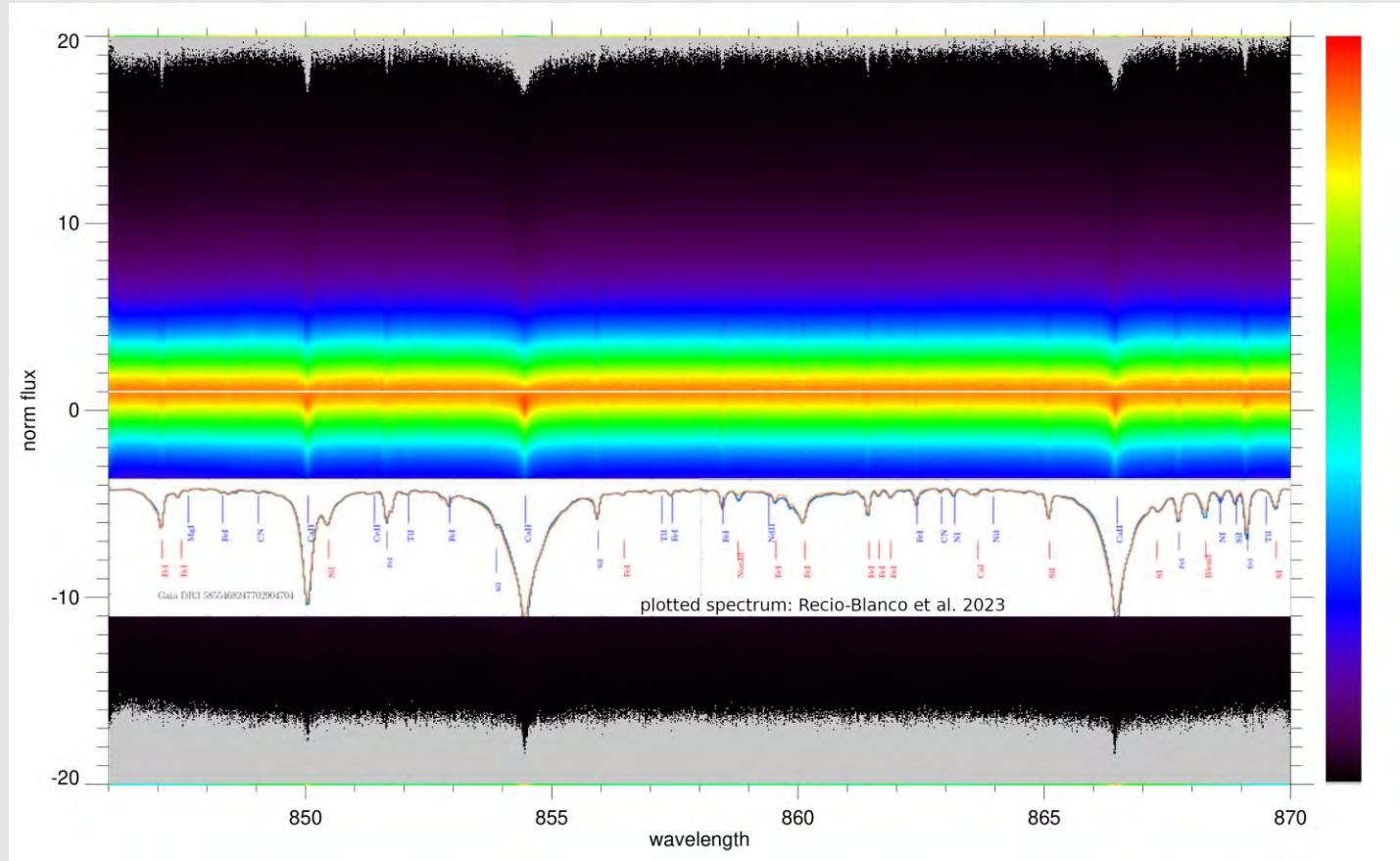


Gaia DR4 2717105133036645760

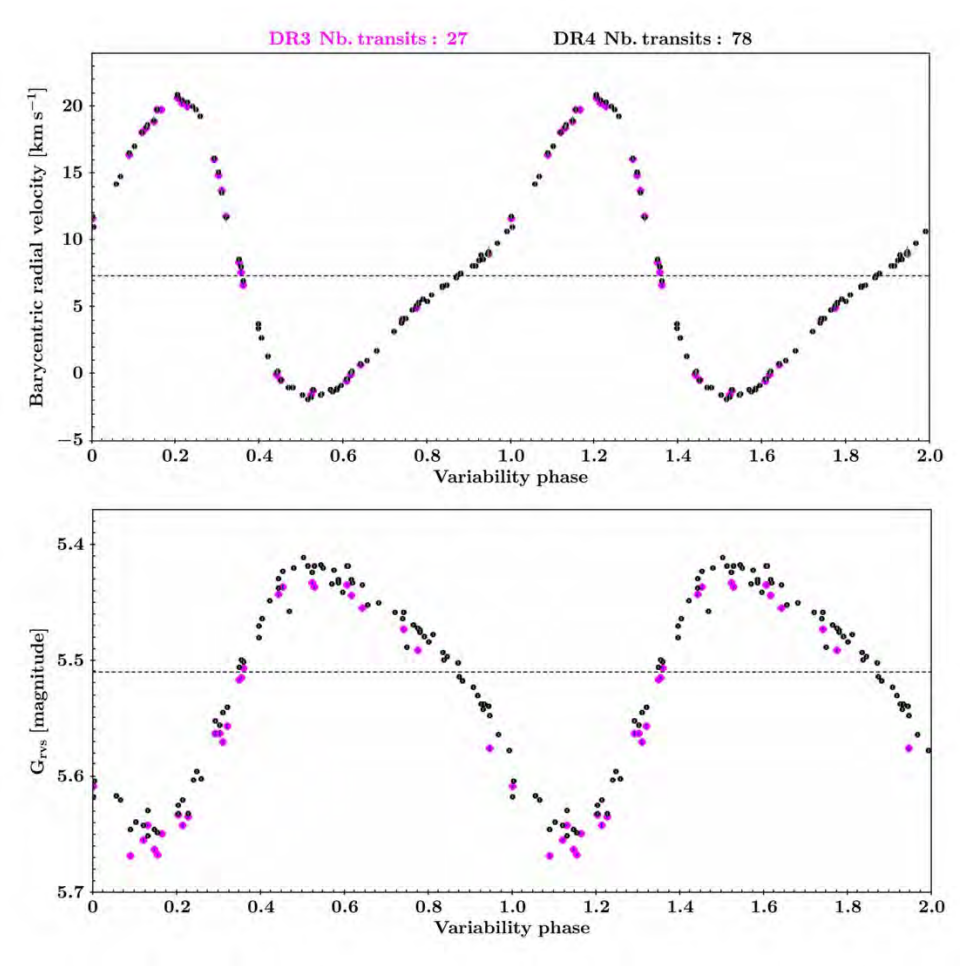


Approximately 6 million faint (GRVS > 14) combined spectra. The colour scale shows the number density of the fluxes at each wavelength bin.
Credit: DPAC/ CU6/ DPCC team

Spectroscopy



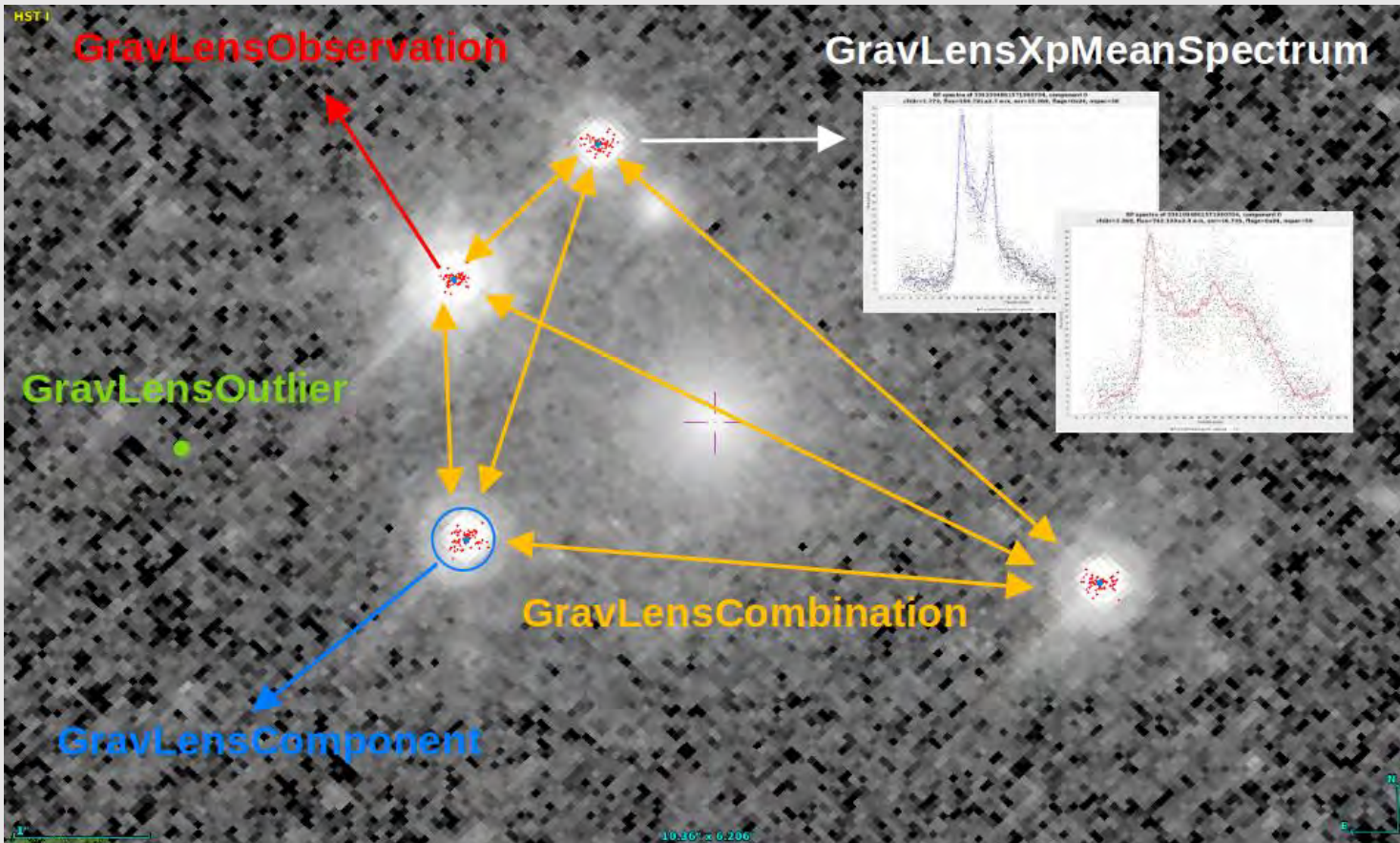
Many lines in addition to Ca seen, high S/N spectrum shown for comparison



Pulsational RV variations for a Cepheid variab
Credit: DPAC/ CU6/ DPCC team

Gaia DR4 includes time series for all bright sources (GRVS < 14) → 650 million reliable epoch RVs (1.3 billion total)

Extended Objects



Credit: DPAC/ CU8/ DPCC team

- QSOs: 4.5 million candidates, 163 000 surface brightness profiles for host galaxies ($z < 0.4$, 10x Gaia DR3)
- Galaxies: 6.6 million candidates, 3.9 million surface brightness profiles (3x Gaia DR3)
- Gravitational lenses: more robust lens identification, including spectral similarity; time delay measurements as a new data product

GREAT Plenaries

slides on-line at: <http://great.ast.cam.ac.uk/Greatwiki/GreatMeet-PM18>

Last GREAT plenary was held at the EAS Annual Meeting 2025 in Cork as Symp S1 (26-27 Jun 2025)

<https://eas.unige.ch/EAS2025/session.jsp?id=S1>

Programme

- Gaia DR3: Highlight Science including a review of recent major science highlights from Gaia DR3, Gaia FPR and science discovery enabled by Gaia, with attention to the potential of Gaia DR4.
- Gaia / GREAT/MW-Gaia / Gaia Unlimited Status
- Gaia EDR3/DR3/FPR: Highlight Science (The Milky Way as a Galaxy)
- Gaia EDR3/DR3/FPR: Highlight Science (The Birth, Life and Death of Stars)
- Gaia EDR3/DR3/FPR: Highlight Science (from Solar system to reference frames)
- Gaia networking and ground based synergies with Gaia
- Lunch session with an update on the Gaia Archive, and update on the ESA Voyage 2050 L mission concept (GaiaNIR), and also an opportunity for poster presenters to deliver a 'lightening' talk of their (e-)poster.



The screenshot displays the EAS 2025 website. At the top, a green banner features a night view of University College Cork, the text 'EUROPEAN ASTRONOMICAL SOCIETY ANNUAL MEETING', the dates '23 - 27 JUNE', and the 'EAS 2025 Cork' logo. Below the banner, a left-hand navigation menu lists various site sections. The main content area is titled 'Symposium S1' and 'Gaia: The (TWO) Billion Star Galaxy Census: Anticipating the Leap in Understanding of Planets, Stars, the Milky Way with Gaia DR4'. It includes a 'News' section with two items, an 'Aims and scope' section with a paragraph of text and a vertical strip of five astronomical images, and a concluding paragraph about the symposium's goals. A footer note mentions the history of GREAT plenary meetings.

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EAS 2025

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Symposium S1 26-27 June 2025

Gaia: The (TWO) Billion Star Galaxy Census: Anticipating the Leap in Understanding of Planets, Stars, the Milky Way with Gaia DR4

News:

- 20240701 Link to access meeting presentation slides added.
- 20240205 Session Information updated.

Aims and scope

The updated ESA Gaia Billion Star Census of the Milky Way, was released in June 2022 as Gaia Data Release 3 (Gaia DR3). This release updated and extended Gaia EDR3, and contains the full five parameter astrometry for ~1.5 billion sources, along with low and medium resolution spectra and a wealth of associated data (such as mean radial velocities for brighter objects). Full details for Gaia DR3 are at <https://www.cosmos.esa.int/web/gaia/data-release-3> for details). More recently the Gaia Focused Product Release (Gaia FPR) (<https://www.cosmos.esa.int/web/gaia/focused-product-release>) with a set of five high value data products, spanning solar system objects to gravitational lenses was issued in Oct 2023.

Gaia EDR3, DR3 and the FPR mark the most recent major milestones in the Gaia mission. Gaia continues to revolutionise our understanding of the formation history of the Milky Way, and is having a significant impact on many other areas of astronomy ranging from solar system science to quasars.

The key goals of this symposium will be for the Gaia/GREAT(1) and related communities (and especially early stage researchers) to present and discuss their science highlights resulting from Gaia EDR3/ DR3/ FPR. It will allow the Gaia project to update the science community with the latest scientific and technical performance of Gaia, review the most recent Gaia enabled science, and provide a look ahead to the rapidly approaching seminal release of Gaia DR4, the full release of the 5 year Gaia nominal mission, which will be released later in 2026. In particular there will be presentations highlighting the new DR4 data products, especially the extended time series data, including epoch photometry, spectroscopy, and astrometry.

GREAT plenary meetings have run since 2009, allowing members of the GREAT and wider community



Gaia: A remarkable mission revolutionising our understanding of the Milky Way, its constituent components and the Universe more widely. Much discovery to come with the future data releases!

<https://www.cosmos.esa.int/web/gaia/data-release-3>



Get the data: <https://gea.esac.esa.int/archive/>

gaia archive

HOME SEARCH SINGLE OBJECT VISUALISATION HELP

Welcome to the Gaia ESA Archive

Gaia is a European space mission providing astrometry, photometry, and spectroscopy of nearly 2000 million stars in the Milky Way as well as significant samples of extragalactic and solar system objects. The Gaia ESA Archive contains deduced positions, parallaxes, proper motions, radial velocities, and brightness

<https://www.cosmos.esa.int/web/gaia/data-release-4>

GAIA DATA RELEASE 4

EXPECTED DECEMBER 2026