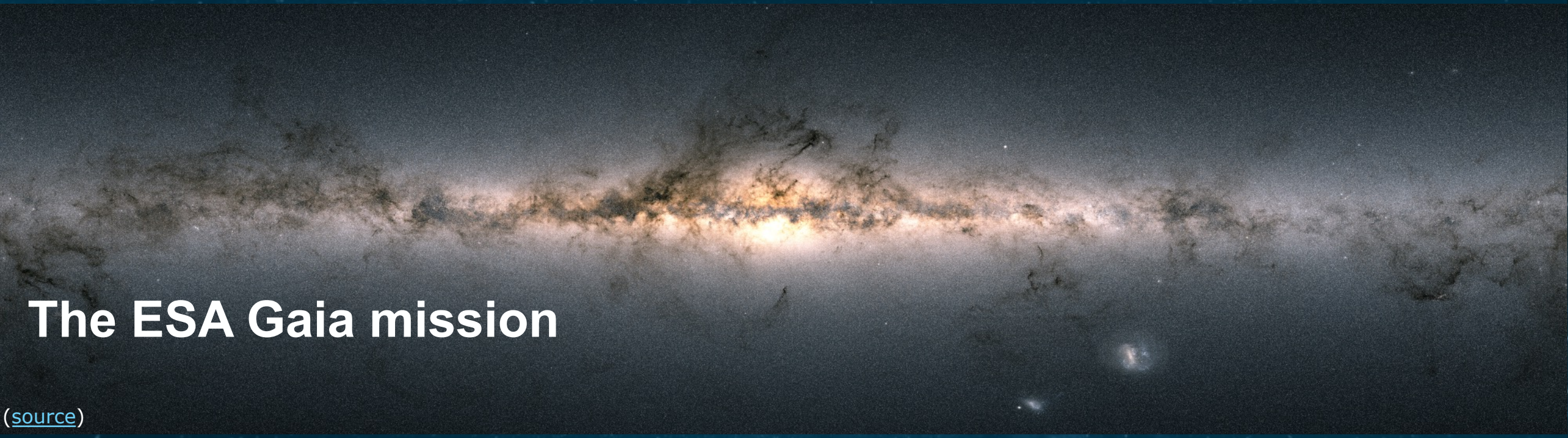


# The ESA Gaia mission

(source)

Johannes Sahlmann
Gaia Project Scientist

25/03/2025

# Gaia reveals the origin and evolution of the Milky Way

- Stellar positions and distances
  ➡️ Galactic structure

- Stellar motions
  ➡️ Galactic kinematics

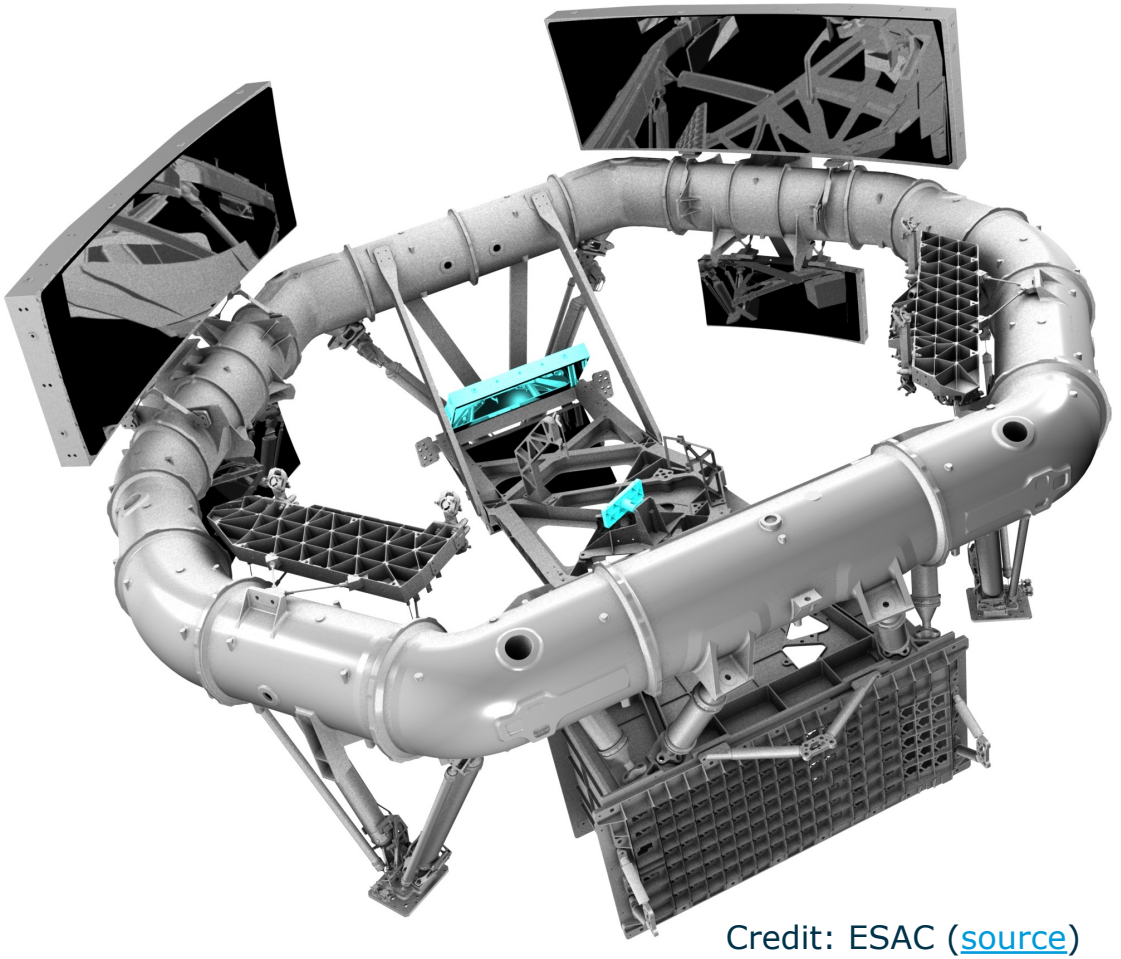
- Stellar parameters, compositions, ages
  ➡️ Galactic evolution

- Gaia implements an optical all-sky survey with 3 instruments: Astrometry, Photometry, Spectroscopy

- Gaia observes ~1% of the stellar content in the Galaxy

Credit: ESA/Gaia/DPAC, Stefan Payne-Wardenaar (source)

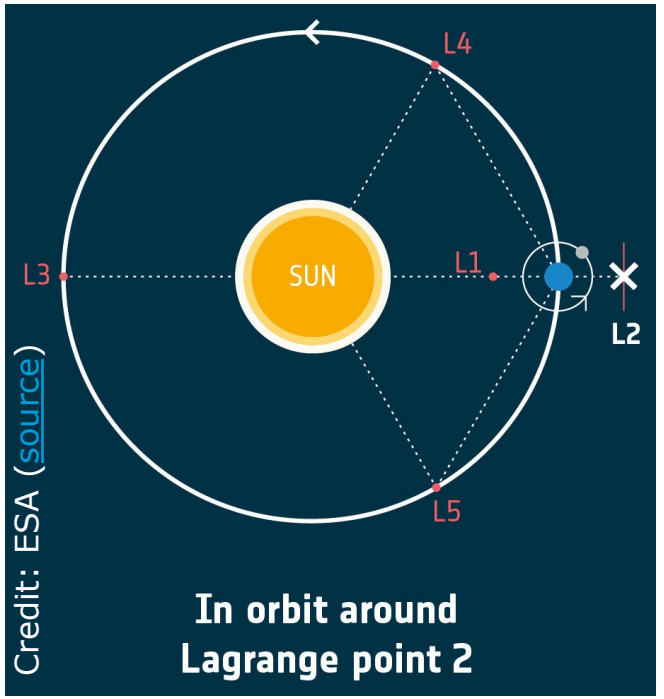
# The Gaia spacecraft is 10 m wide and has 2 telescopes

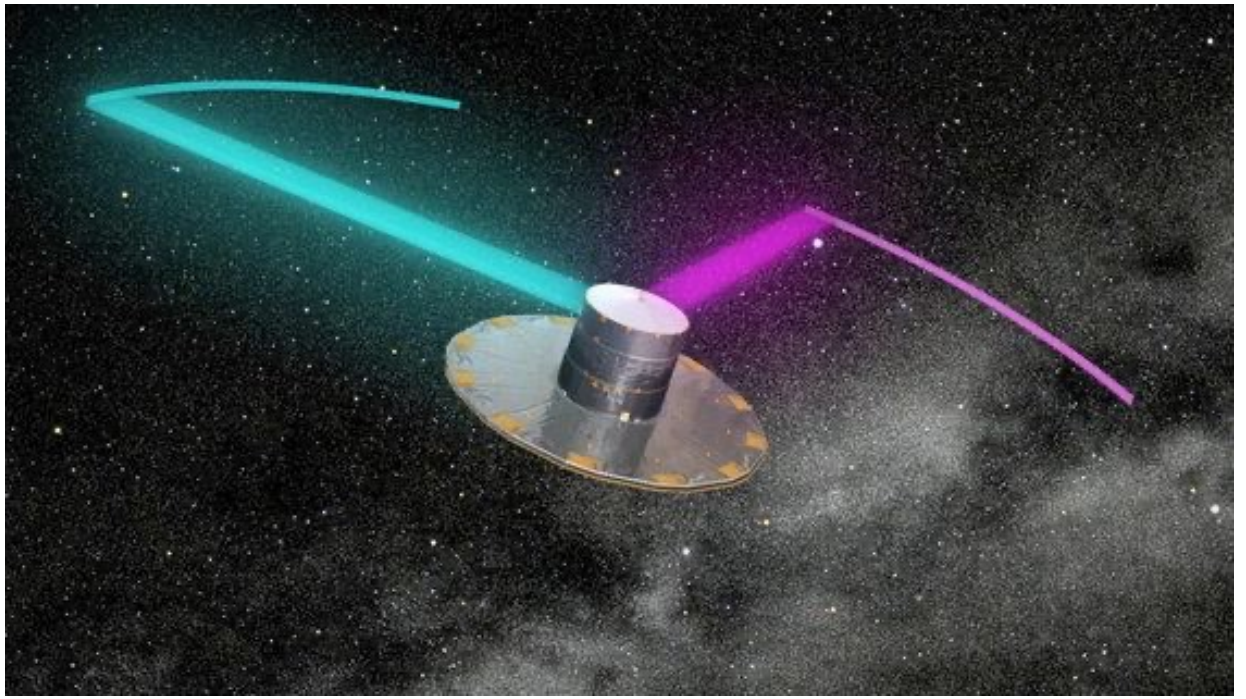


Credit: ESAC (source)

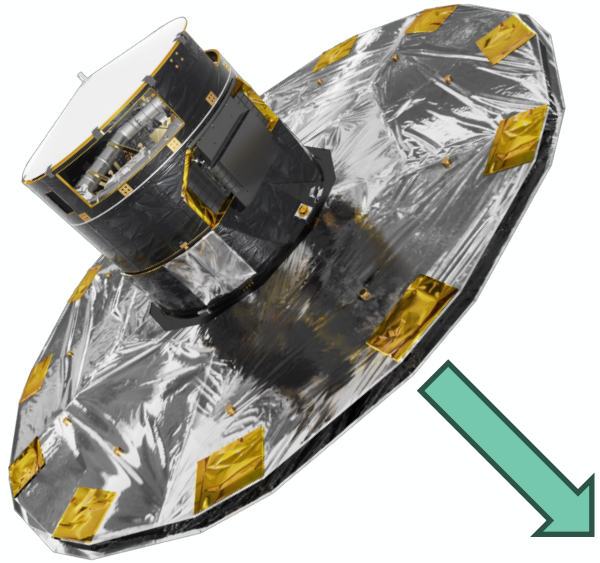
# Gaia was launched to L2 in December 2013


- 10.5 years of science observations from July 2014 to January 2025
- Gaia was constantly spinning and scanning the sky
- Surveying star-like sources, e.g. stars, galaxies, asteroids, …
- Magnitudes range G ≈ 3-21



# Gaia data flow from the spacecraft to the ESA archive



Credit: ESA/ATG medialab (source)

Gaia consortium incl. ESA

Gaia DPAC


Credit: ESA (source)

Archive

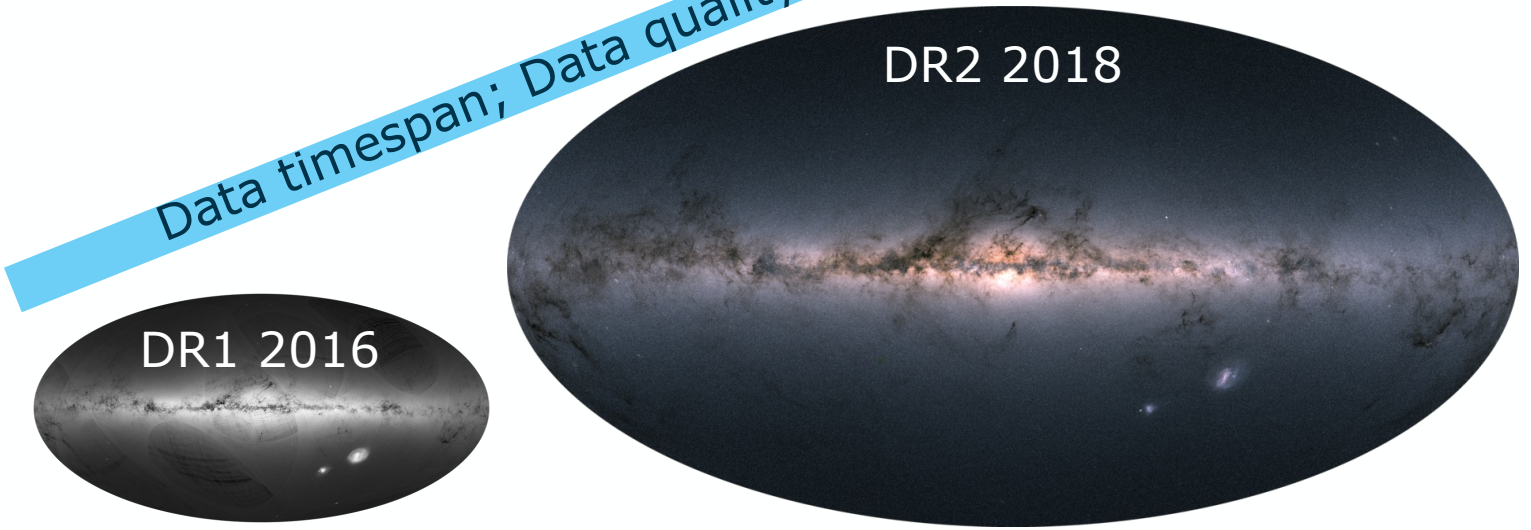
# There were 3 intermediate Gaia data releases so far

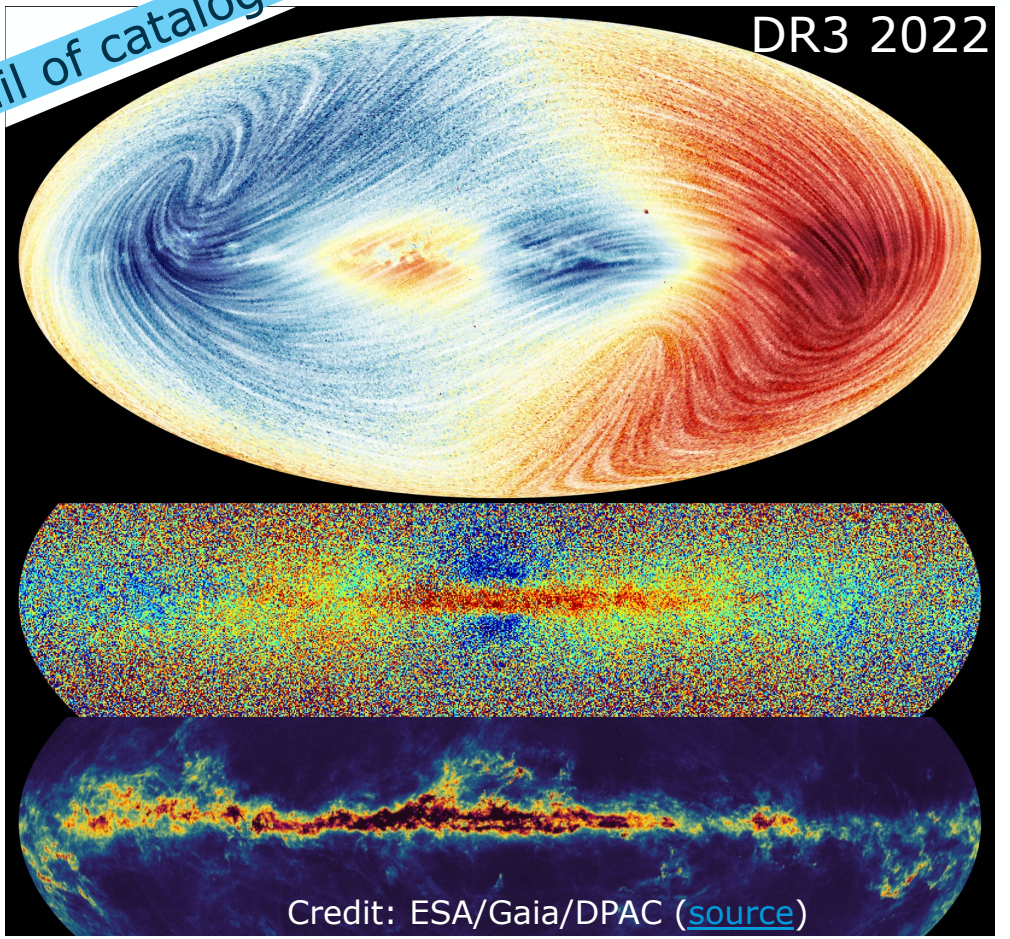
- Iterative process of incremental data releases
- There is no proprietary period on science data for the Gaia collaboration

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

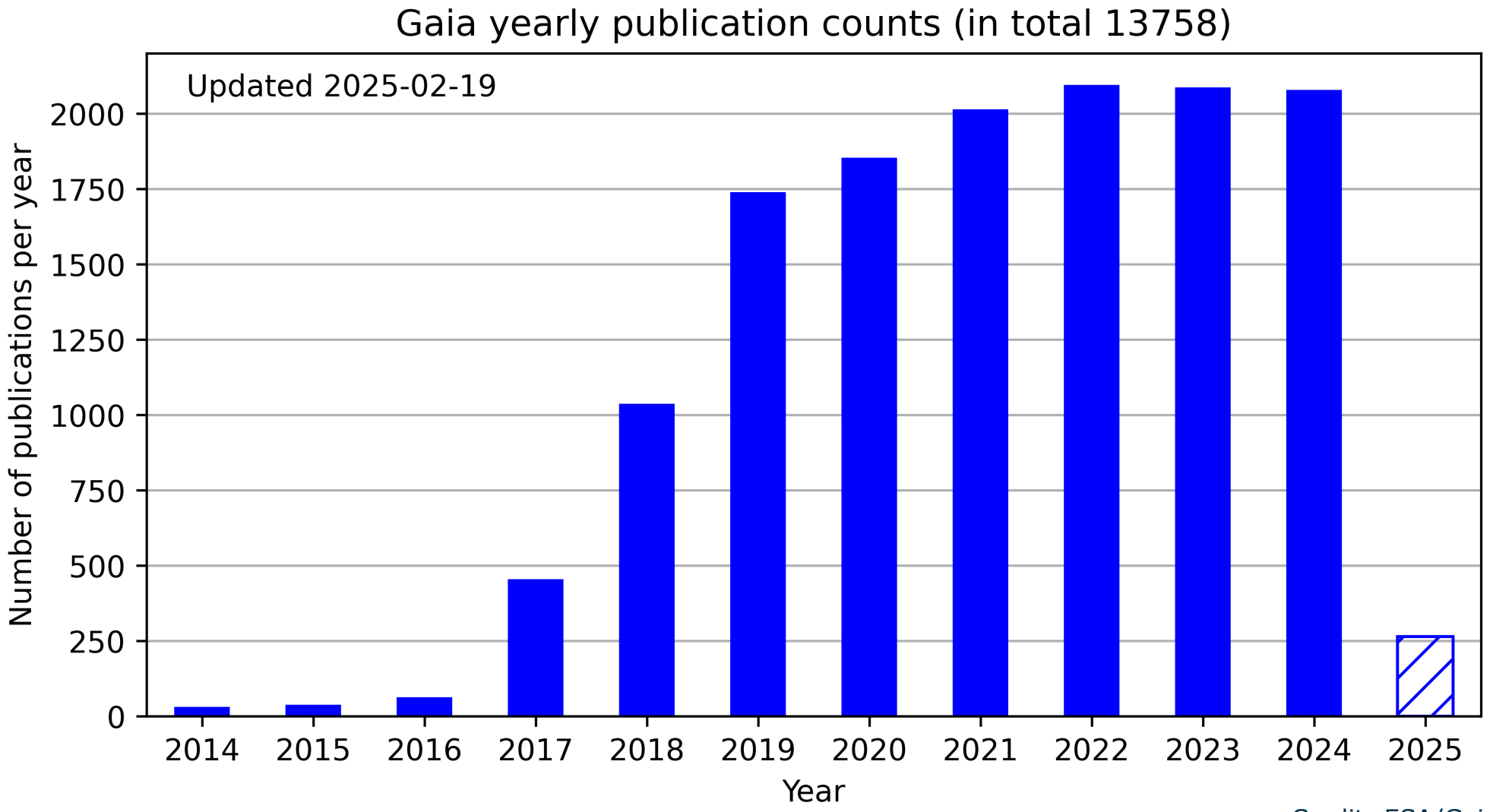
- Focused Product Release (5 products, 2023)

Data timespan; Data quality; Data volume; Number and detail of catalogues



# Gaia is a very productive science mission



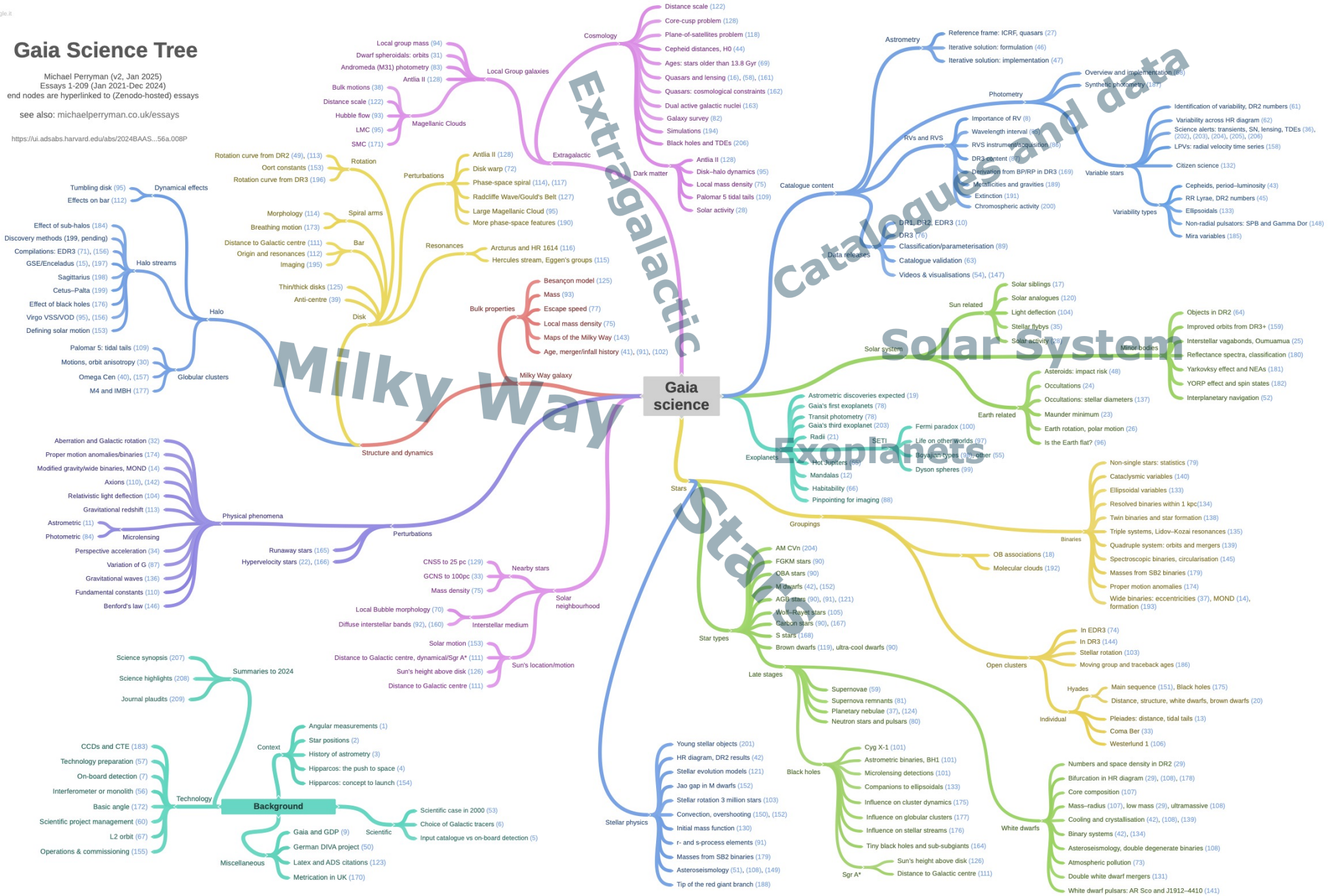

Credit: ESA/Gaia/DPAC (source)

# Gaia Science Tree

Michael Perryman (v2, Jan 2025)
Essays 1-209 (Jan 2021-Dec 2024)
end nodes are hyperlinked to (Zenodo-hosted) essays

see also: michaelperryman.co.uk/essays

https://ui.adsabs.harvard.edu/abs/2024BAAS...56a.008P

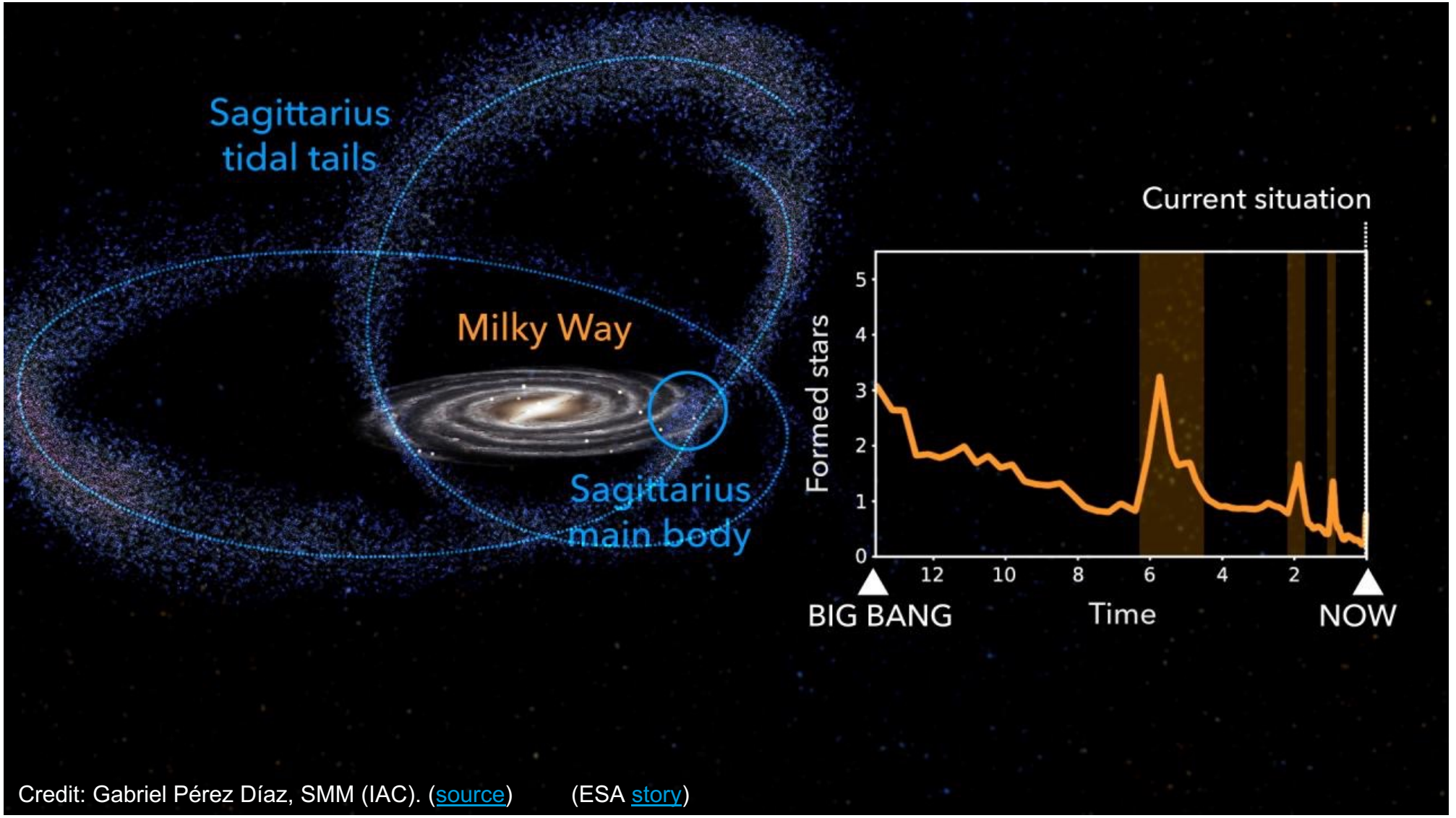



Credit:
Michael Perryman
(source)

Video presenting the Gaia Milky Way map:
https://www.esa.int/ESA_Multimedia/Videos/2025/01/The_best_Milky_Way_animation_by_Gaia/(lang)

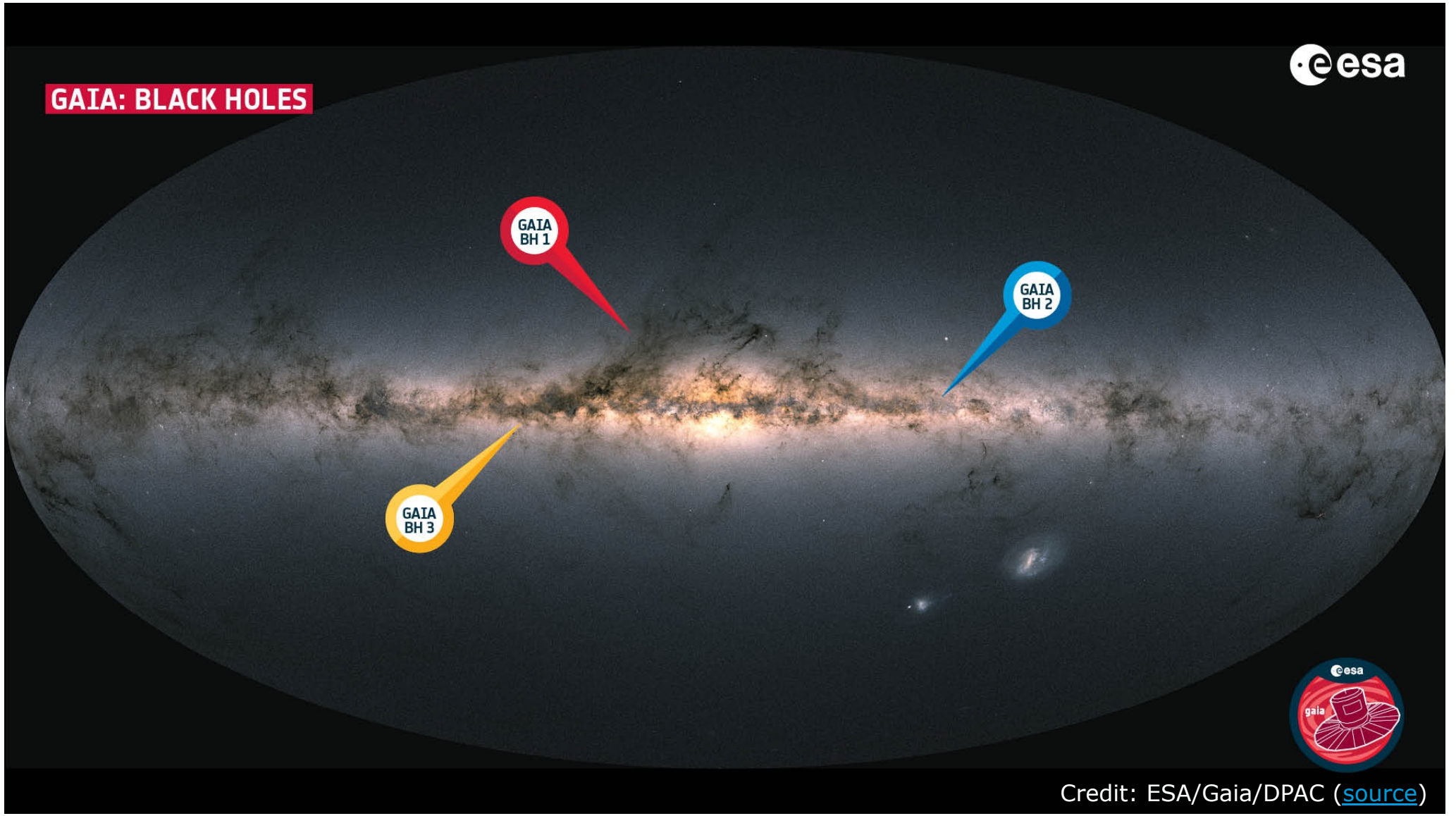

Credit: ESA/Gaia/DPAC, Stefan Payne-Wardenaar (video)

# Interactions with Sagittarius dwarf galaxy trigger increased star formation



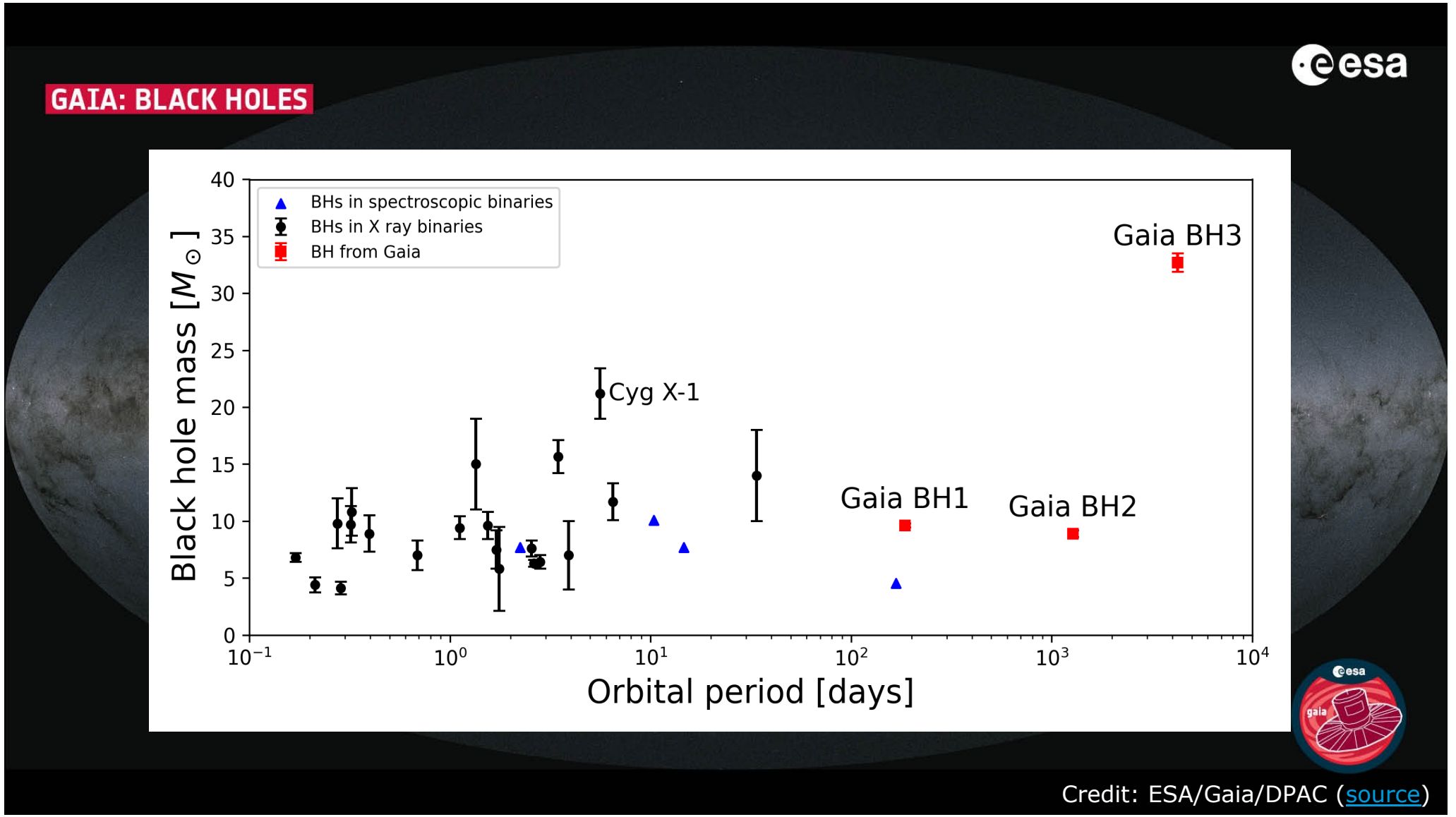

Credit: Gabriel Pérez Díaz, SMM (IAC). (source) (ESA story)

# Gaia uncovered a new family of stellar mass black holes




Credit: ESA/Gaia/DPAC (source)

# Gaia uncovered a new family of stellar mass black holes



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

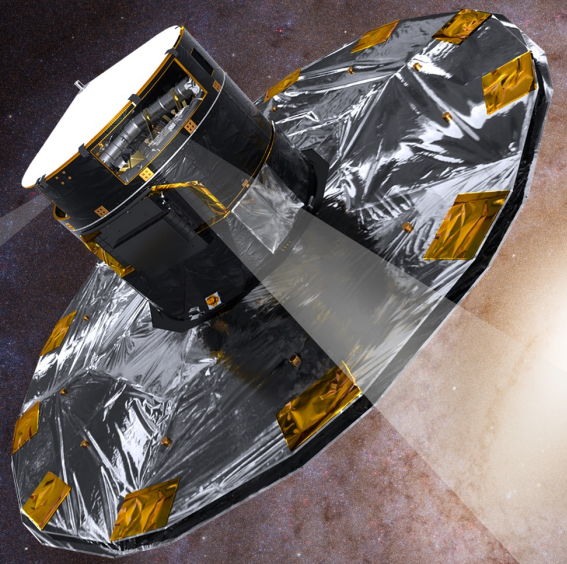
From 24 July 2014 to 15 January 2025, Gaia made more than three trillion observations of two billion stars and other objects, which revolutionised the view of our home galaxy and cosmic neighbourhood.

**3 TRILLION**
Observations

**2 BILLION**
Stars & other objects observed

**938 MILLION**
Camera pixels on board

**15 300**
Spacecraft 'pirouettes'



**580 MILLION**
Accesses of Gaia catalogue so far

**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)

**55 KG**
Cold nitrogen gas consumed

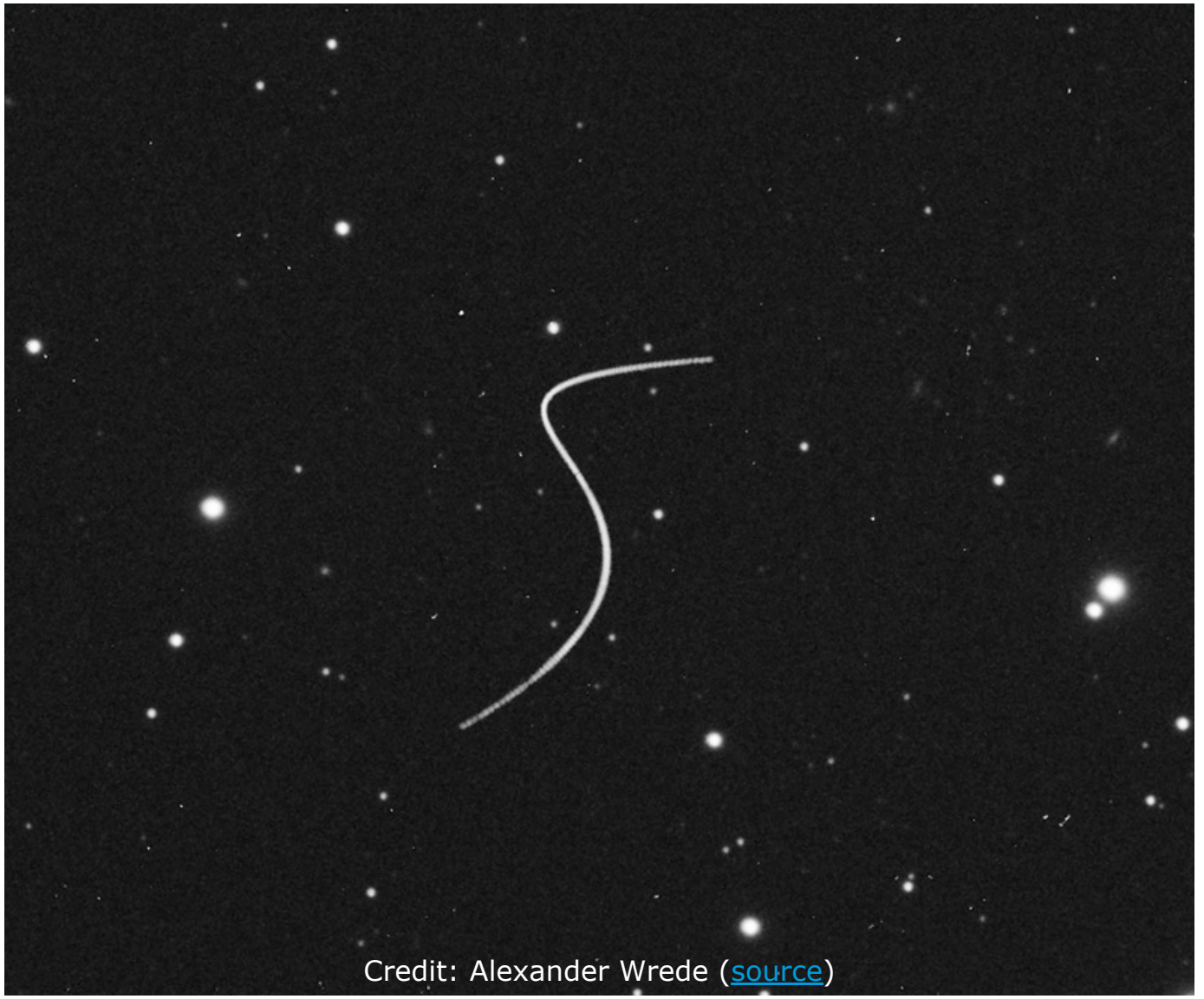
**3827**
Days in science operations

**50 000 HOURS**
Ground station time used

Credit: ESA/Gaia/DPAC, Milky Way impression by Stefan Payne-Wardenaar (source)

# Gaia spacecraft will be passivated on 27 March 2025

- Gaia technical tests from 15 Jan 2025 – 26 March 2025
- “Bright” Gaia was observed by citizen astronomers with telescopes worldwide
- Post-presentation addition: Gaia was permanently switched off on 27 March 2025: https://www.esa.int/Enabling_Support/Operations/Farewell_Gaia!_Spacecraft_operations_come_to_an_end
  See also: https://www.cosmos.esa.int/web/gaia/iow_20250327

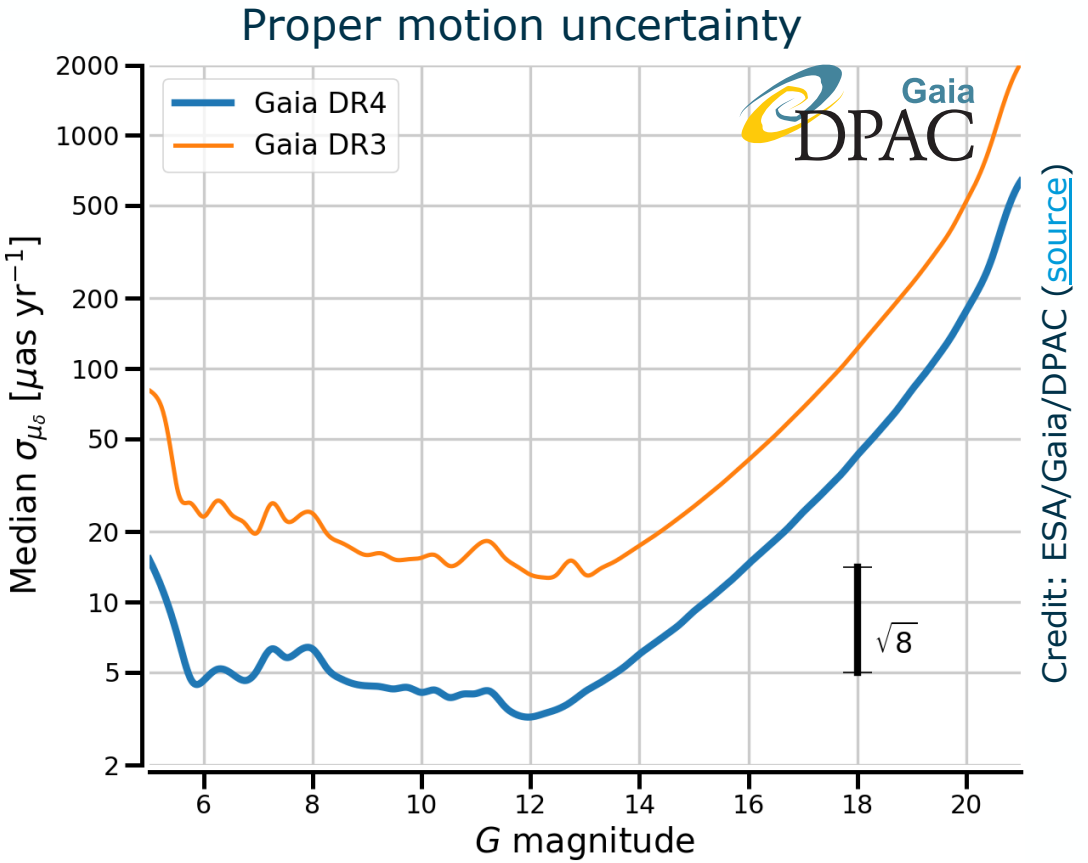


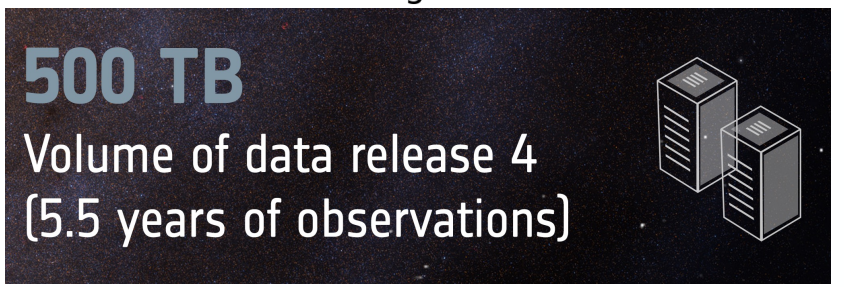
Credit: Alexander Wrede (source)

# Upcoming Gaia DR4 is the “nominal mission” data release

- Less than 1/3 of data collected by Gaia have so far been released
- Gaia DR4 covers 5.5 years (2014-2020) of Gaia data

- More data, longer timespan, better precision, higher accuracy
- >2 billion sources
- More data products, including lower-level data:
  - Time series of astrometric data + CCD images
  - Lightcurves: time series of photometric data
  - Radial velocity time series
  - Time series of low- and high-resolution spectra
  - and more
- Gaia DR4 will produce another flurry of discoveries
- Gaia DR5 (all 10.5 years of data) not before end of 2030



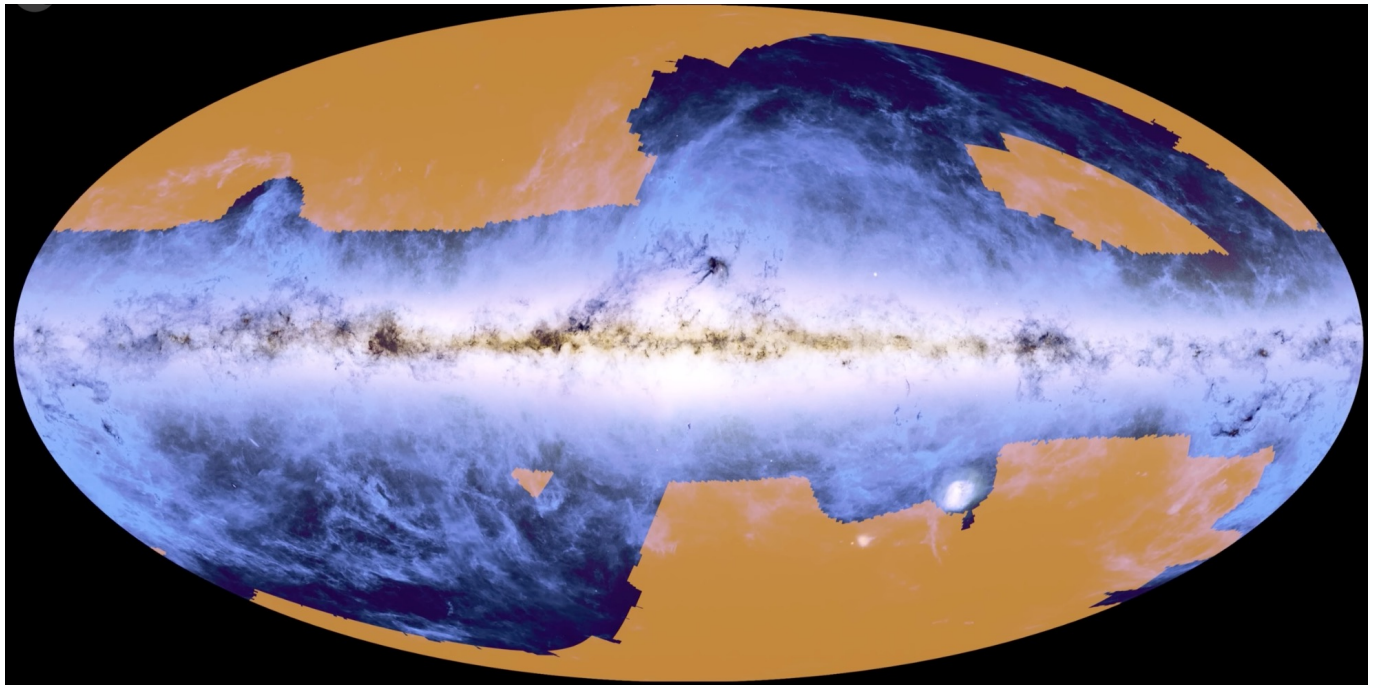
# There are plenty of science synergies with Euclid

- Gaia surveys the “bright” Euclid stars: faint extension of the Gaia celestial reference frame e.g. for proper motions (Libralato et al. 2024)
- Euclid – Gaia low-mass initial mass function (Martín et al. 2024) (talk by M. Žerjal)
- Combination of Gaia photometry (G, BP, RP) with Euclid’s optical and near-infrared photometry for stellar physics and more
- Quasars in Gaia and Euclid (talk by Y. Fu)
- Distance scale; Dark matter; …

- Synergies between Gaia studies of the local universe and Euclid results on large-scale structure and properties of the cosmos will be manifold.

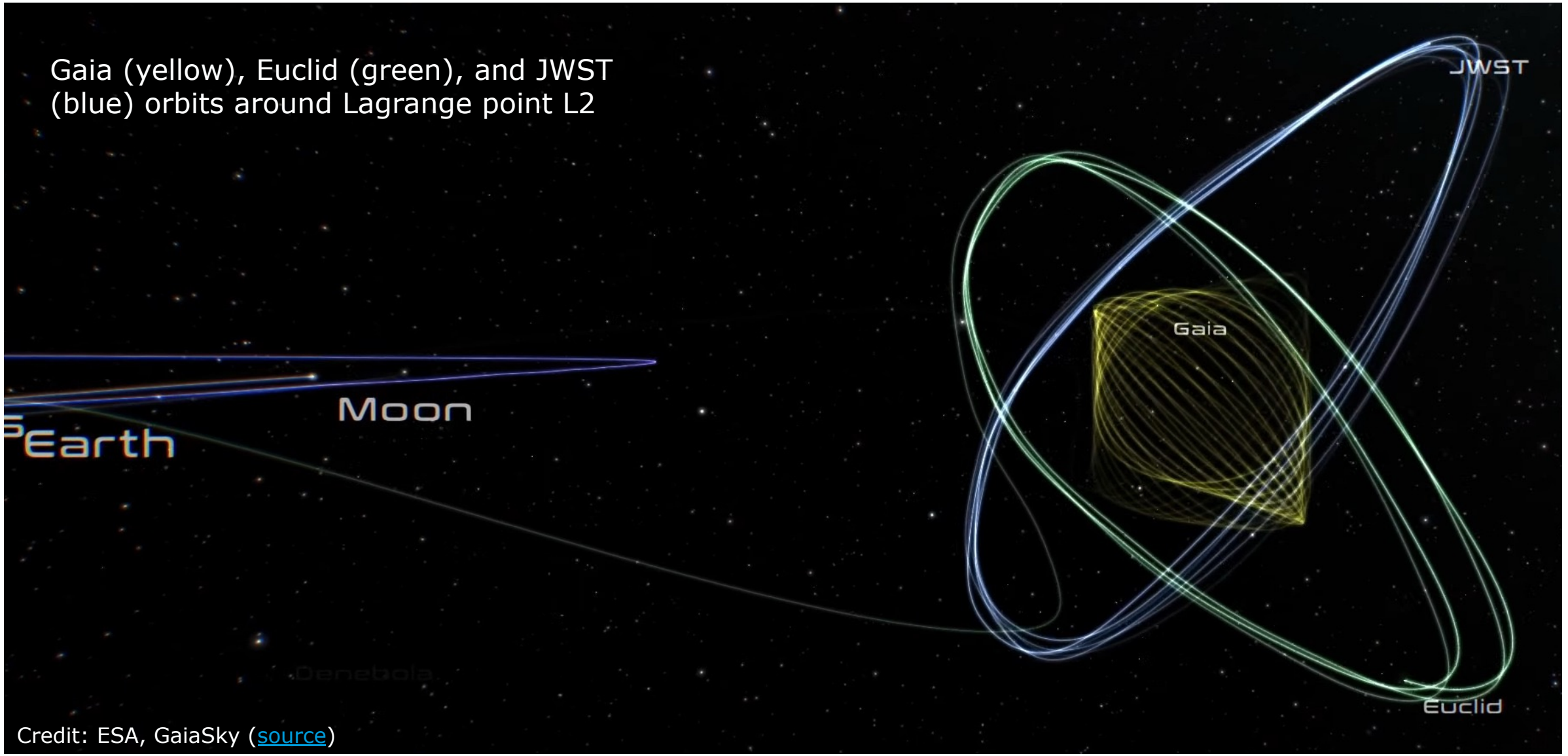


Credit: ESA (source)



Credit: ESA/Euclid/Euclid Consortium/NASA; ESA/Gaia/DPAC; ESA/Planck Collaboration (source)

# Gaia and Euclid are good friends



# Conclusions

- Gaia delivered on the promise to revolutionise our understanding of the Milky Way.
- The next Gaia data releases are on track and the best from Gaia is still to come.
- There are many science synergies between Gaia and Euclid.
- We wave goodbye to the Gaia spacecraft, but the Gaia mission continues strong.


Credit: ESA (source)

- Information for Gaia Scientific Community: https://www.cosmos.esa.int/web/gaia (data access, data documentation, and much more)
- Receive Gaia data user notifications by signing up for the Gaia Bulletin emailing list: https://www.cosmos.esa.int/web/gaia/bulletin
- Please acknowledge the use of Gaia data in your research: https://www.cosmos.esa.int/web/gaia-users/credits
- Interested in boosting the visibility of your Gaia-related research with an ESA news release? See https://www.cosmos.esa.int/web/gaia/communicating-your-results
- Information on ESA Research Fellowships in Space Science: https://www.cosmos.esa.int/web/space-science-faculty/opportunities/research-fellowships
- Information on ESA Archival Research Visitor Programme: https://www.cosmos.esa.int/web/esdc/visitor-programme