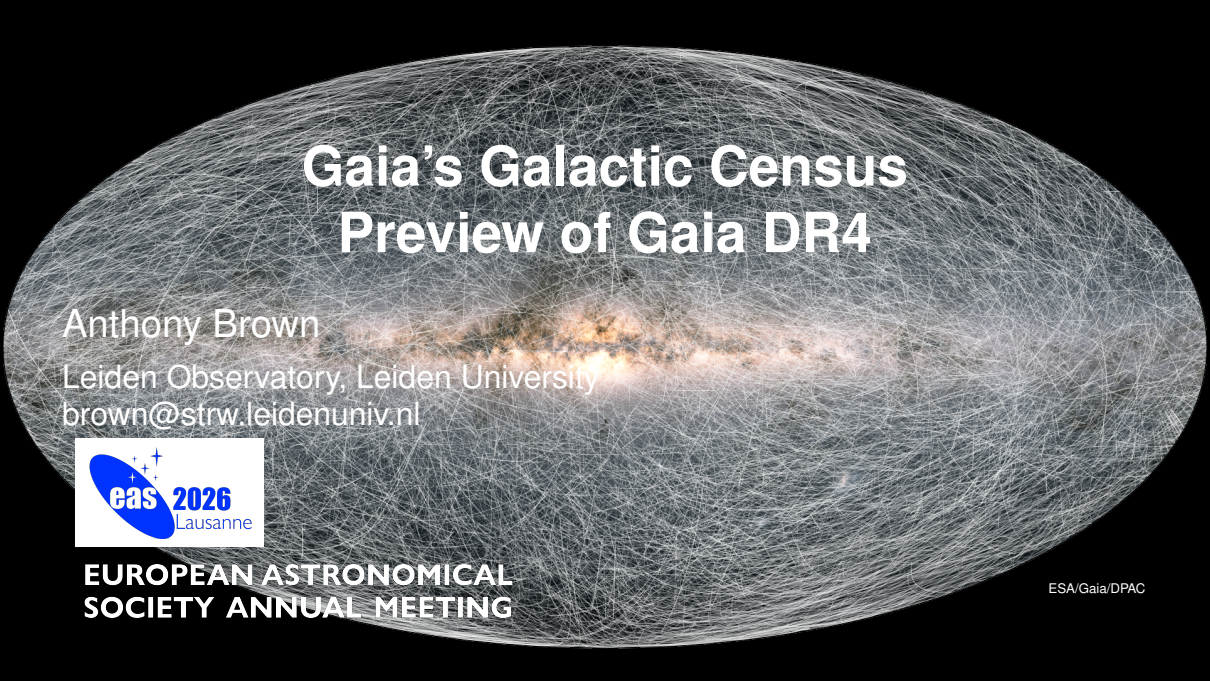
Gaia's Galactic Census
Preview of Gaia DR4

Anthony Brown

Leiden Observatory, Leiden University
brown@strw.leidenuniv.nl

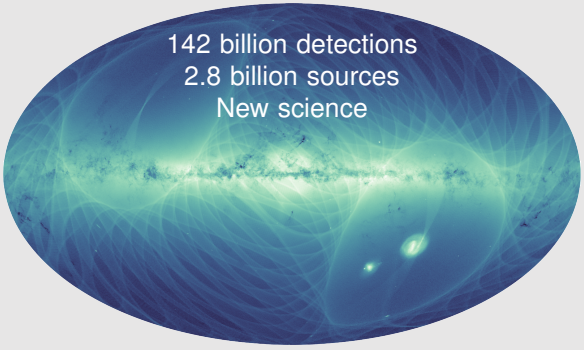
eas 2026 Lausanne

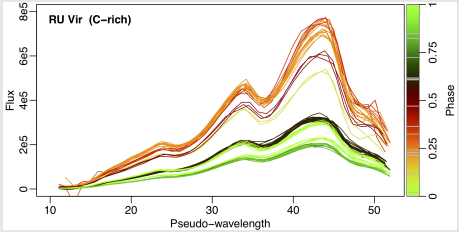
EUROPEAN ASTRONOMICAL SOCIETY ANNUAL MEETING

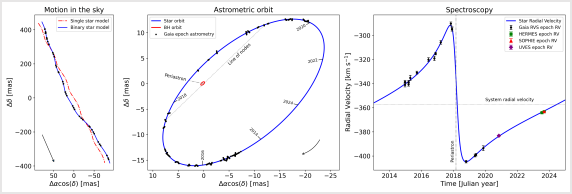


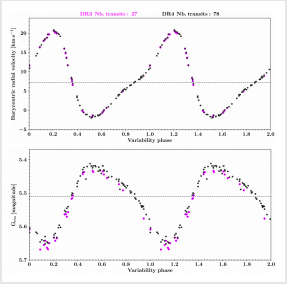
ESA/Gaia/DPAC

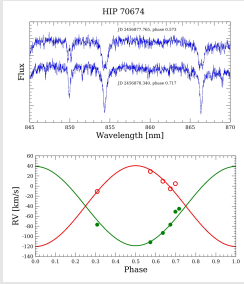
Dec 2 2026: Gaia DR4 – all sources, all time-series



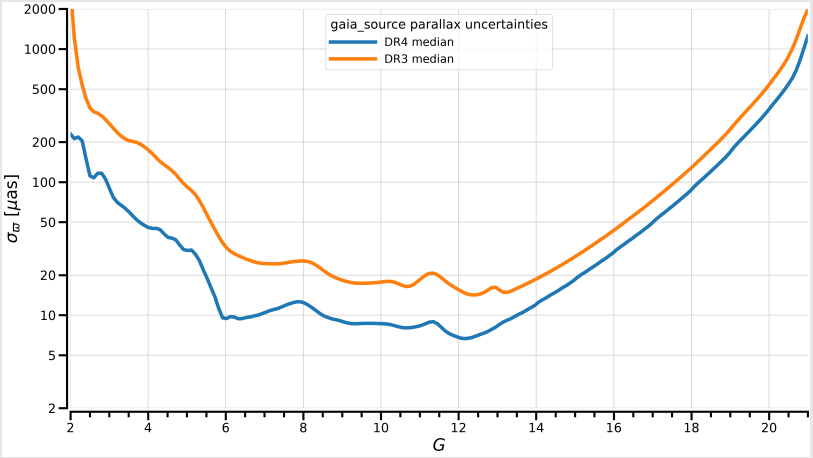








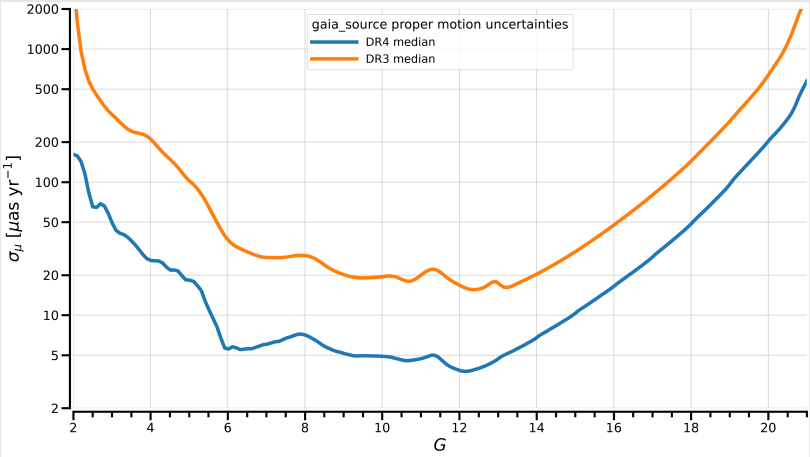
Astrometric uncertainties



DPAC/CU3/DPCE/DPCB team

- Uncertainties as reported in `gaia_source` table (for DR4, only astrometry flagged as 'reliable')
- Pre-launch expected magnitude range was $G = 6$–20

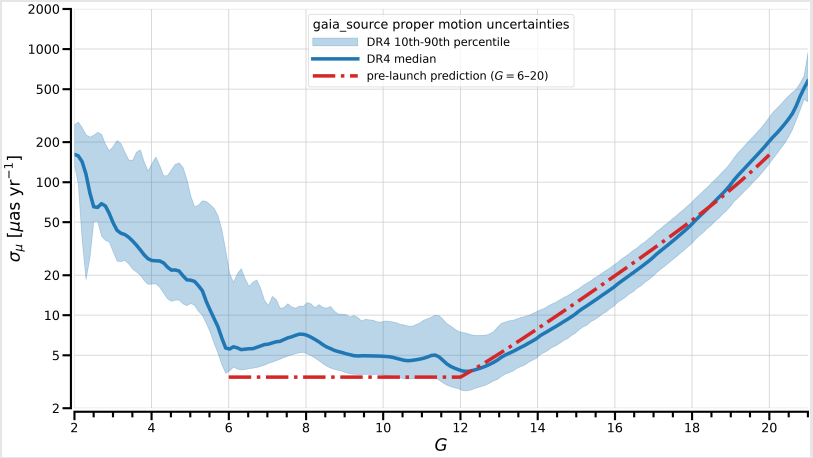
Astrometric uncertainties



DPAC/CU3/DPCE/DPCB team

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- σ_μ: semi-major axis of uncertainty ellipse of proper motion

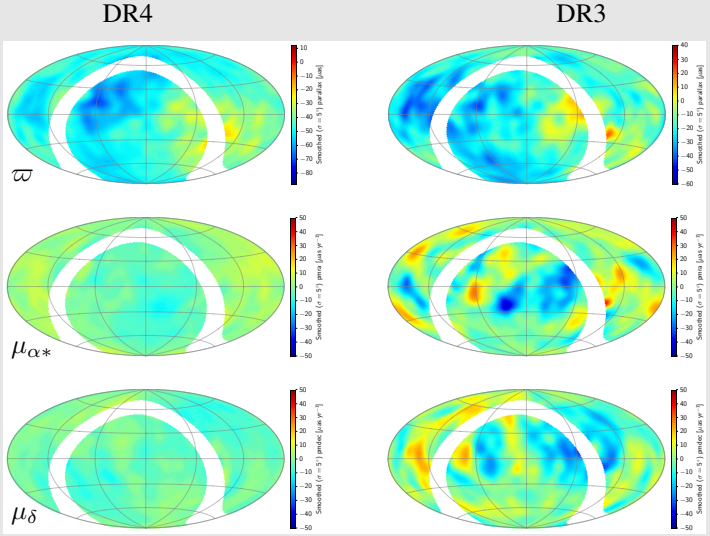
Astrometric uncertainties



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Suppressed systematic errors

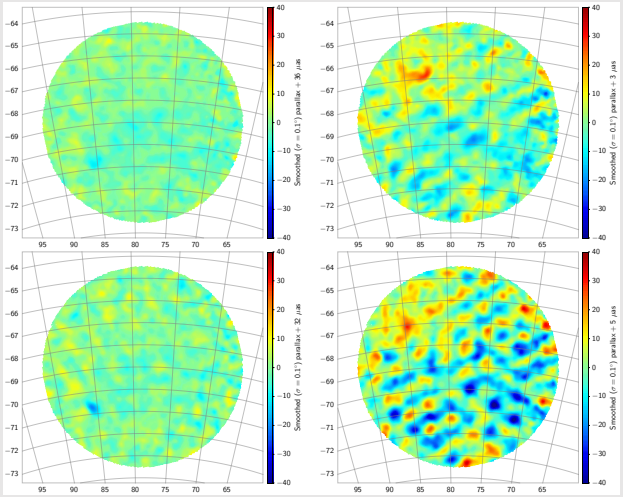


DPAC/CU3/DPCE/DPCB team

- QSO parallaxes and proper motions
- 0.8 million sources at $G < 20$
- Solar system barycentre acceleration subtracted from proper motion maps
- Maps smoothed with 5° Gaussian kernel

Suppressed systematic errors

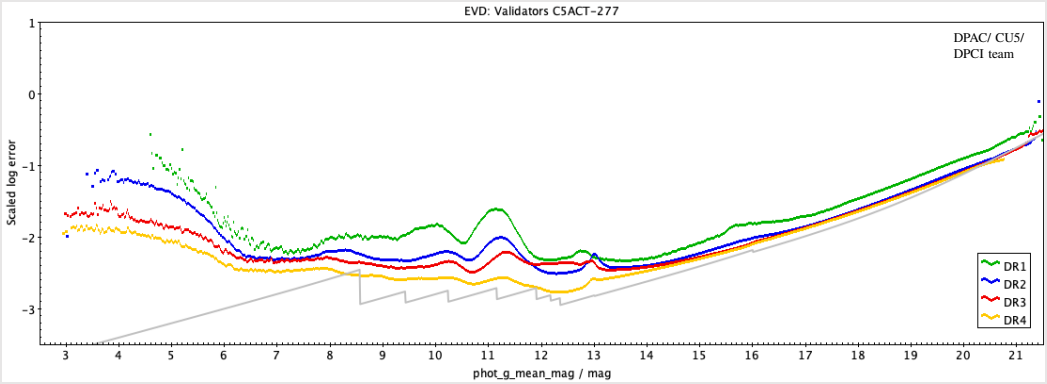
DR4 DR3



- Parallaxes in 4.5° radius region around LMC centre
- Top $G = 16$–18 (826k sources)
- Bottom $G = 18$–20 (6.38M sources)
- Maps smoothed with 0.1° Gaussian kernel
- Median subtracted from each map

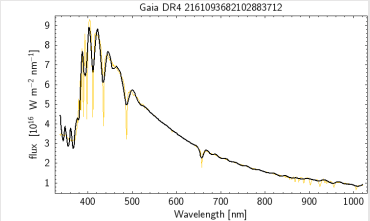
DPAC/CU3/DPCE/DPCB team

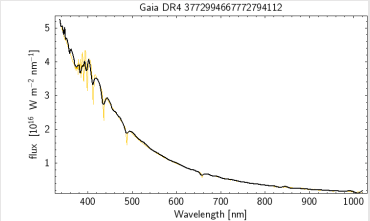
Photometry: uncertainties across releases

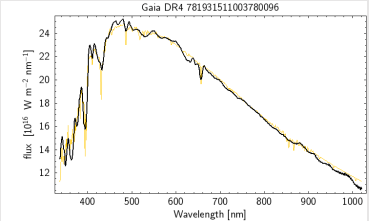


- Uncertainties are scaled to single CCD transit
  - shows the improvements in photometric processing from one release to the next
- Uncertainties on the means will include effect of increasing number of observations

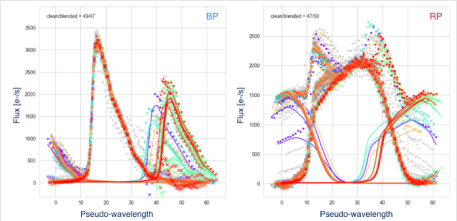
XP spectra: spectrophotometric standard stars, deblending, completeness



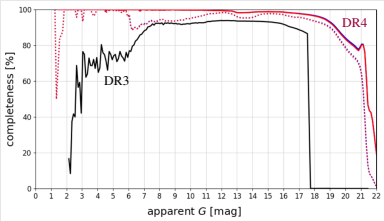




Deblending example

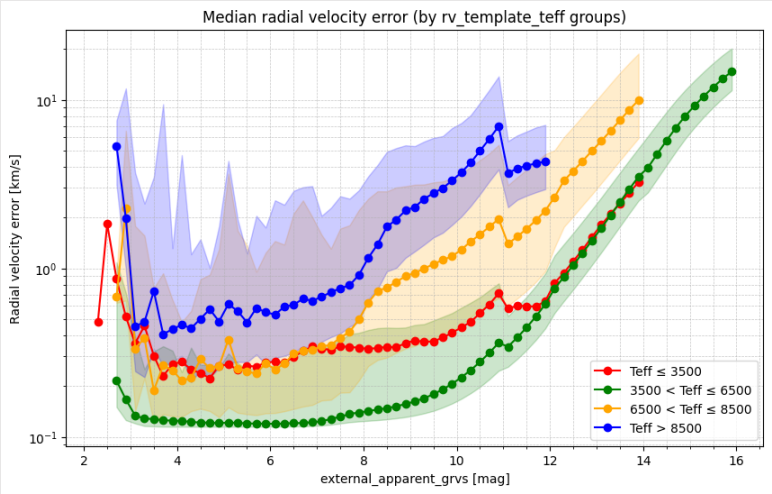


Completeness with respect to catalogue



DPAC/ CU5/
DPCI team

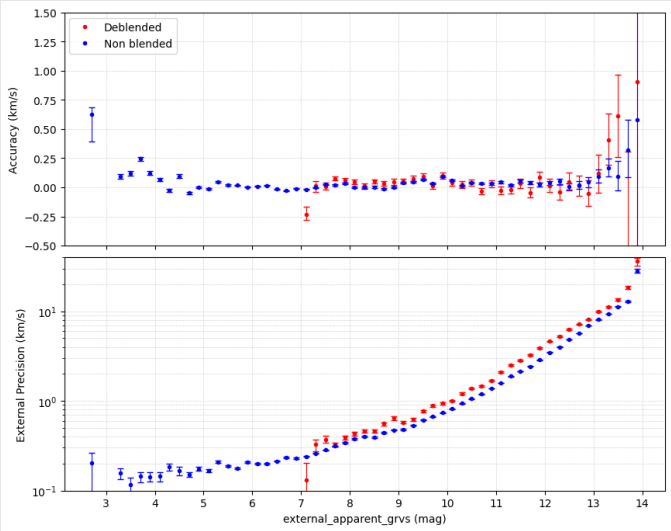
Radial velocities: uncertainties



DPAC/CU6/DPCC team

- 250 million radial velocities, of which **85 million** reliable
- 7 million line broadening parameters, of which **2.6 million** reliable

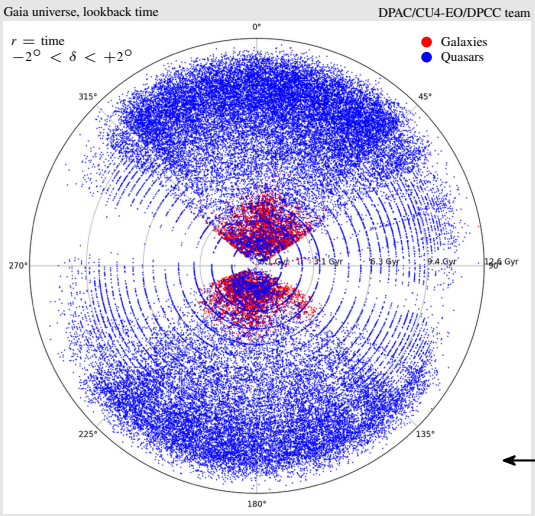
Epoch radial velocities: accuracy and precision

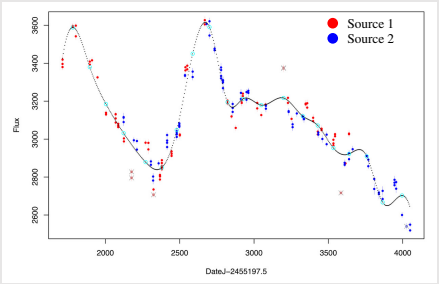


- Epoch radial velocities for sources at $G_{\mathrm{RVS}} \leq 14$
- Assessment of epoch radial velocity quality vs. reference stars
- No deblending is done for bright stars with 2D observations windows
- RVs from blended spectra are as accurate as non-blended, deblending process slightly degrades precision

DPAC/CU6/DPCC team

A peak into Gaia DR4 extragalactic content





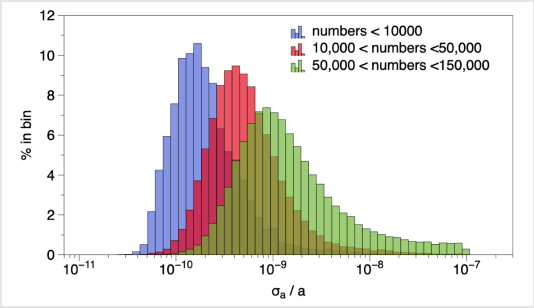
- New: gravitational lens detection from source clustering, BP/RP spectra, correlated variability
- Time delays measured for known lenses, including new delay measurements

- 4.5 million QSOs analysed, 163 000 host galaxy profiles determined (Sérsic, $z < 0.4$)
- Profiles of 3.4 million galaxies determined ($Z < 0.2$, Sérsic, de Vaucouleurs, bulge+disk)

Solar system content

- 8 283, 838 transits of 436 551 objects
  - 7 149 713 have a calibrated G
- 100 648 objects with reflectance spectrum
- 215 000 orbits with $\sigma_a/a < 10^{-7}$
  - 345 000 in total
- Science applications
  - Determine the precise mass for several tens of asteroids (Gaia only observations)
  - Enable new stellar occultations by small objects
  - Detect non-gravitational effects on asteroids and comets
  - Improve dynamical models of planetary satellite orbits
  - Find satellites around asteroids

Object category	Object count
Natural satellite	42
Asteroid	434 237
Comet	314
Unidentified SSO	1 957

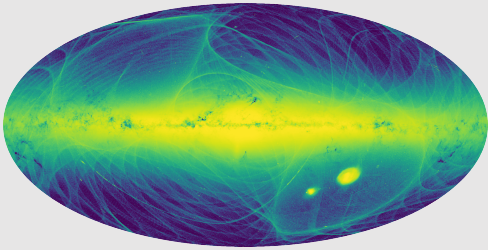


DPAC/CU4-SSO/DPCC team

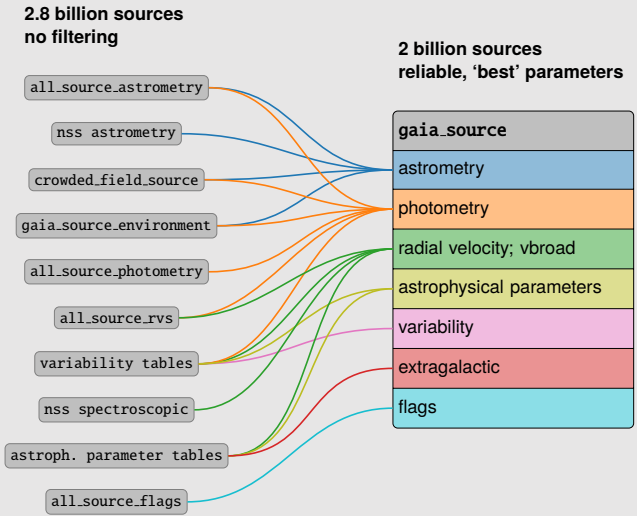
Gaia DR4: major table structure change

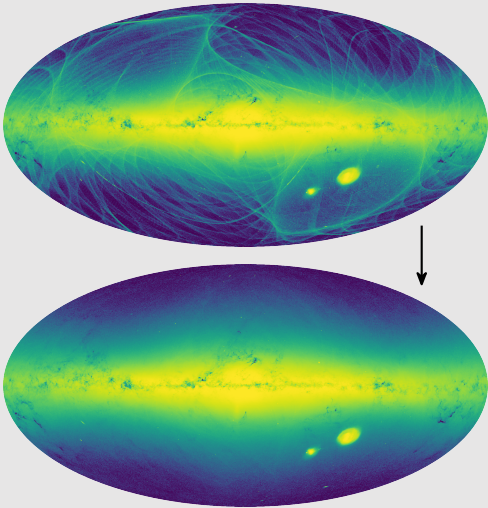
2.8 billion sources
no filtering

- all_source_astrometry
- nss astrometry
- crowded_field_source
- gaia_source_environment
- all_source_photometry
- all_source_rvs
- variability tables
- nss spectroscopic
- astroph. parameter tables
- all_source_flags



Gaia DR4: major table structure change





Gaia DR4: major table structure change

Gaia DR4 source list and table structure

- *All* $\sim$ 2.8 billion sources will be published
  - That is, no filtering on solution quality
  - Solutions for many sources will be of lower quality, should be used with care!
- The `gaia_source` table will contain:
  - the subset of reliable (high confidence) sources — 2 billion
  - 'best' values for the source parameters (e.g. astrometric solution from non-single star pipeline, instead of from AGIS pipeline)
- Supplementary tables for astrometry, photometry, radial velocities will contain homogeneous data for *all* sources (i.e. including low confidence sources)
- And many other tables
  - Details at `https://www.cosmos.esa.int/web/gaia/dr4`
  - Detailed data model available at: `https://www.cosmos.esa.int/web/gaia/dr4-prerelease`

Gaia data is brought to you by



Please credit the team!

- Cite the data release and data processing papers
- https://gea.esac.esa.int/archive/documentation/credits.html

Gaia DR4 is coming . . .

- Wednesday December 2 2026
- Accompanied by papers documenting the release, and performance verification papers
- Largest Gaia data release so far, containing a rich variety of exciting new data products
- Stay up to date
  - https://www.cosmos.esa.int/web/gaia/data-release-4
- Stay with us in Symposium 7 for more previews!



