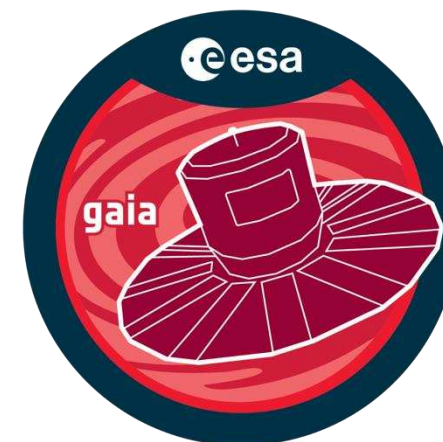


Scattered Light in Gaia DR4

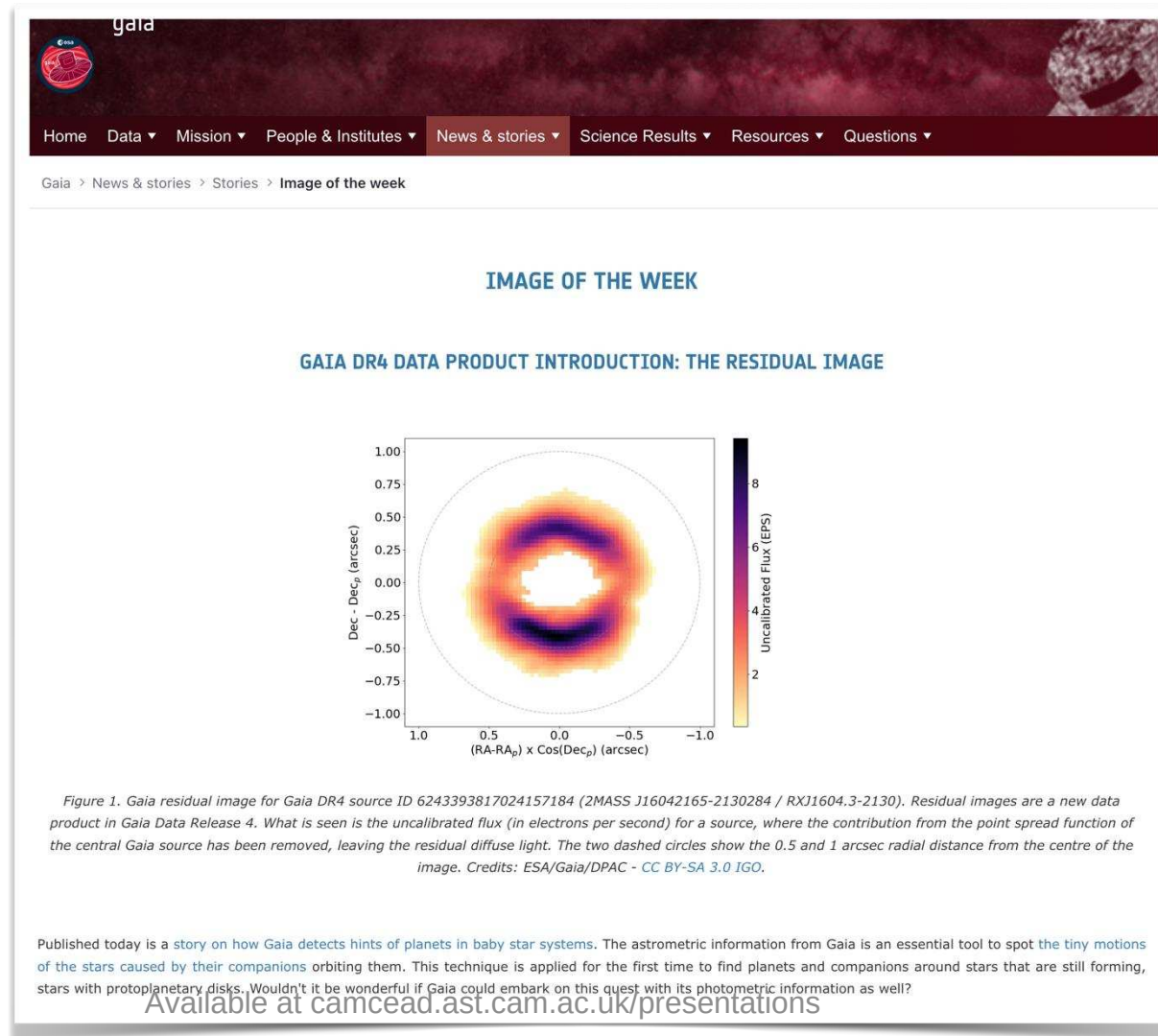
Diana Harrison

Héctor Cánovas, Simon Hodgkin, Patrick Burgess,
Francesca De Angeli, Dafydd Wyn Evans



A new product for Gaia DR4 : residual images

Announced in this
[image of the week](#)



Overview

New Product in [DR4](#) : residual images

Will include images of scattered light from protoplanetary disks, debris disks and dusty circumstellar environments around evolved stars

There will be an accompanying paper: Gaia Data Release 4: Diffuse light imaging

This talk:

Imaging scattered light was never in the plan for Gaia

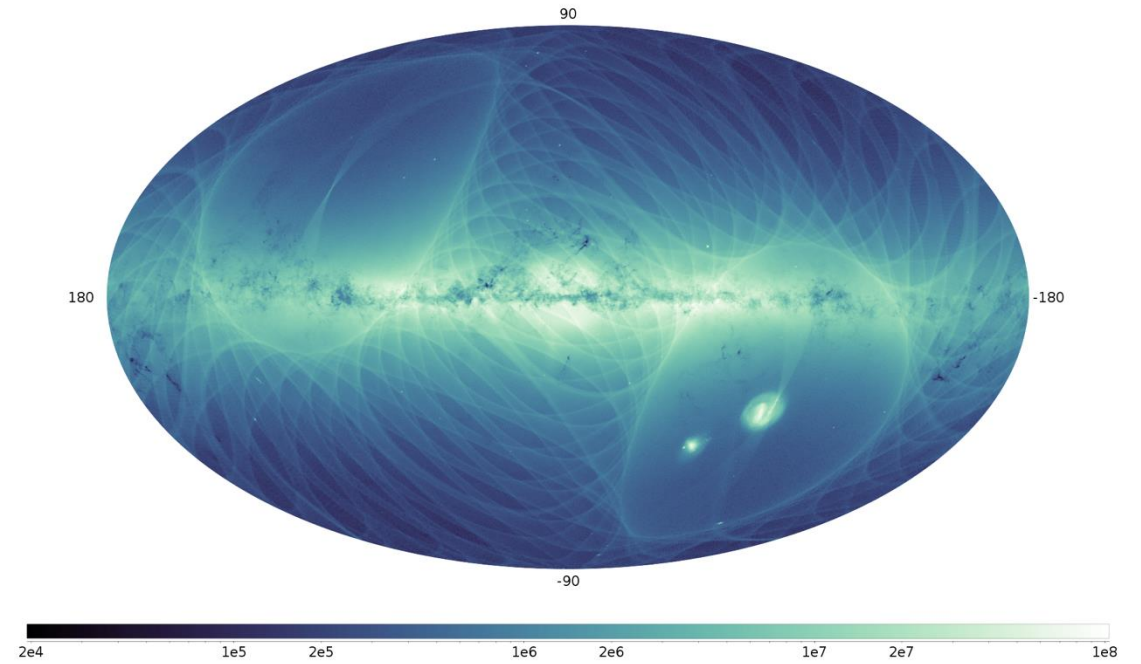
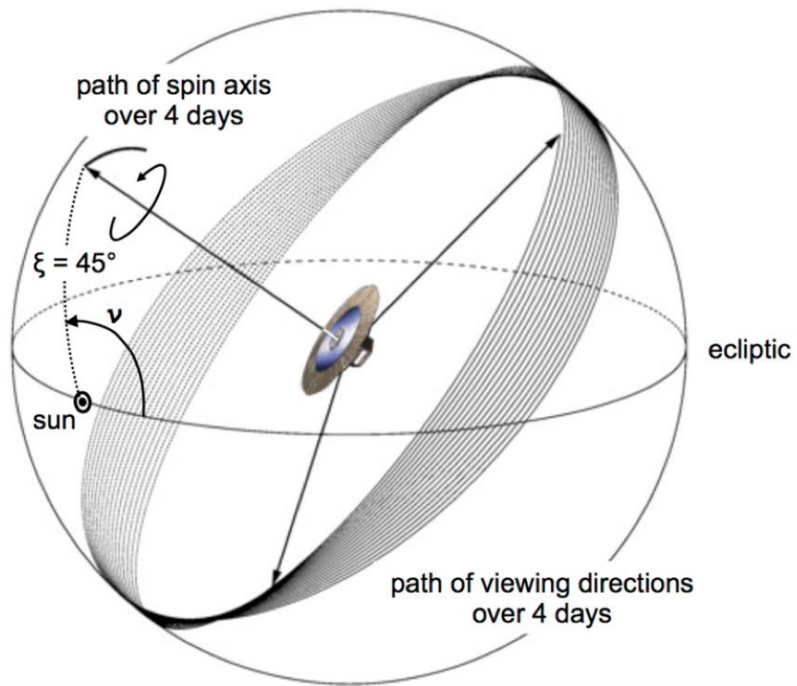
Some background as to how this product came about, and how Gaia takes data

How this product is generated

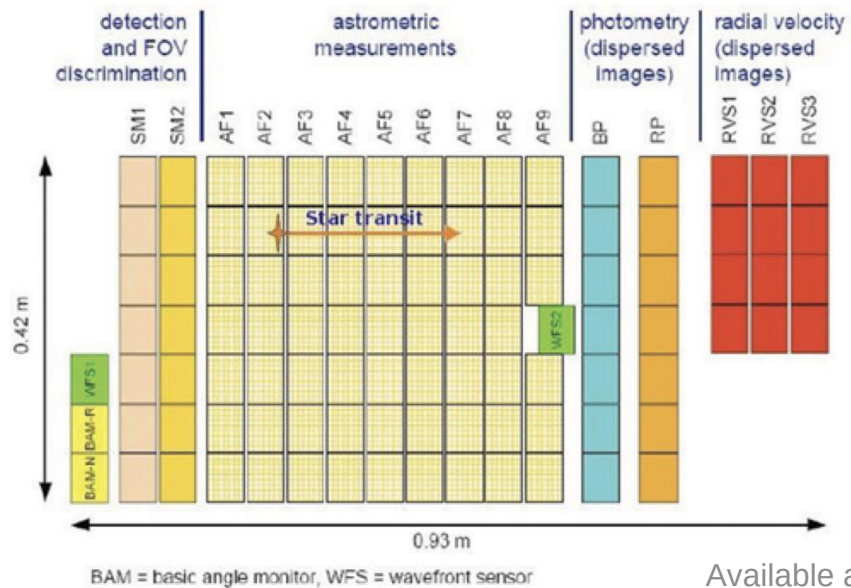
Some properties and caveats about these images

More about the sources for which these images will be available

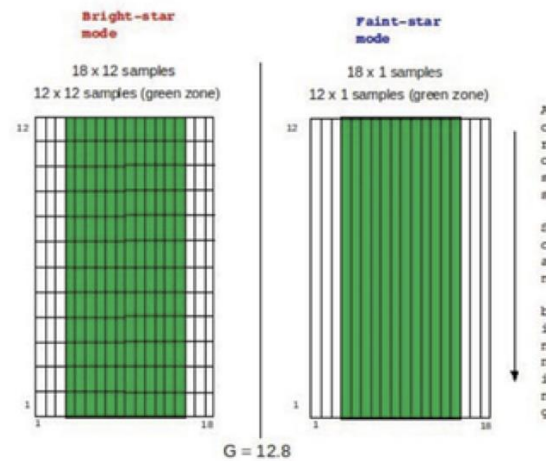




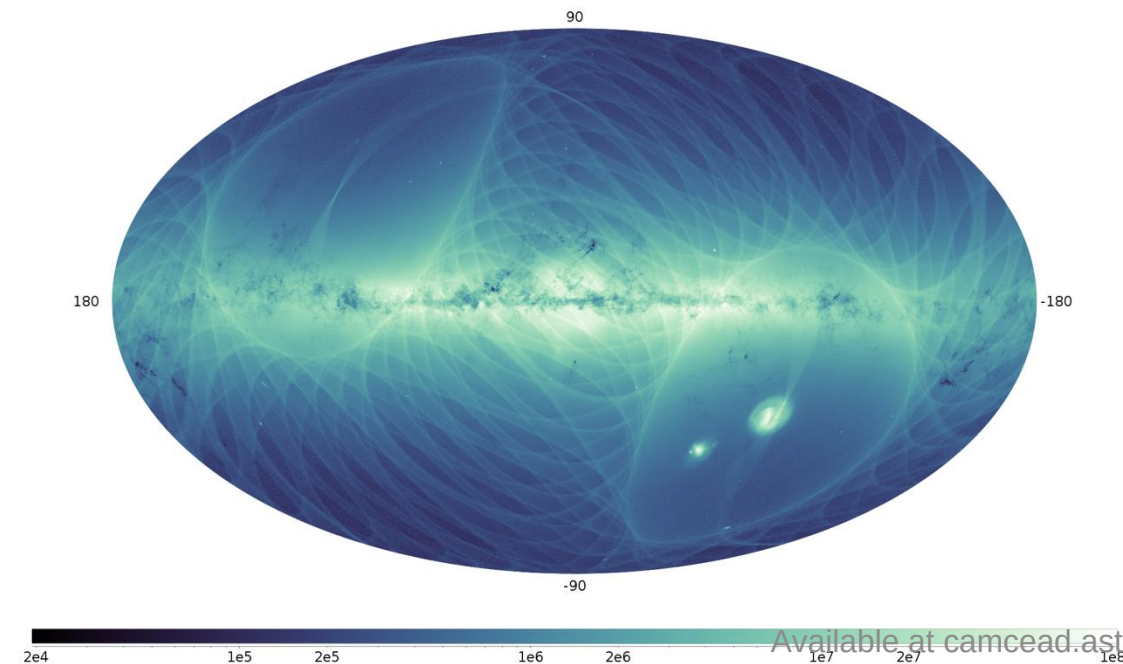
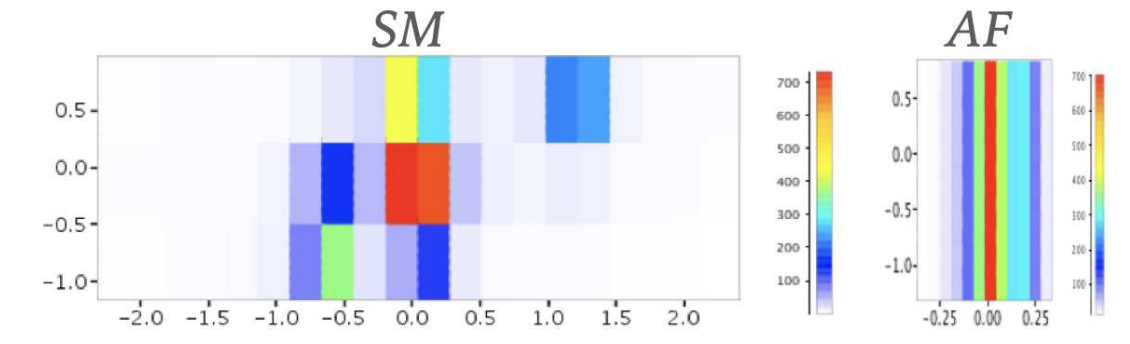
Star transit



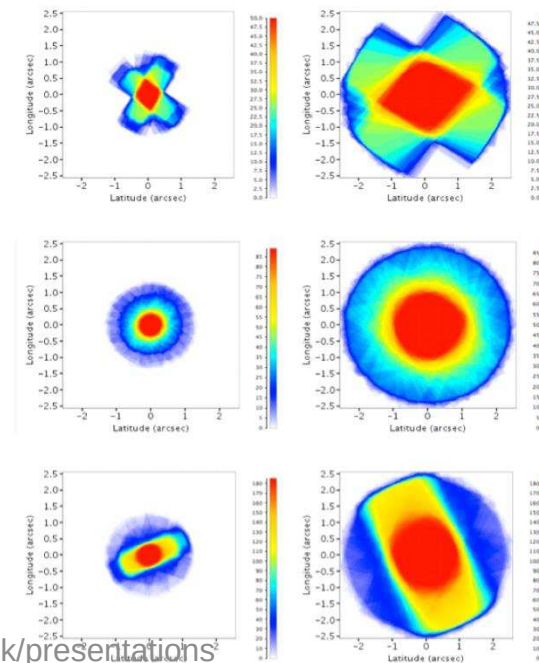
read-out window strategy

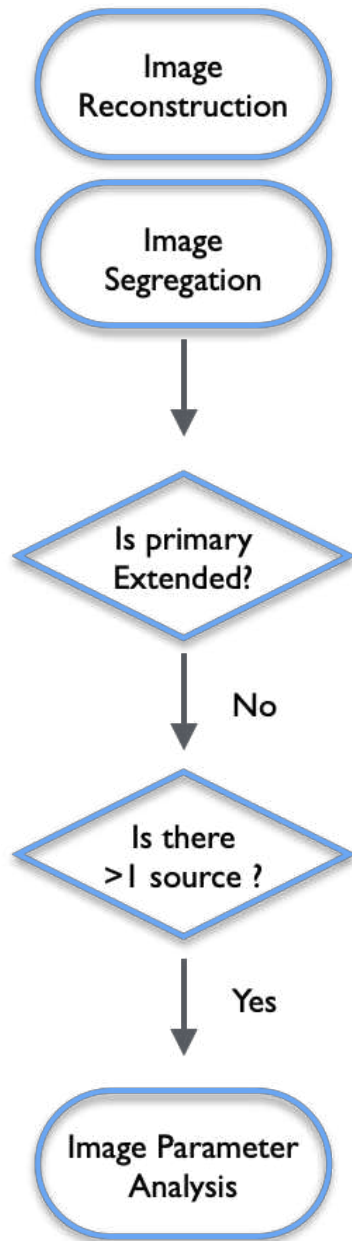


Source Environment Analysis



Window footprint



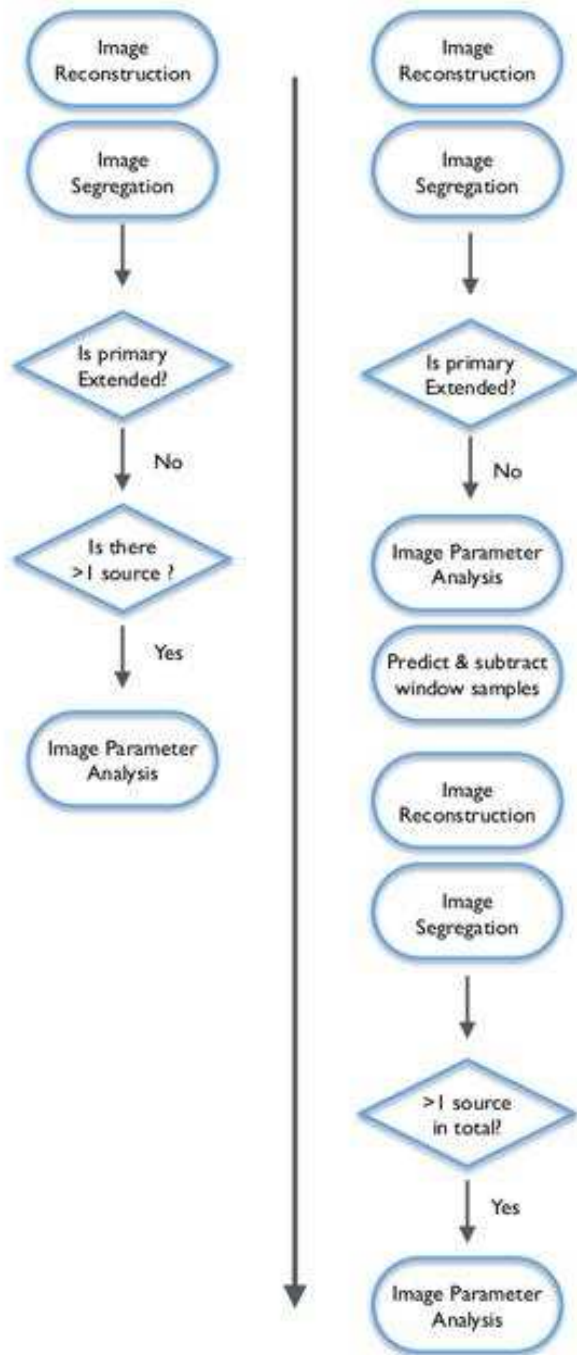


Source Environment Analysis : SEAPipe

Identify extended sources

Find additional sources in the windows of Gaia sources (on-board detection)

Solve for the flux and astrometric parameter (position, proper motion, parallax) for the additional sources together with their parent source (the one detected on-board)



SEAPipe: we can find fainter, closer companions

An image subtraction version of SEAPipe was also developed

Gaia data processing SEAPipe: The source environment analysis pipeline

[A&A, 679 \(2023\) A158](#)

Can we see scattered light ?

Given the high-contrast between the central Gaia sources and companion achievable by SEAPipe this raised the question as to whether seeing scattered light was possible.

SEAPipe was designed to cope with the faint (1D AF data) and to be able to process all the Gaia sources.

Restricting to $G < 13$ we have 2D AF data and more resources per source so we should be able to do better

So after some more coding ...



We can see scattered light

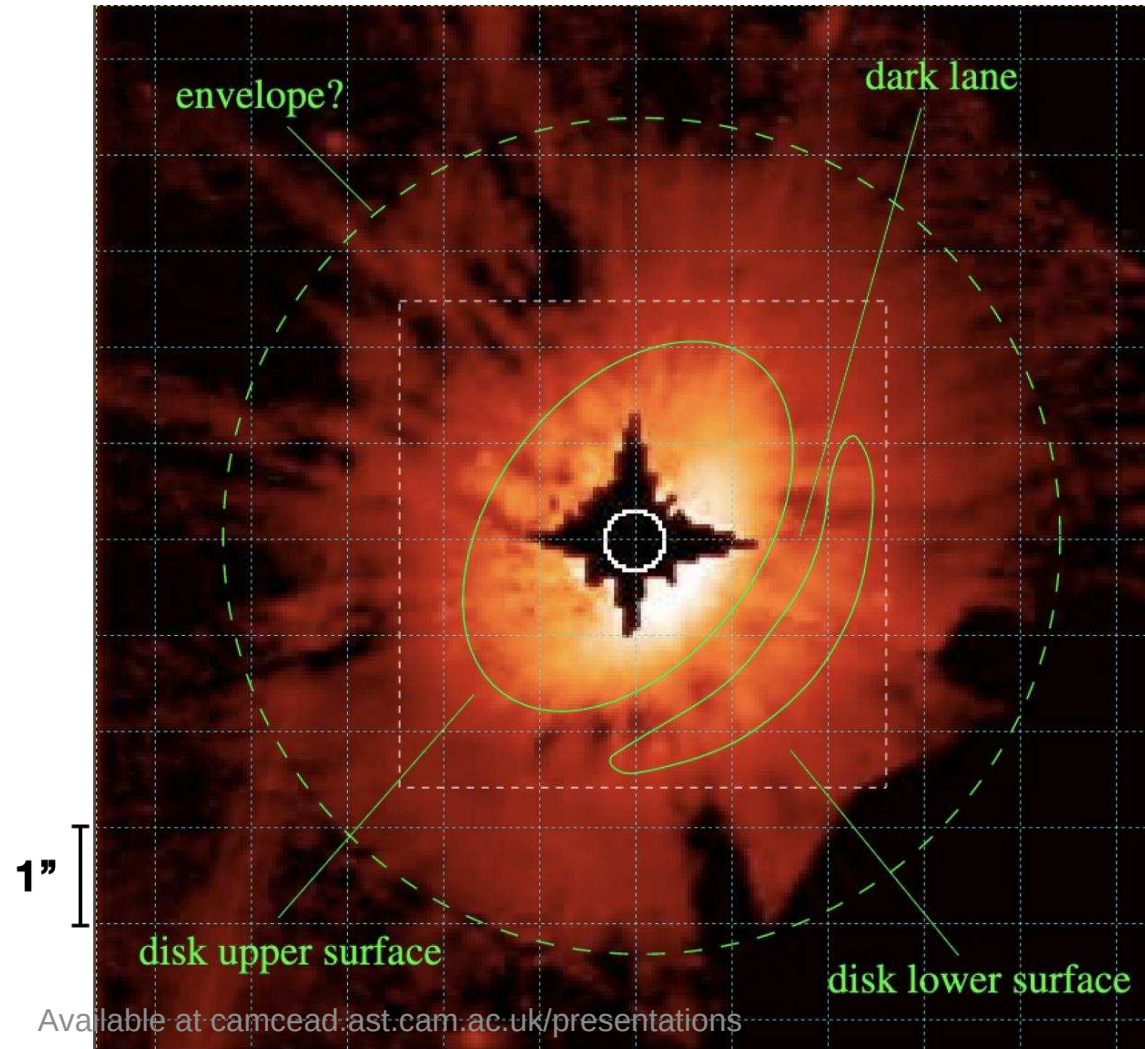
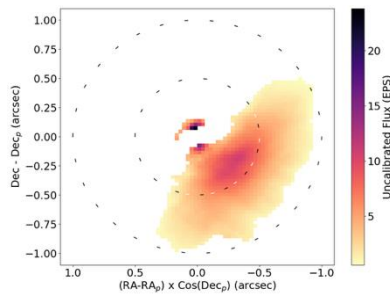
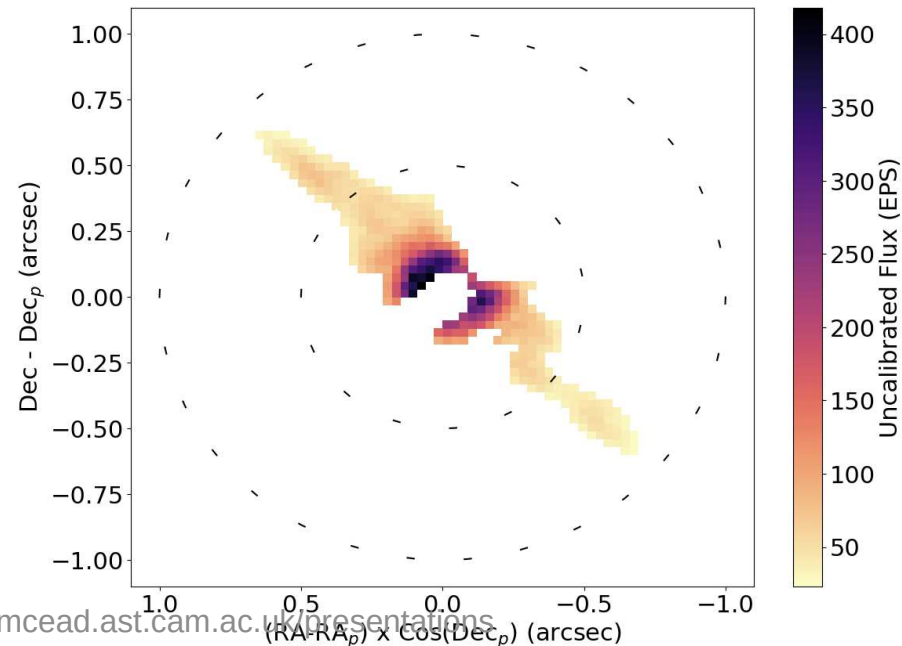
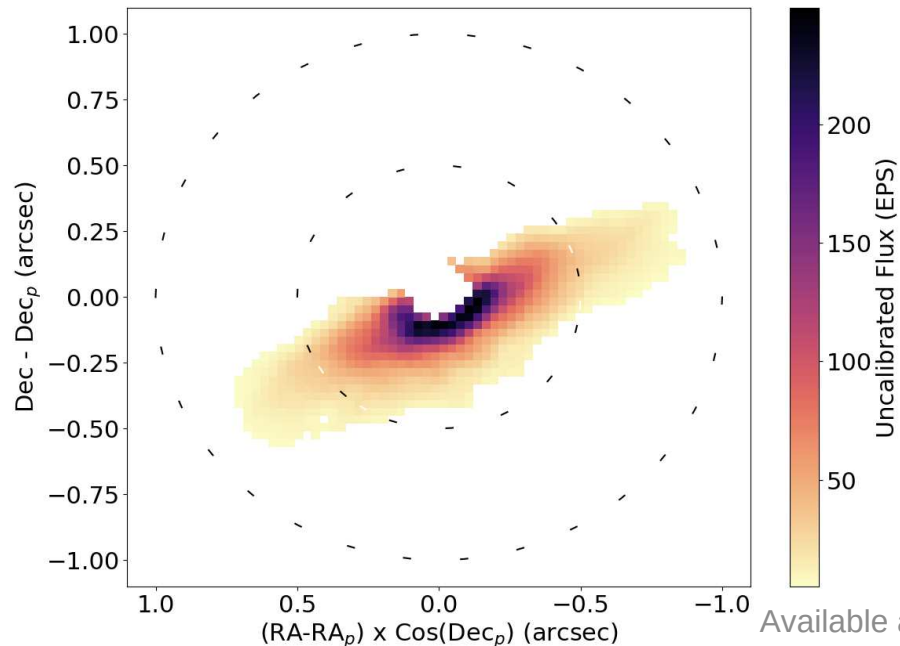
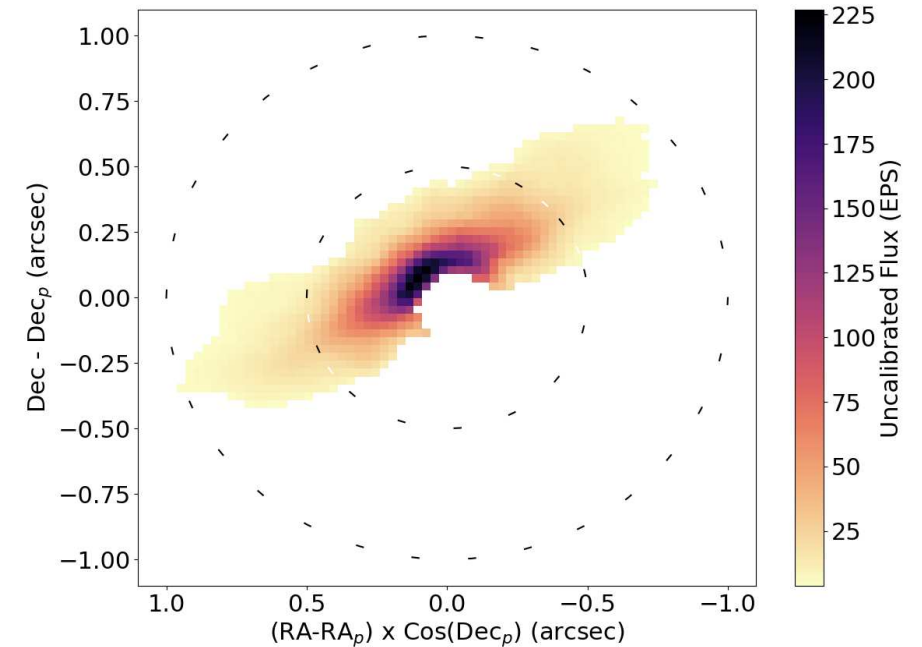


Fig. 2 from
*Probing dust grain
evolution in IM Lupi's
circumstellar disc*
[A&A 489, 633–650
\(2008\)](#)

We can see scattered light

Examples of debris disks in Gaia with alignments which agree with polarised intensity observations

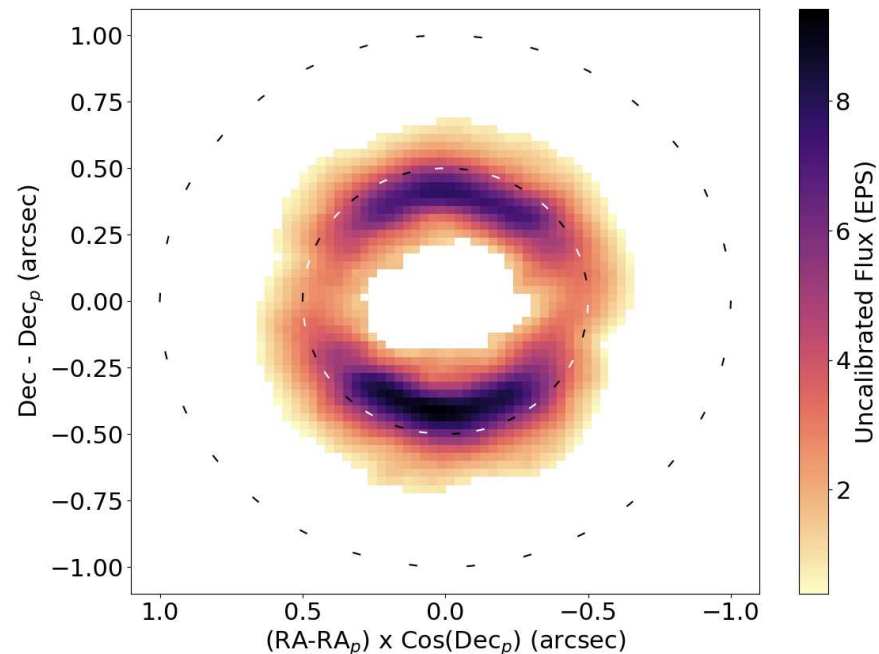


A note on time variability

Residual images are constructed from observations which span DR4

DR4 covers observations between 25 July 2014 to 29 January 2020

A given residual image will be the average over the epochs at which its source is observed by Gaia



Diffuse Light Pipe

Produces a new product for DR4 : residual images

Images after the removal of the flux of the central star

Sources with a companion within $\Delta m \lesssim 3$ are not included

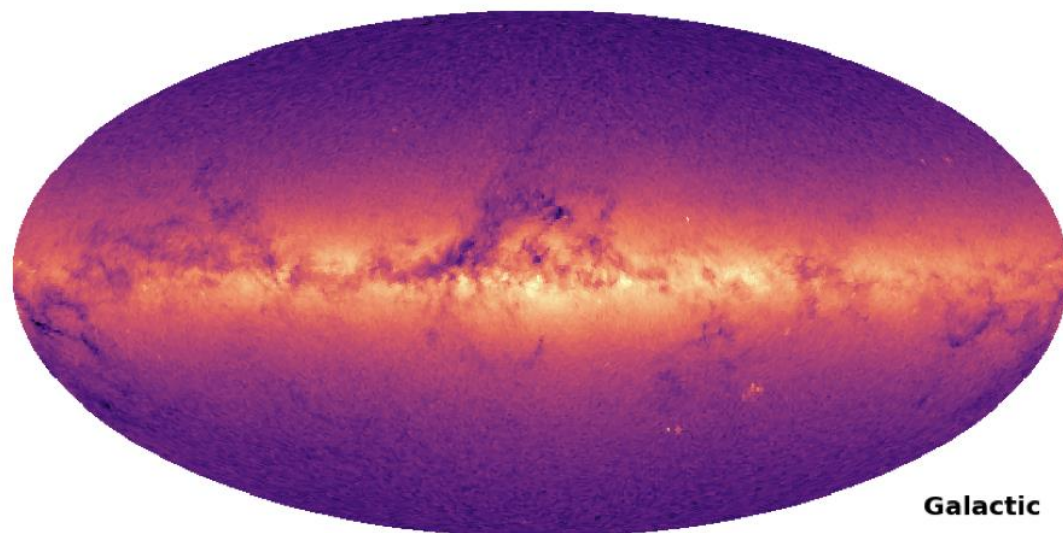
Formed from the 5.5 years of DR4

Images are averages of the emission over the observed epochs (source dependent)

Stacked on the co-moving position of the central star

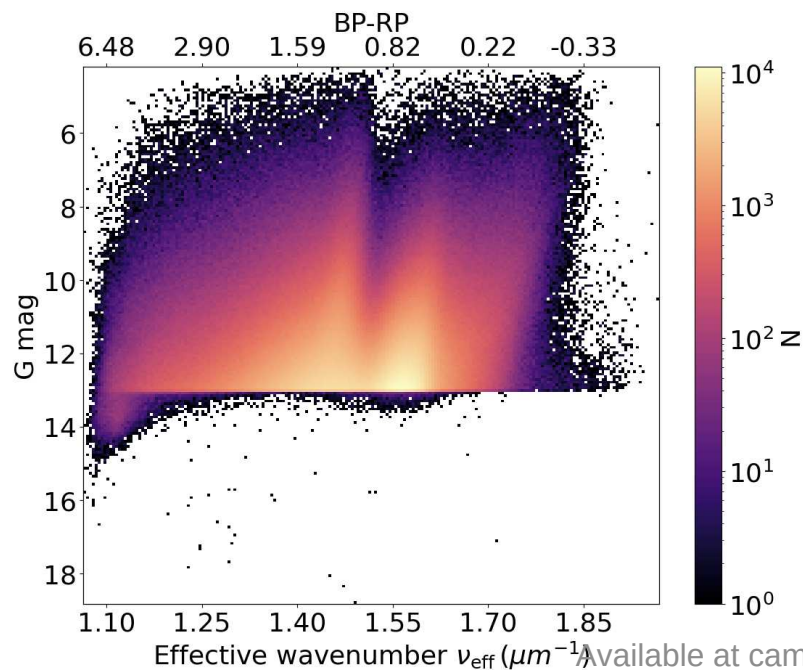
A bound companion star may be visible as an arc along its orbital path





Galactic

11 No. of residual images 1377

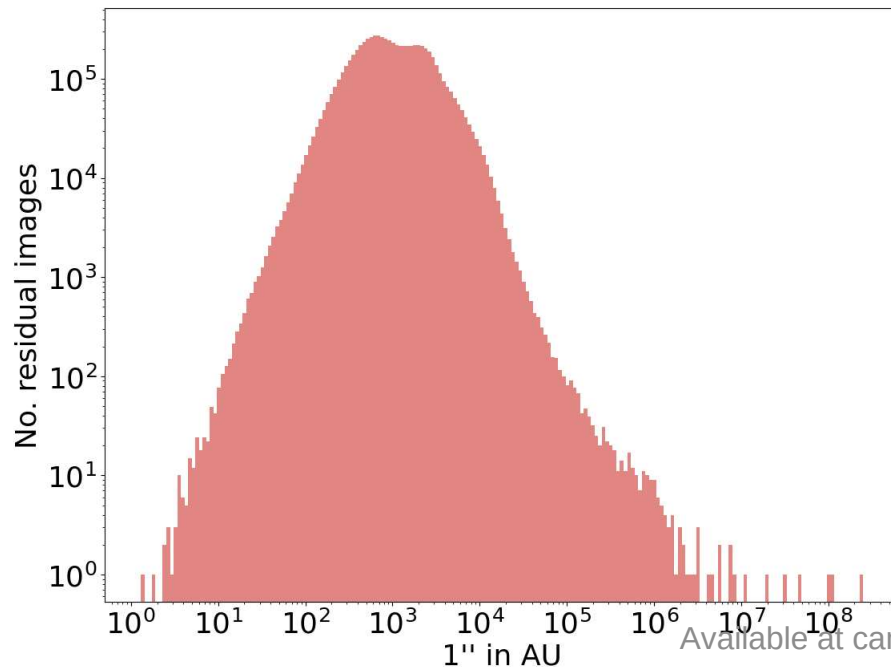
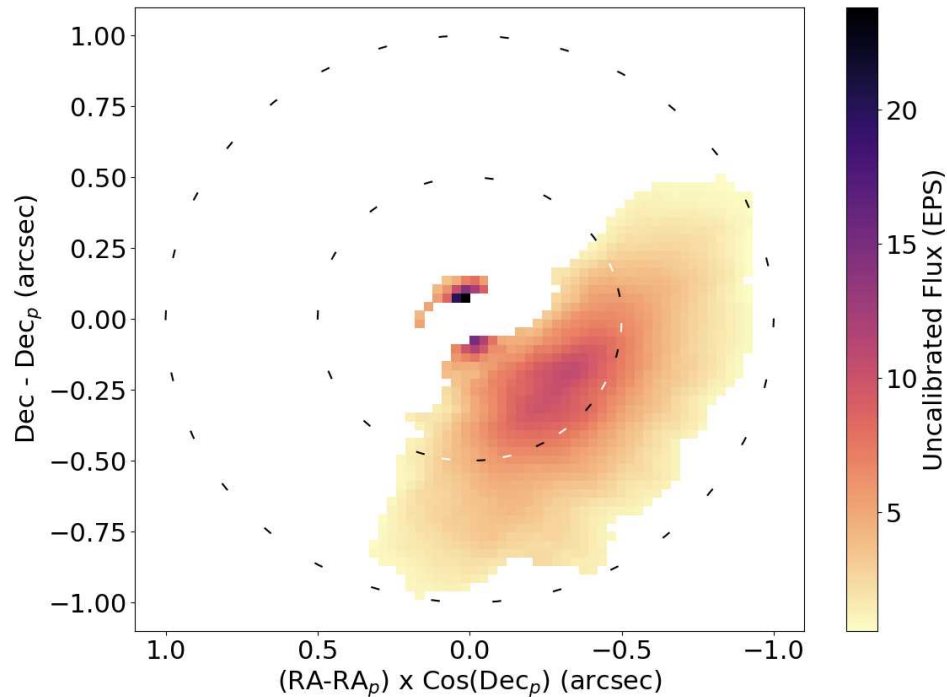


Residual image product

~ 7 million residual images distributed over the whole sky will be available in DR4

Majority $G < 13$ however a few will be fainter

If a source was assigned enough 2D windows, it is processed by DiffuseLightPipe and will have a residual image



Residual image product

Size of the images is restricted to the height of the AF windows in combination with how well the windows are centred on the Gaia source

Radius $\sim 1.1''$ to $1.2''$

Some disks maybe too big to see... or to see all or it.

Summary

Residual images is a new product for [DR4](#) (December 2026)

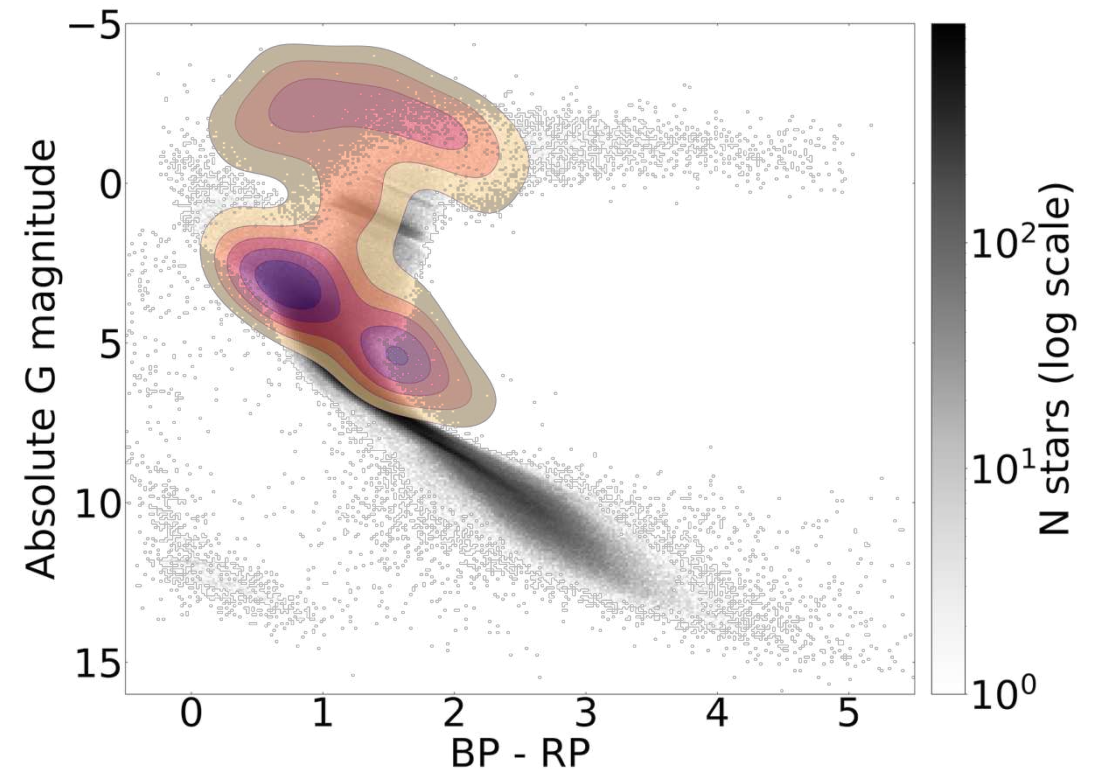
Available for majority of $G < 13$ Gaia sources

Full-sky survey of scattered light

The accompanying paper

Will characterise the sensitivity of these images (So, absence of emission will also be informative)

Will present the most visually obvious case of diffuse emission and describe how these were found





eas 2026

Lausanne

Available at camcead.ast.cam.ac.uk/presentations