



**The Solar neighborhood
in the age of Gaia**

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Introduction to Gaia

Why you should care about Gaia

- Full sky survey ($M=20$)
- Proper motion, parallax, radial velocity
- Precision: $6.7 \mu\text{arcsec}$ ($M=12$)
 $\sim 100 \mu\text{arcsec}$ ($M=20$)

→ 6D map of solar neighborhood ($\sim 2\text{kpc}$)

Why you should care about Gaia

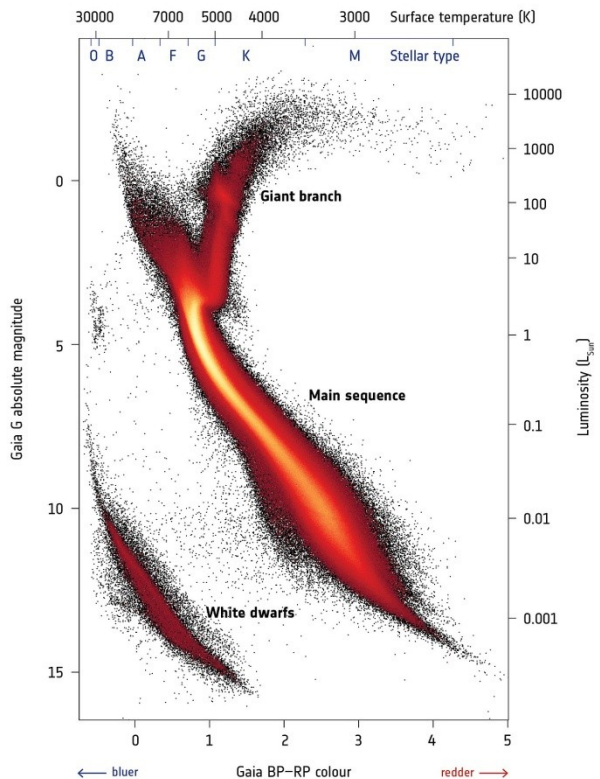


Fig 2: ESA/Gaia/DPAC,CC BY-SA 3.0 IGO

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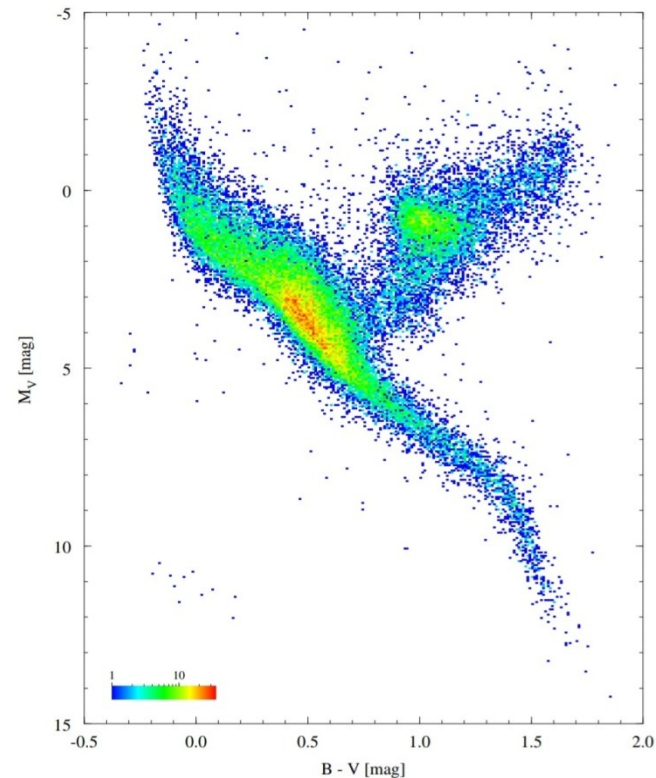


Fig 1: ESA/Hipparcos/DPAC,CC BY-SA 3.0 IGO

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Why you should care about Gaia

- Star + planet formation/evolution
- Distribution and kinematics of dust and gas
- Kinematics of clusters
- Galactic dynamics and structure formation

→ Broad scientific utility!

What is Gaia?

Technology:

- 2x 1.45x0.5m Primary Mirror
- 10m sun shade
- No reaction wheels, gyroscopes
- Lissajous Orbit at L2



Fig 3: ESA-M. Pedoussaut, 2013

Gaias Orbit

Equatorial view

Polar view

From the sun

2013-12-19

Gaia

2013-12-19

Gaia

2013-12-19

Gaia



0.000km/s

8,339km

0.000km/s

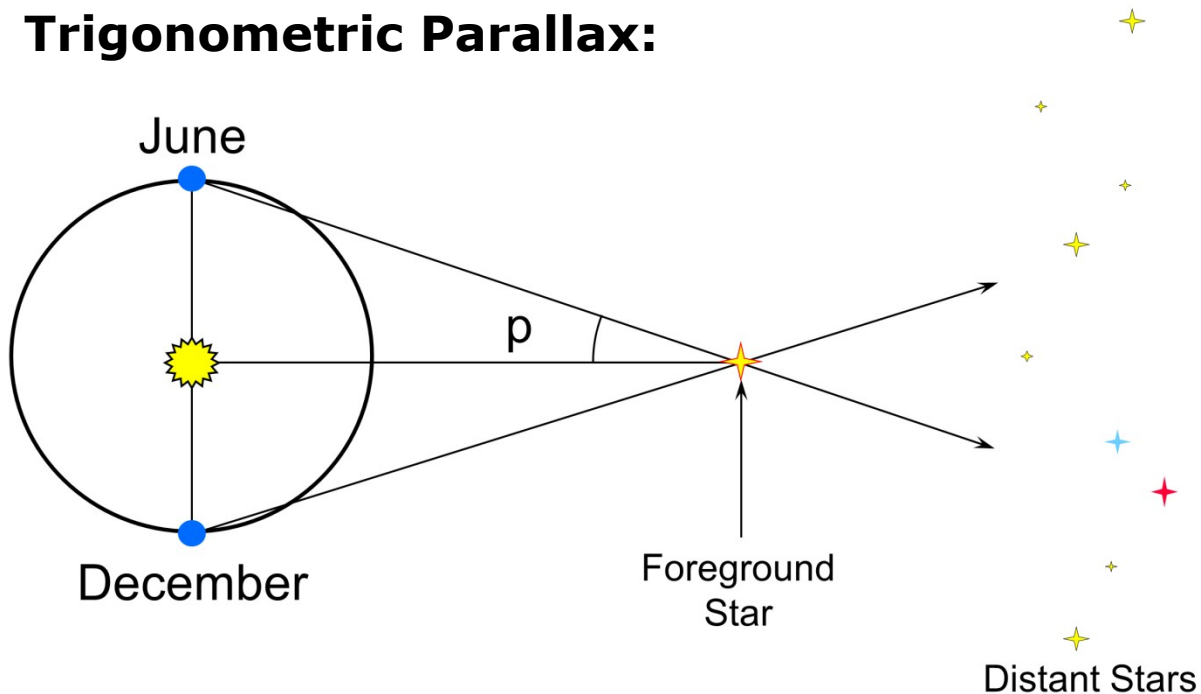
8,339km

0.000km/s

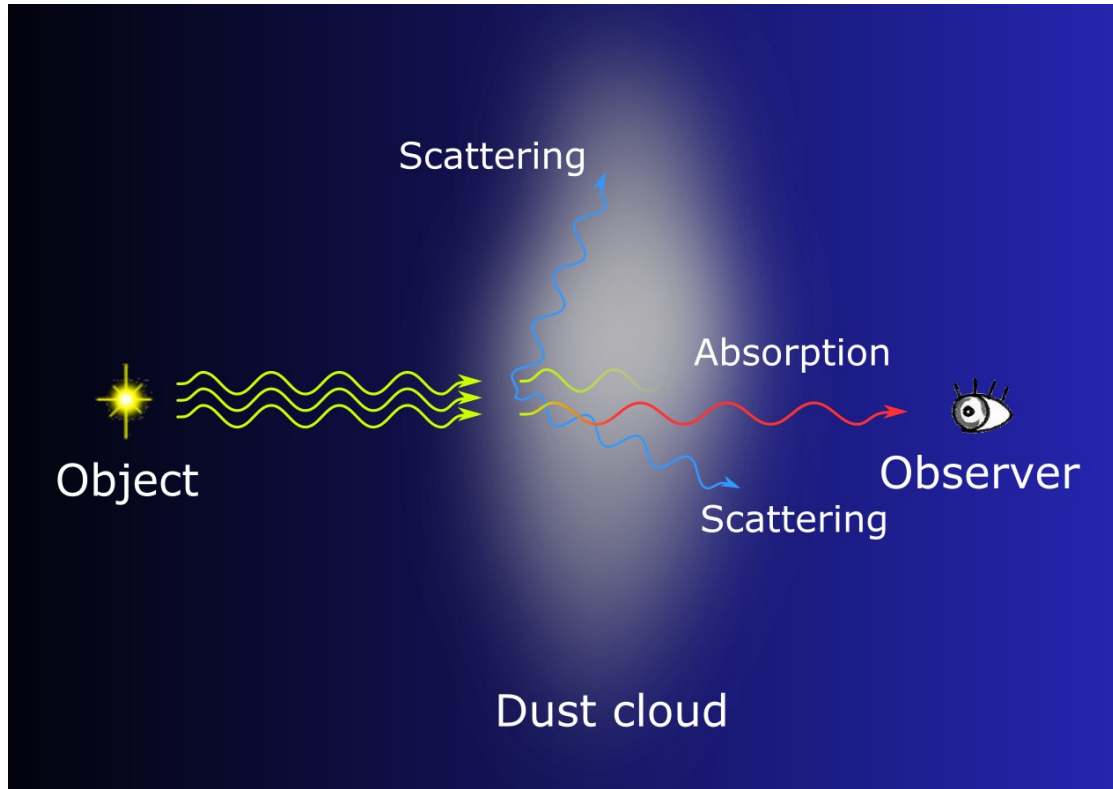
8,339km

How Gaia Collects Data

Trigonometric Parallax:



How Gaia Collects Data



How Gaia Collects Data

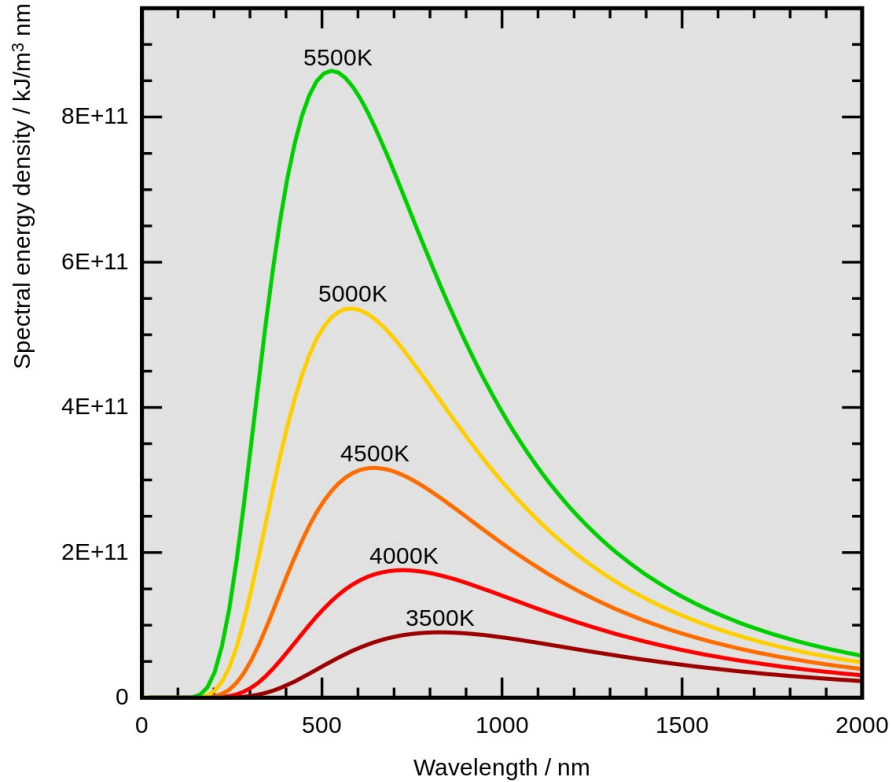


Fig 9: Wikipedia: CC BY-SA 4.0
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How Gaia Collects Data

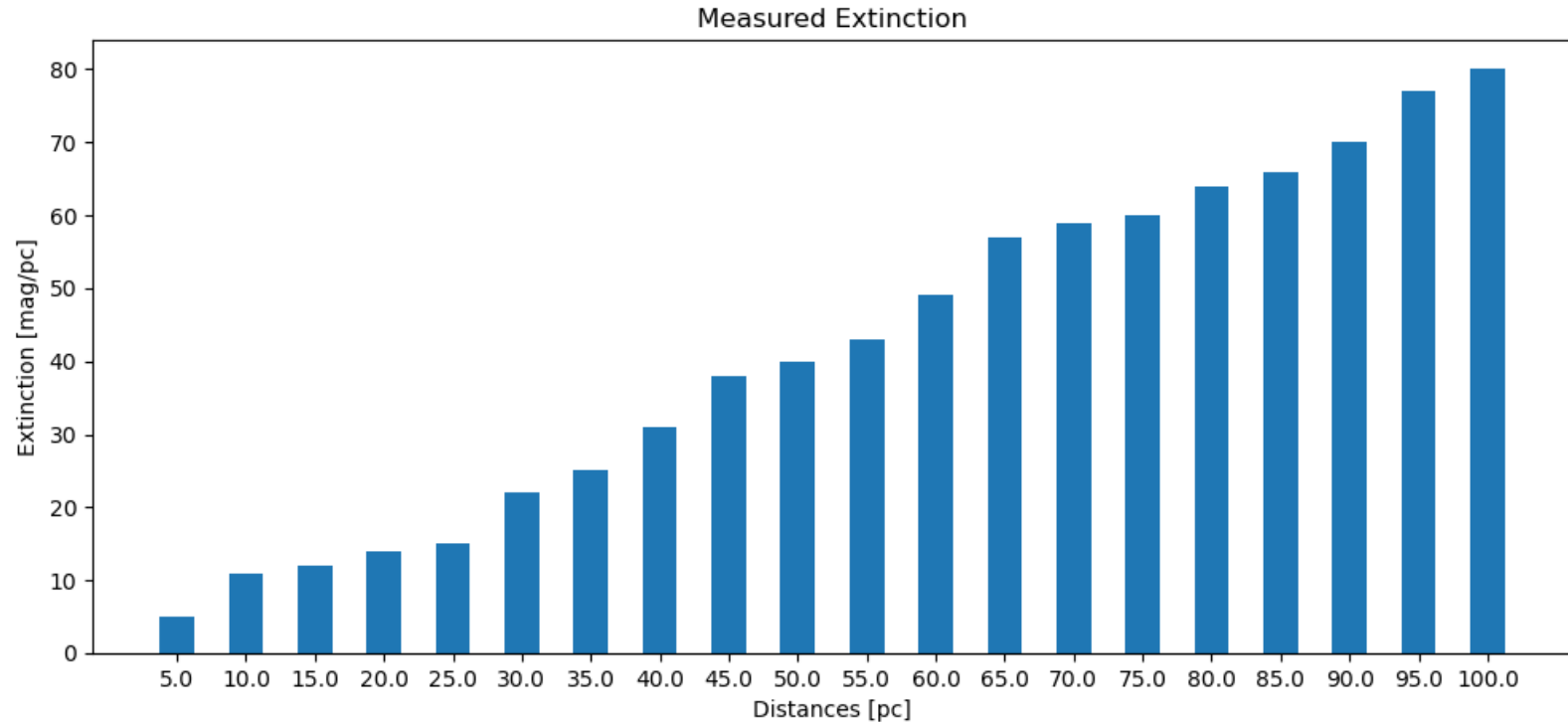
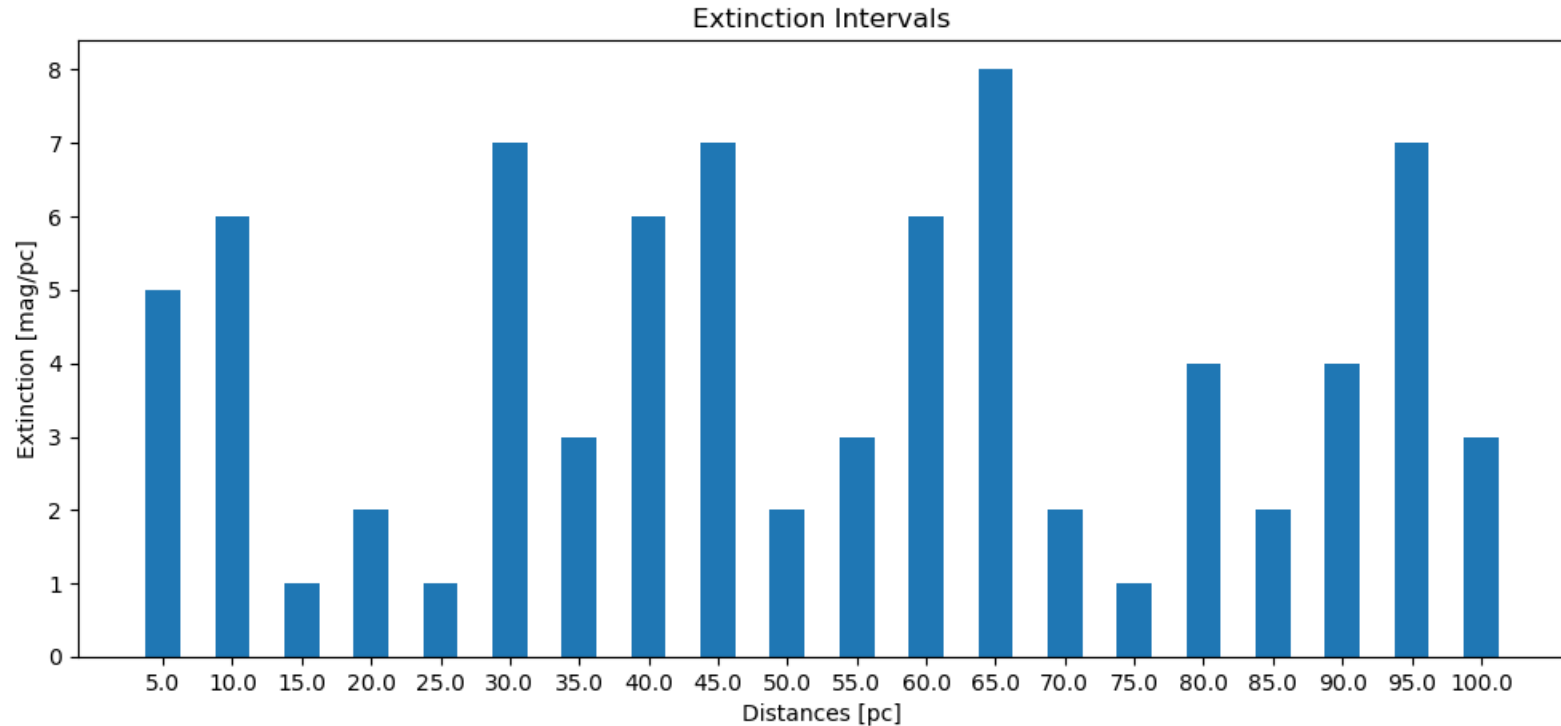
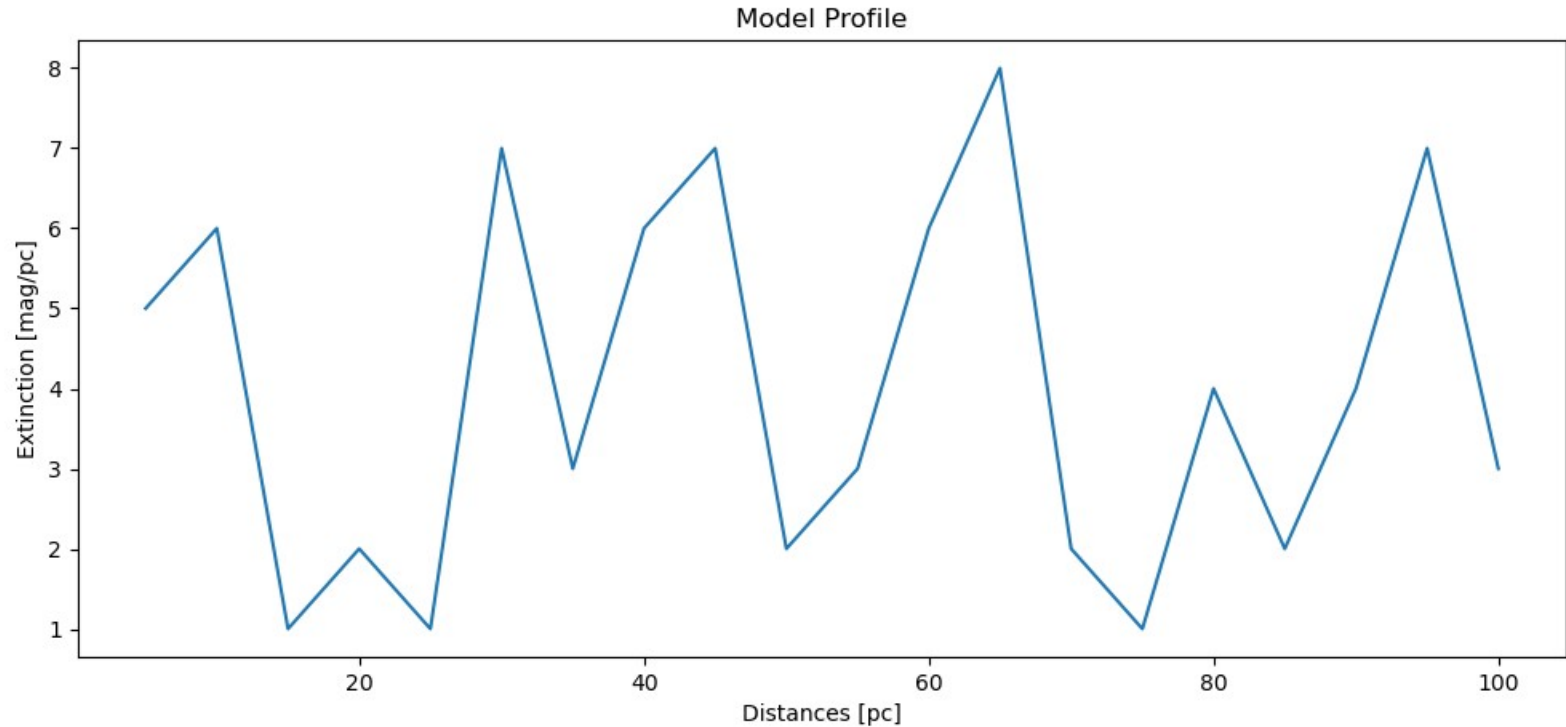


Fig 10: Self made

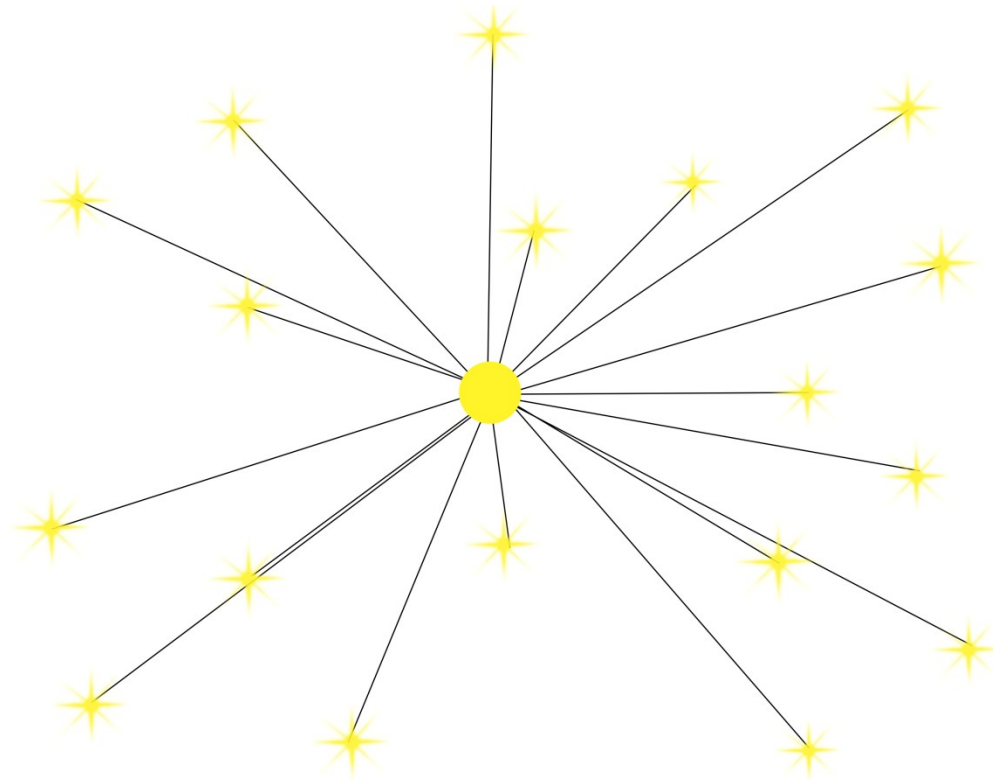
How Gaia Collects Data



How Gaia Collects Data



How Gaia Collects Data



Molecular Cloud Locations/Positions

Interstellar Dust Map

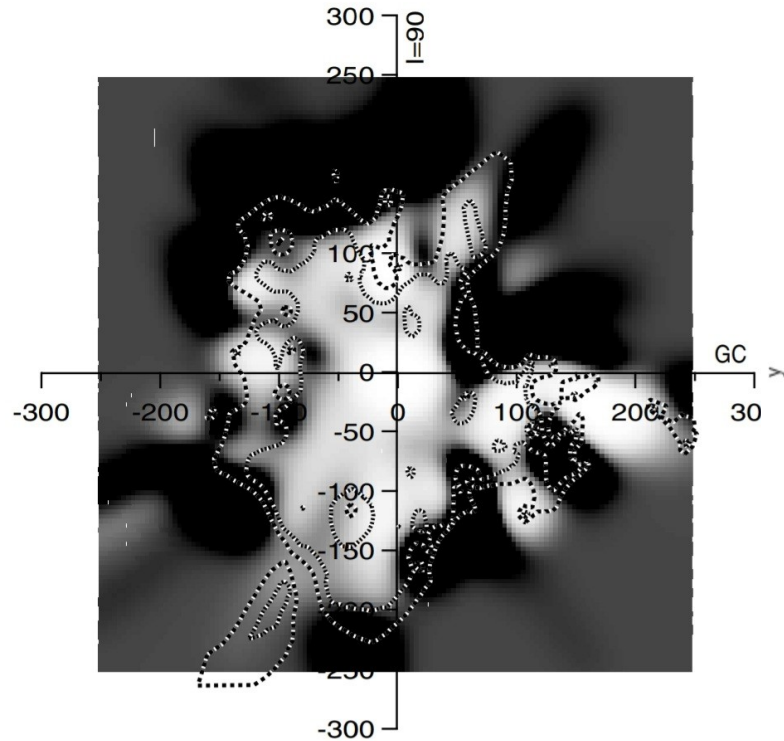


Fig 15: Lallement et al 2003, Fig 3
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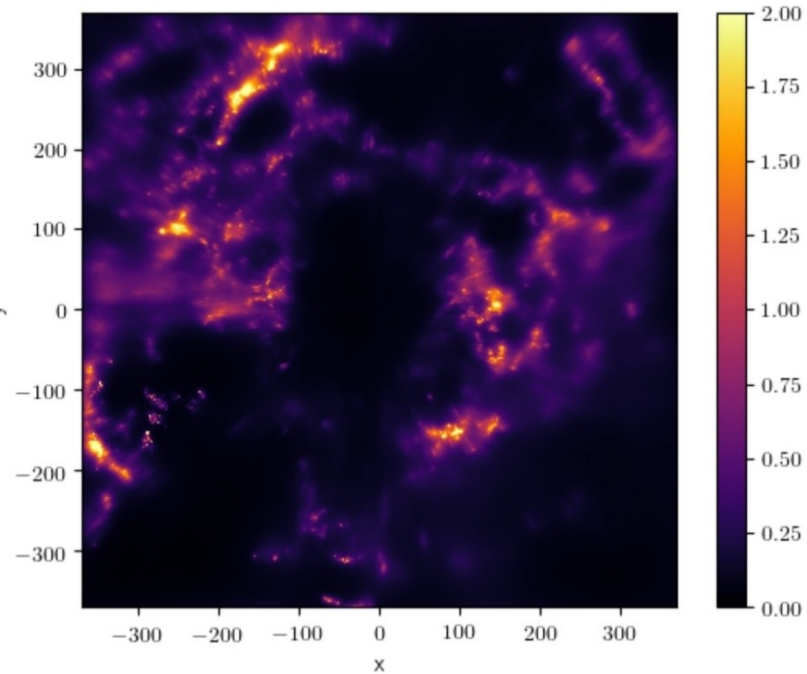
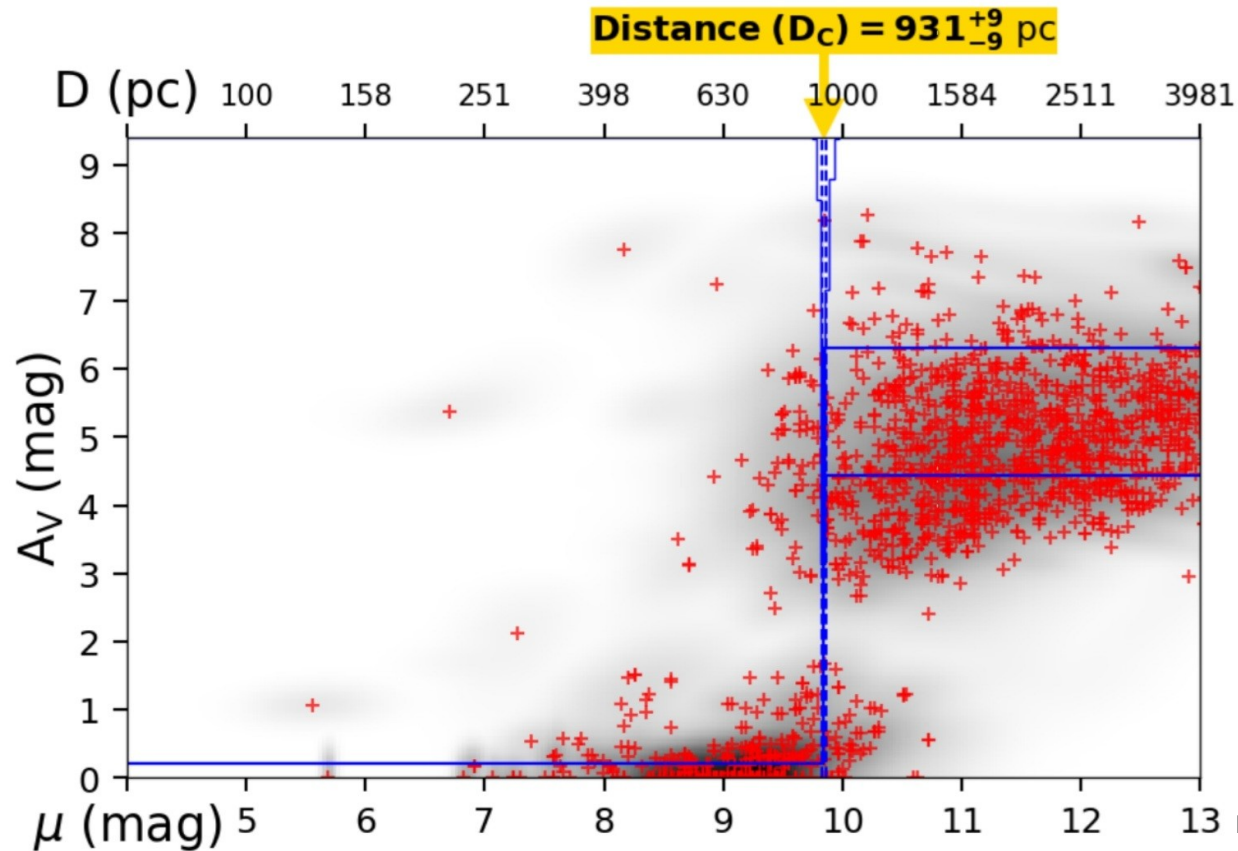


Fig 16: Leike et al 2020, Fig 9
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MC Distance Estimation



Interstellar Dust Map

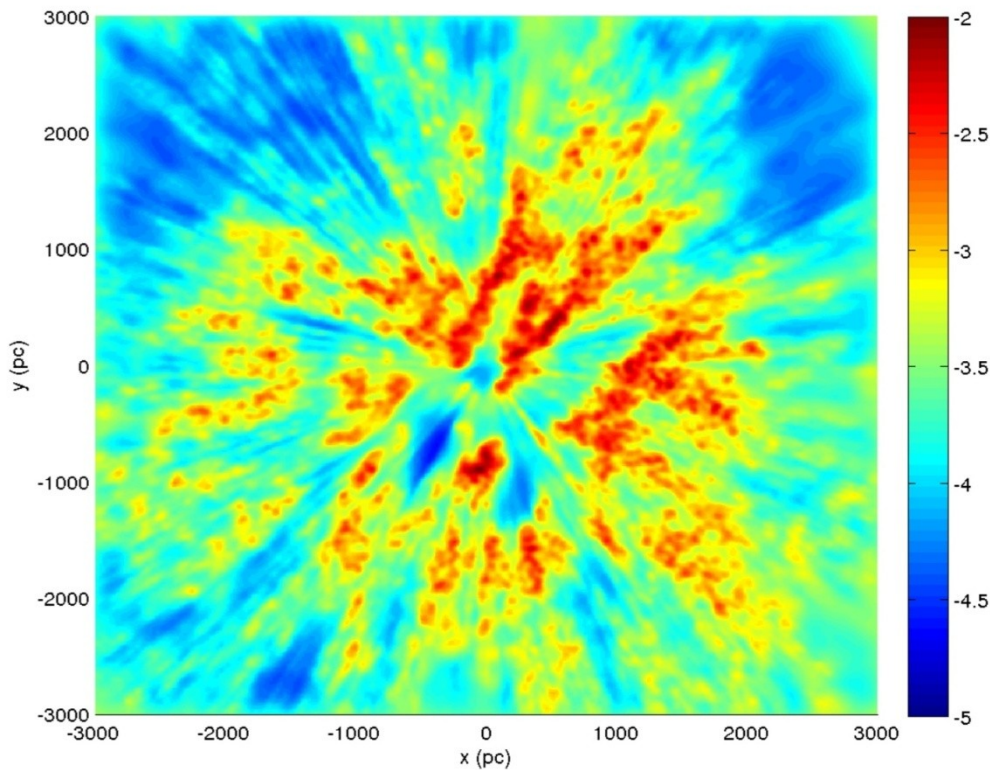


Fig 18: Lallement et al 2019, Fig 6

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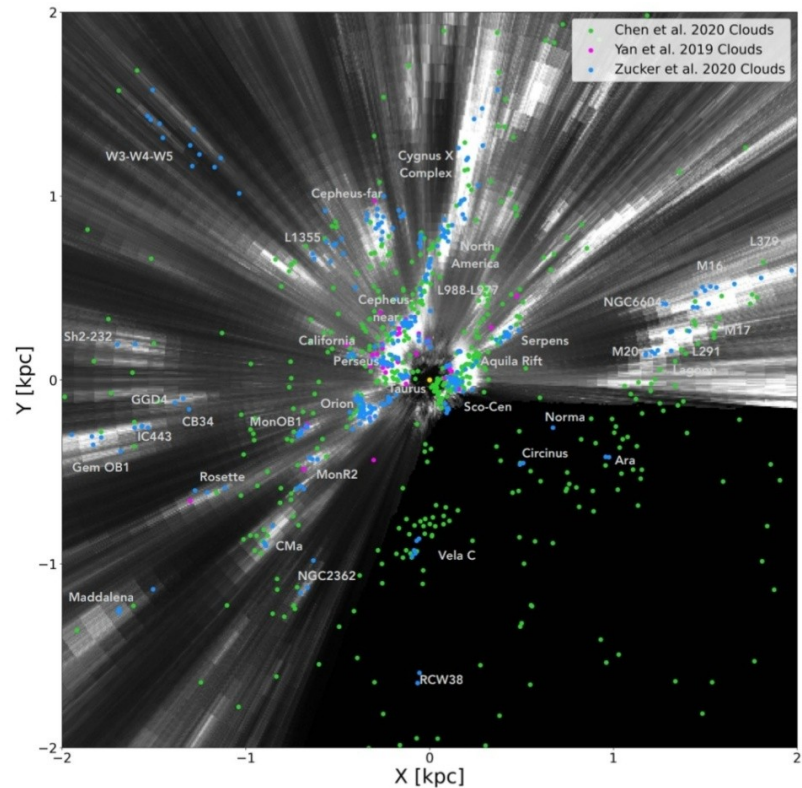


Fig 19: Zucker et al 2022, Fig 2

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Orion A vs. California

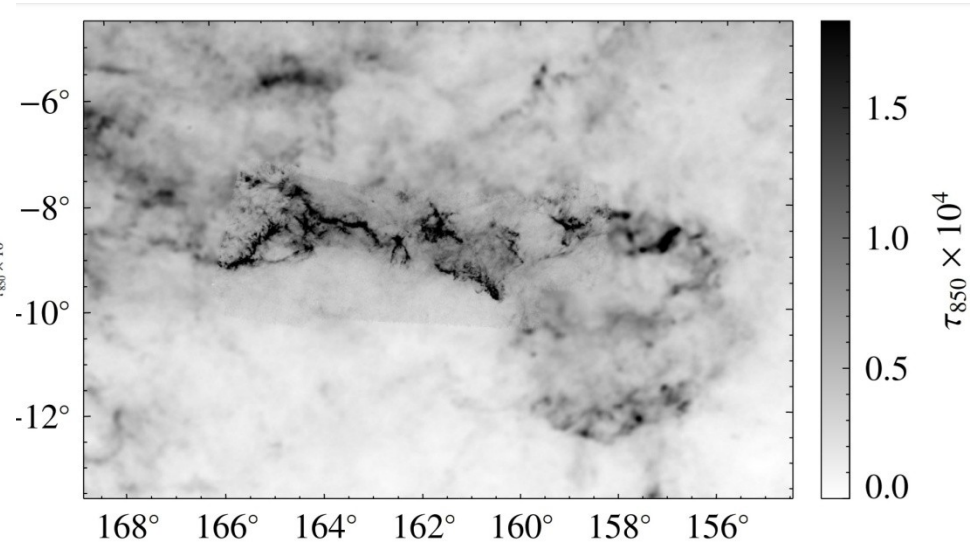
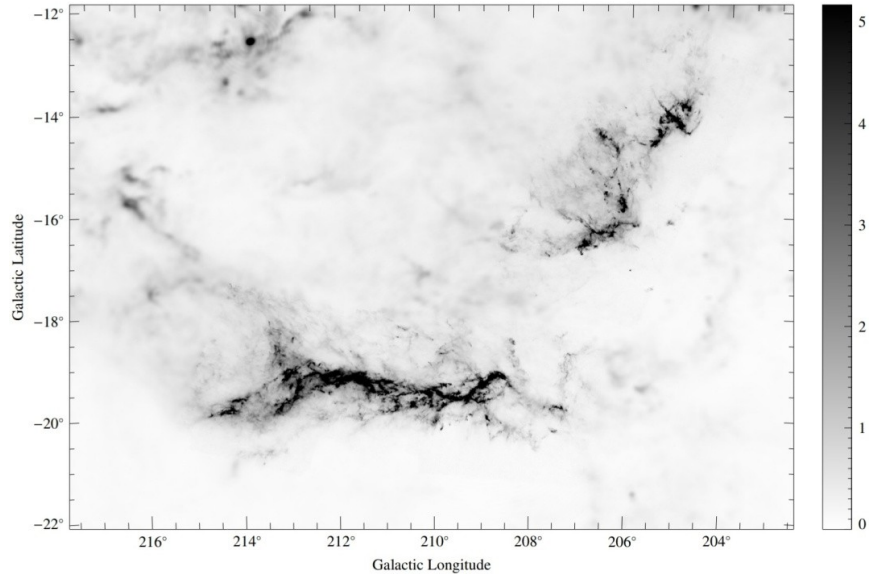


Fig 20: Lombardi et al 2014, Fig 8

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U. Heidelberg/Master Seminar

Fig 21: Lada et al 2017, Fig 3

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Orion A vs. California

Similar:

- Size
- Mass
- Apparent physical structure
- Kinematics
- Column density

Different:

- Star forming efficiency

Orion A > California

!!! Factor 10 !!!

Orion A vs. California

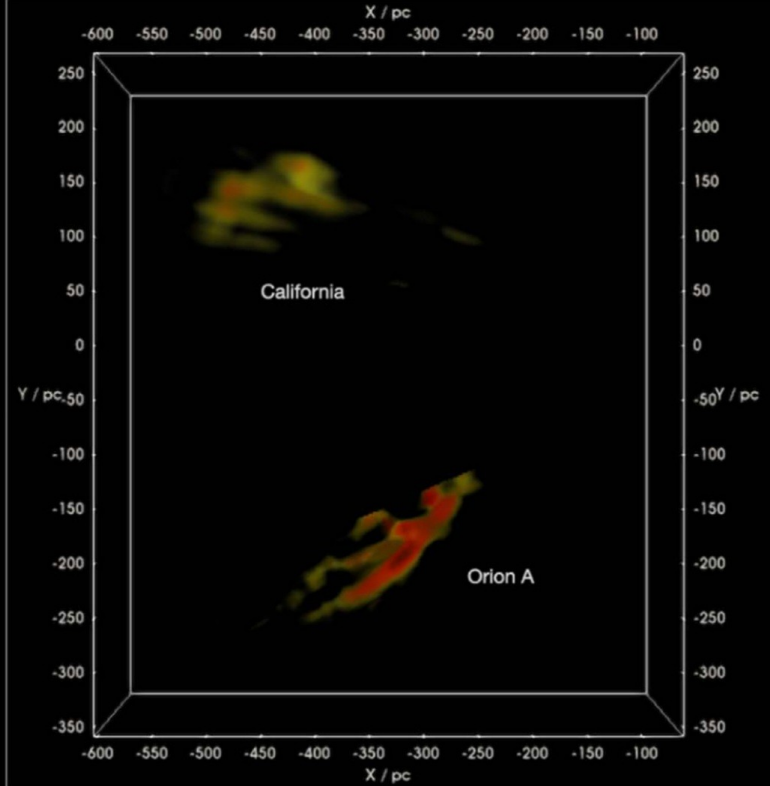
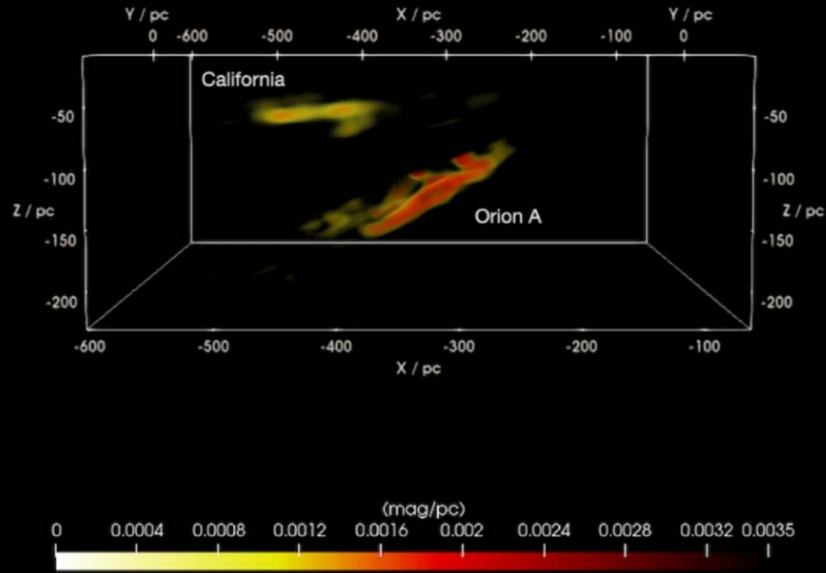


Fig 22: Rezaei et al 2022, Fig 4

Orion A Molecular Cloud

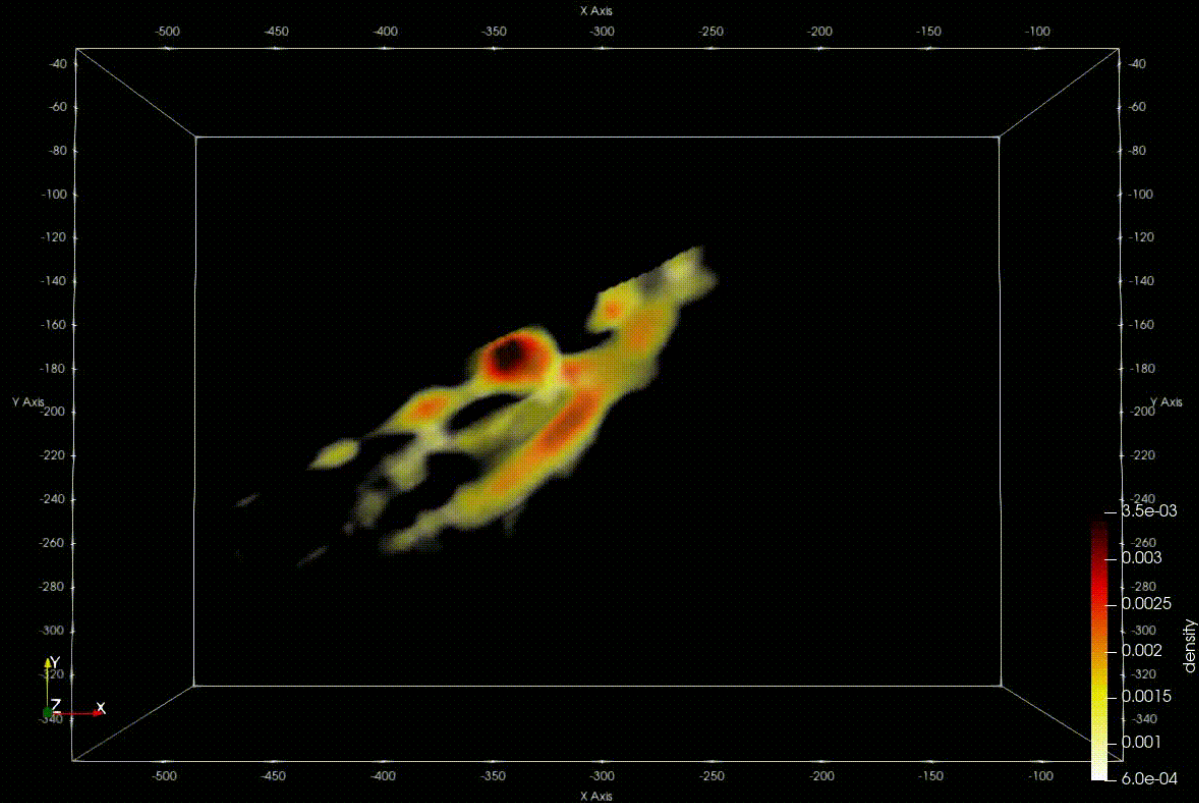


Fig 23: Provided by
Dr. S. Rezaei Kh.

California Molecular Cloud

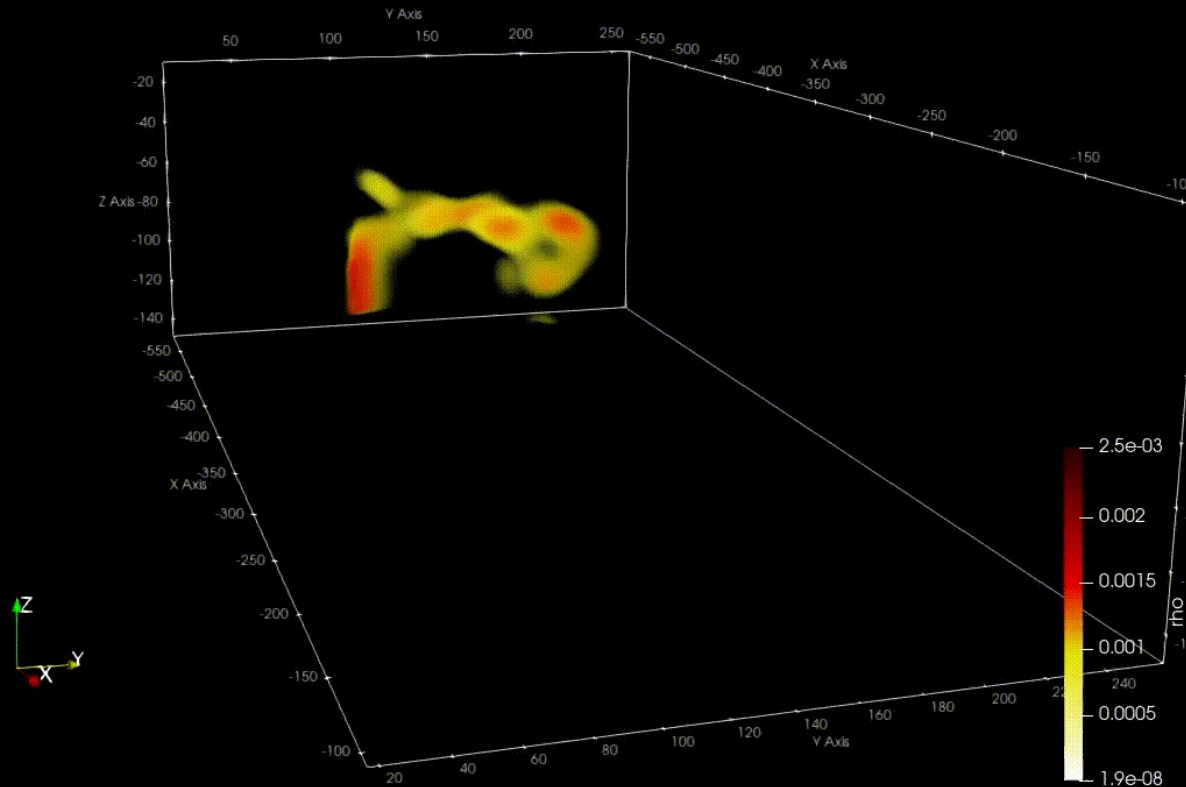


Fig 24: Provided by
Dr. S. Rezaei Kh.

Young Stellar Structures

Orion Big Blast Event

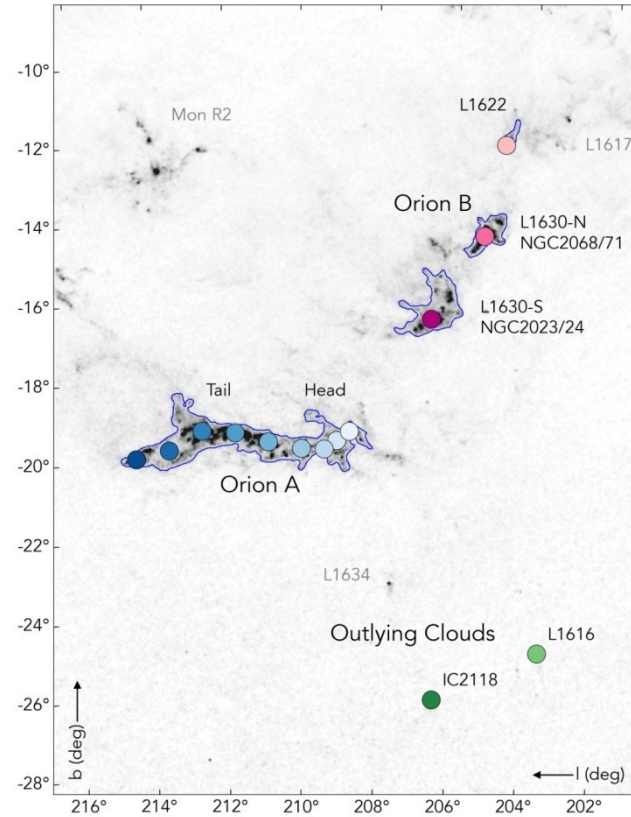
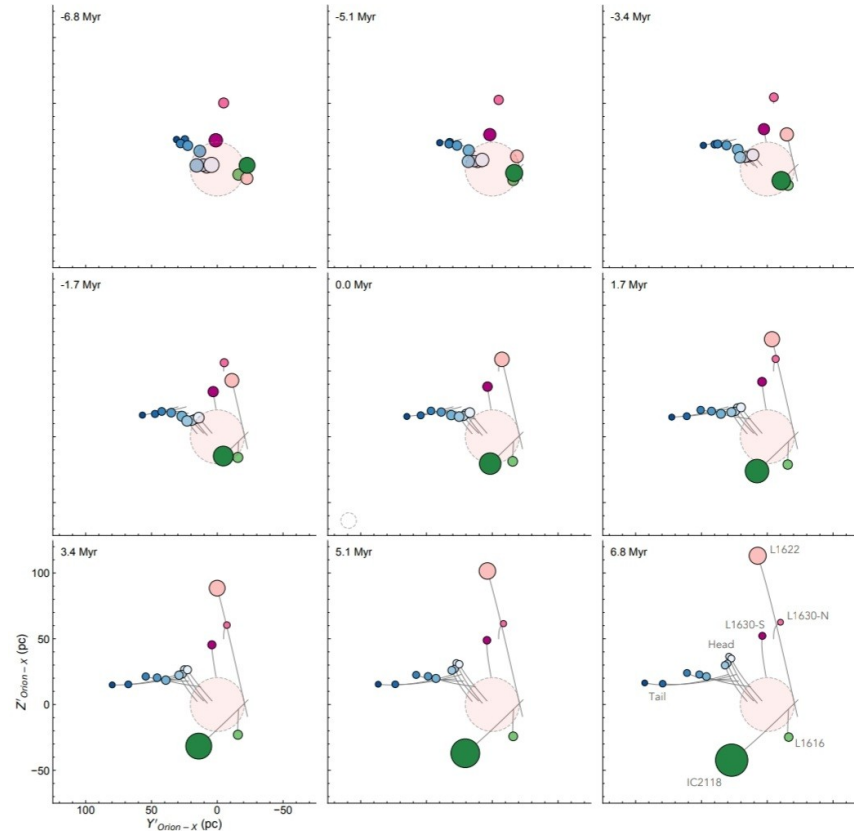
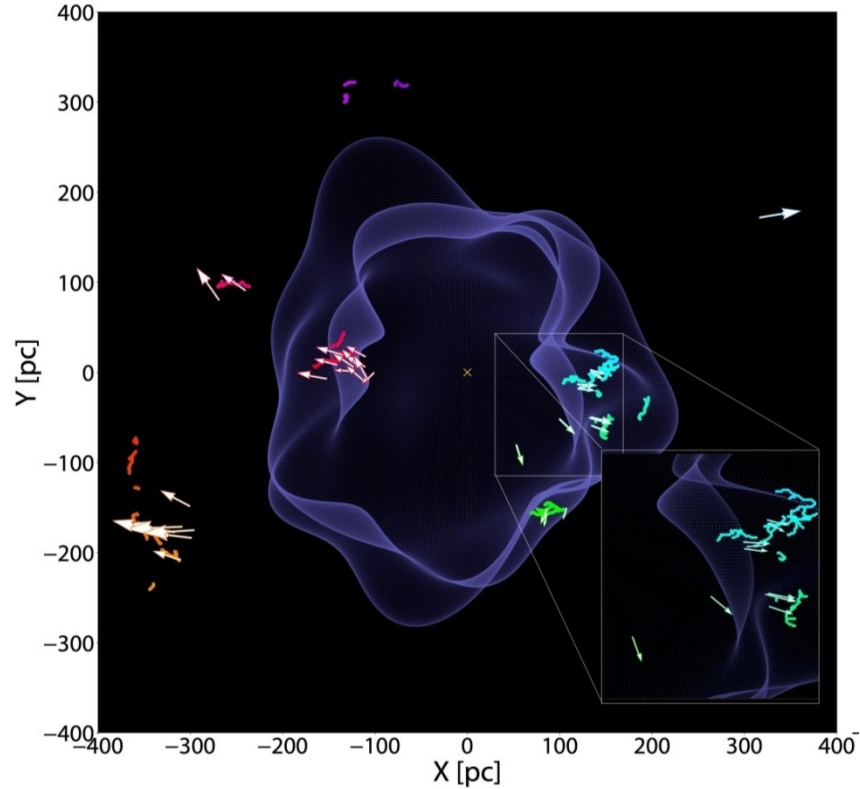


Fig 25: Großschedl et al 2020, Fig 1
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Orion Big Blast Event



Local Bubble



Local Bubble

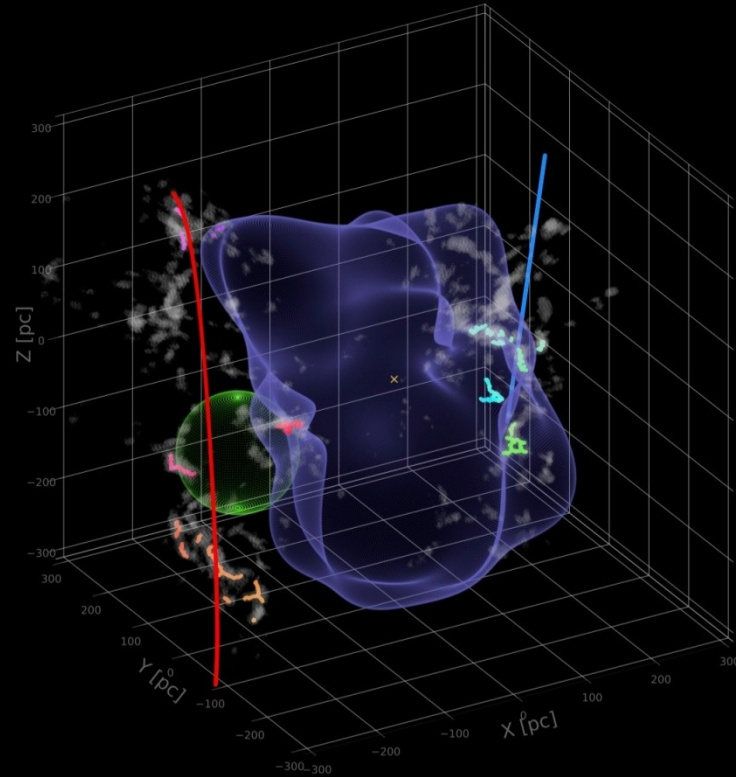


Fig 28: Zucker et al 2022, Fig 7b
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Galactic Context

Mystery of the Gould`s Belt

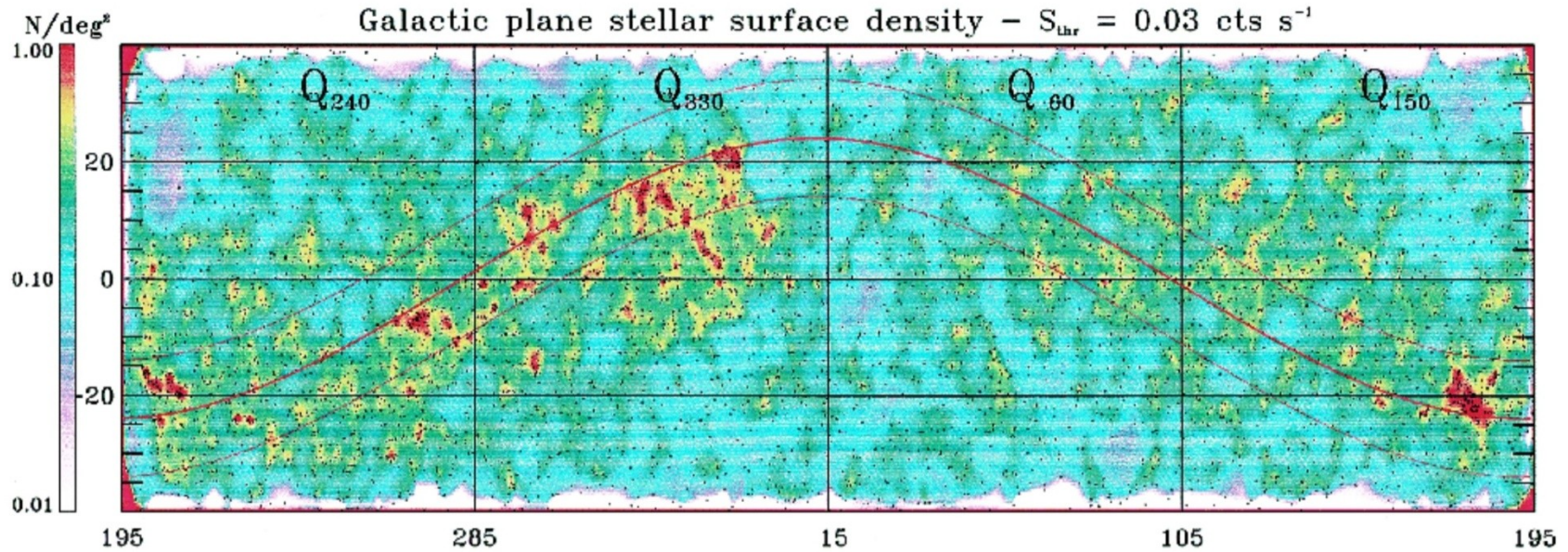
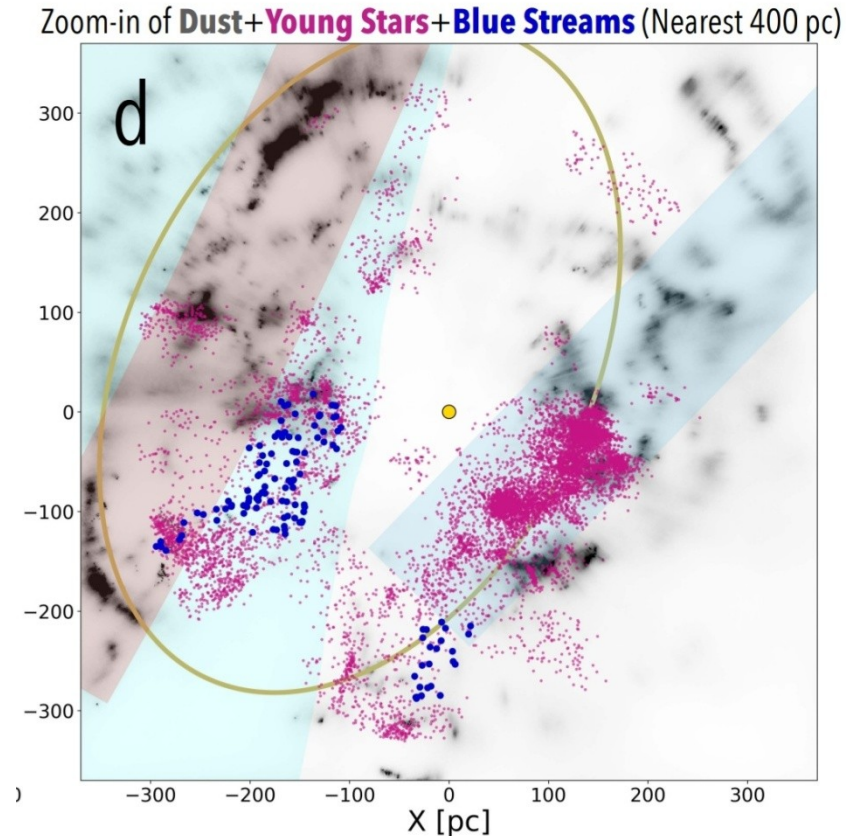


Fig 29: Ptak et al 2009, Fig 2
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Mystery of the Gould`s Belt



Radcliffe Wave

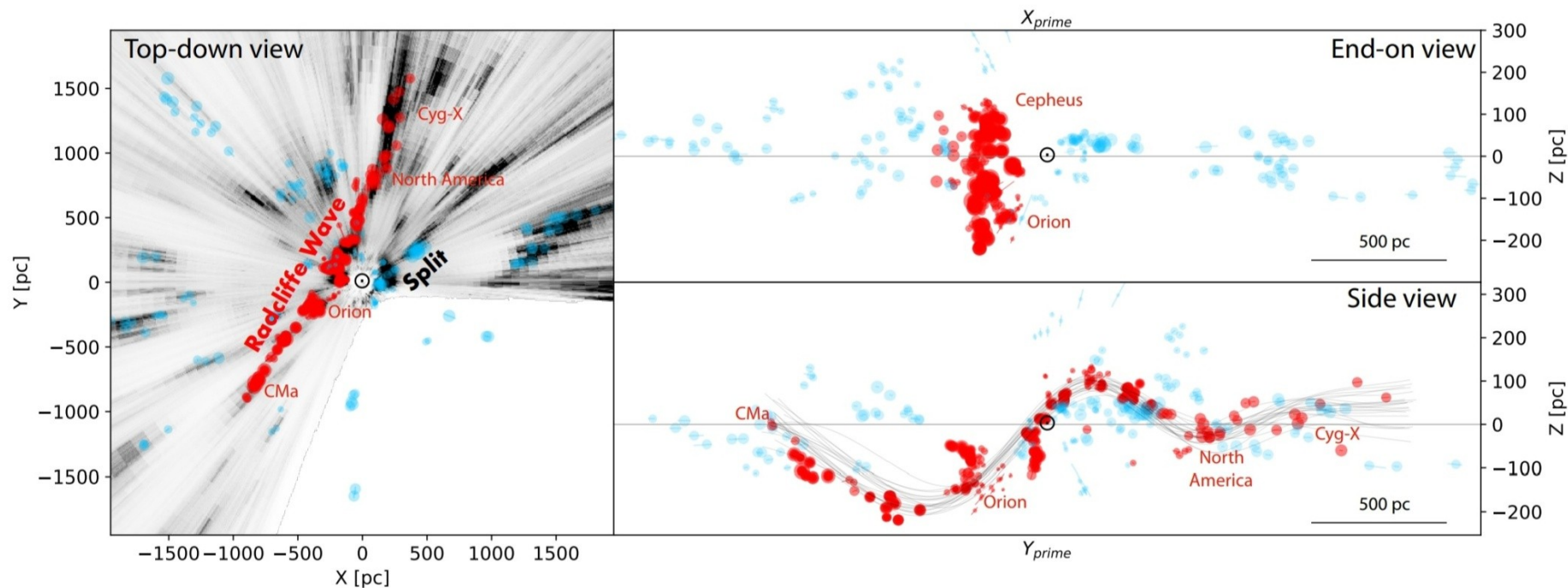
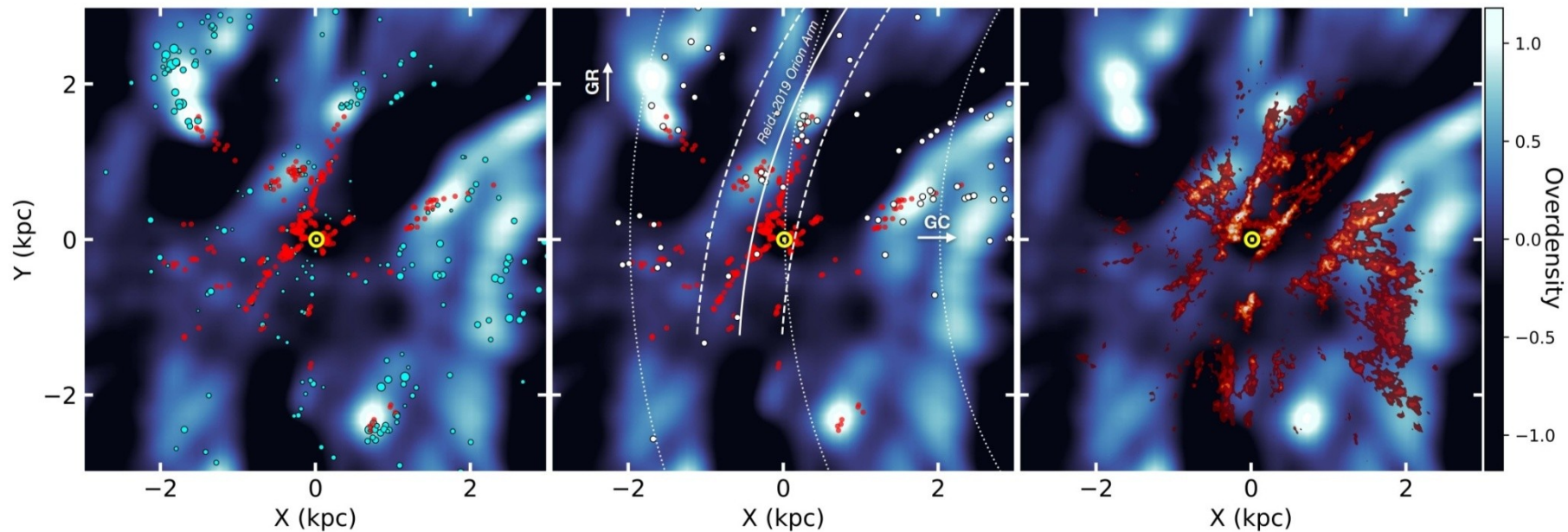


Fig 31: Zucker et al 2022, Fig 13
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Radcliff Wave



Conclusions

Take Home Message

- Gaia astrometry is extremely powerful
- Even better with photometry from 2MASS
- 3D structure is important

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- Zucker, Catherine, João Alves, et al. (Mar. 27, 2023). *The Solar Neighborhood in the Age of Gaia*. DOI: 10.48550/arXiv.2212.00067. arXiv: 2212.00067[astro-ph]. URL: <http://arxiv.org/abs/2212.00067> (visited on 11/07/2023).

Image Sources

Fig 1: <https://www.cosmos.esa.int/web/hipparcos/h-r-diagrams>

Fig 2: https://commons.wikimedia.org/wiki/File:Gaia%E2%80%99s_Hertzsprung-Russell_diagram_ESA393151.jpg

Fig 3: <https://sci.esa.int/web/gaia/-/53112-deployment-of-gaias-dsa>

Fig 4: https://commons.wikimedia.org/wiki/File:Animation_of_Gaia_trajectory_-_Equatorial_view.gif

Fig 5: https://commons.wikimedia.org/wiki/File:Animation_of_Gaia_trajectory_-_Polar_view.gif

Fig 6: https://commons.wikimedia.org/wiki/File:Animation_of_Gaia%27s_trajectory_-_viewed_from_Sun.gif

Fig 7: <https://www.astronomy.ohio-state.edu/pogge.1/Ast162/Unit1/distances.html>

Fig 8: https://commons.wikimedia.org/wiki/File:Interstellar_extinction.jpg

Fig 9: https://en.wikipedia.org/wiki/Wien%27s_displacement_law#/media/File:Wiens_law.svg

Fig 14: https://www.esa.int/ESA_Multimedia/Images/2022/06/Gaia_map_of_interstellar_dust_in_the_Milky_Way

**Thank you for
your Attention**

