Galactic Astronomy

2023-2024

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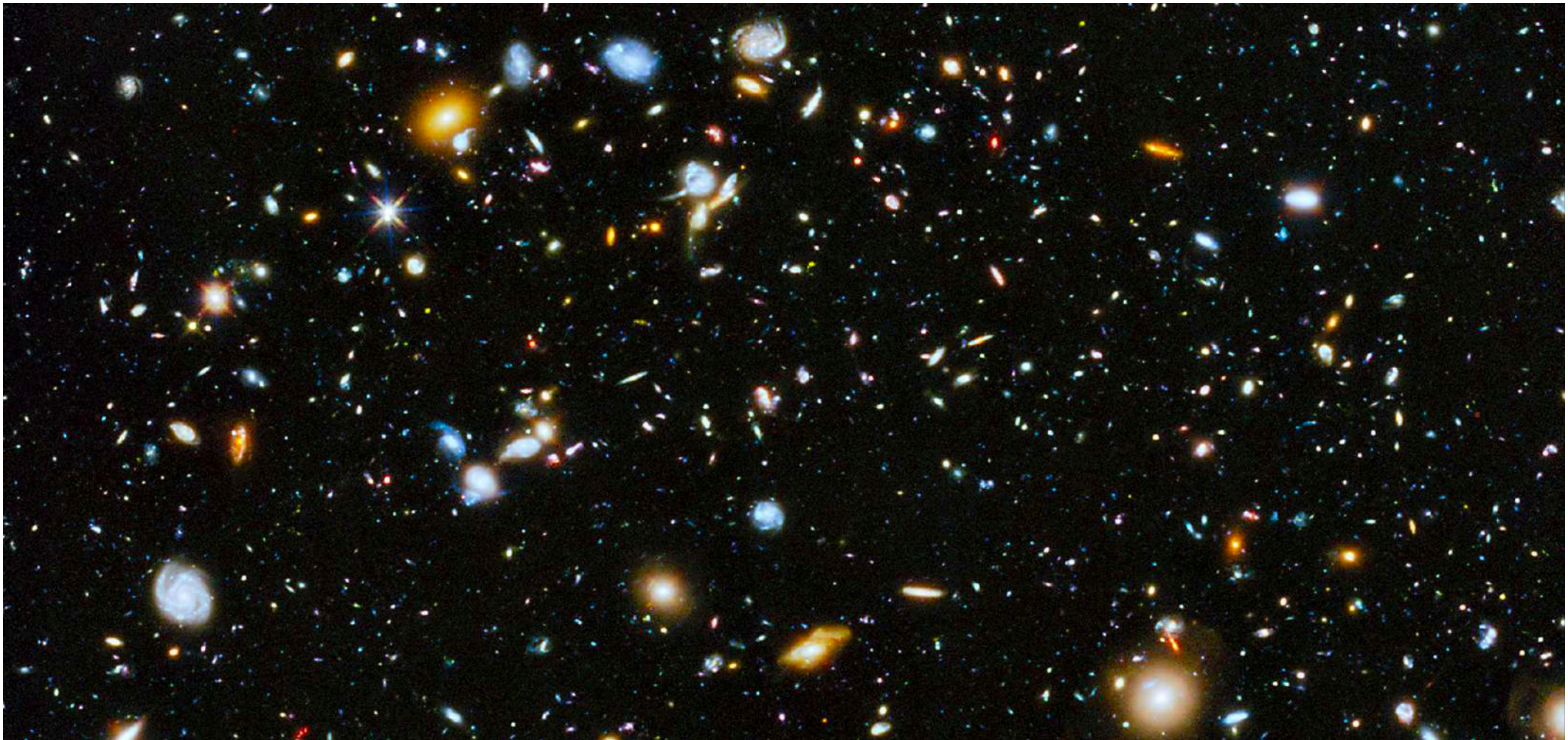
U Gaia B

How do galaxies form and evolve?

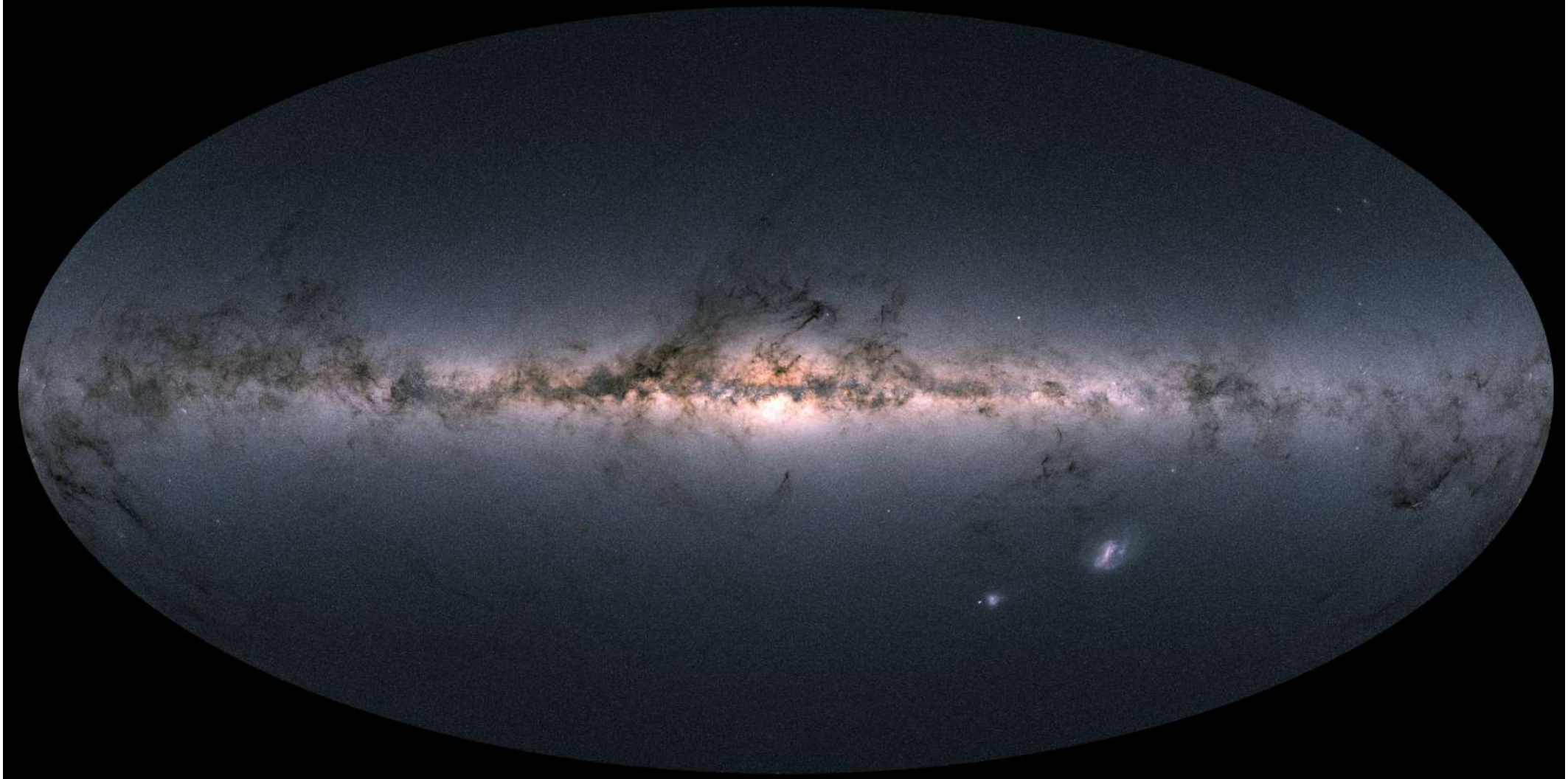
One of the key questions in modern astrophysics:

- A Science Vision for European Astronomy, ASTRONET, 2007
- Science Vision and Infrastructure Roadmap, ASTRONET, 2022 *(DRAFT)*

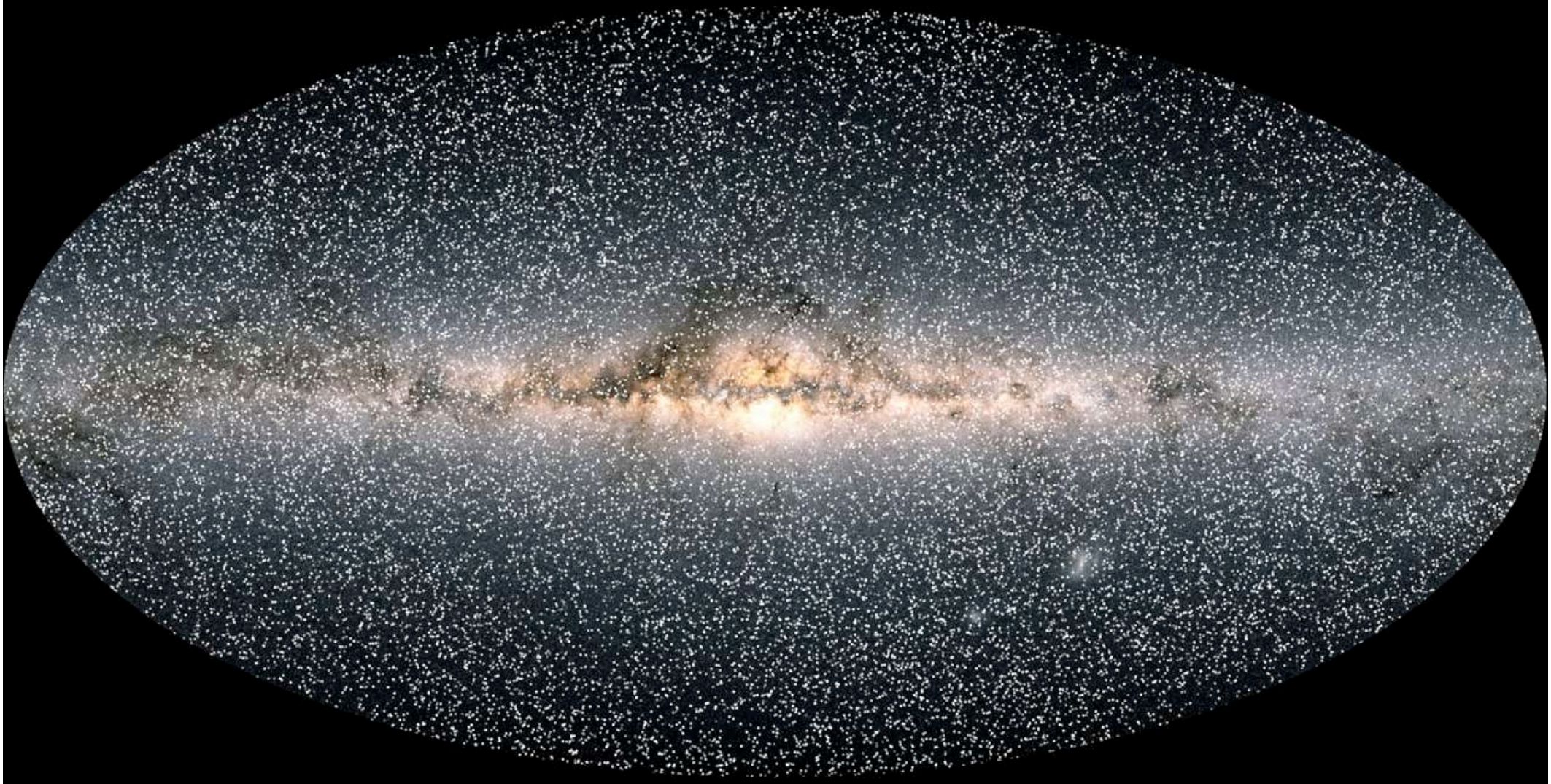
Hubble Ultra Deep Field



Gaia DR2

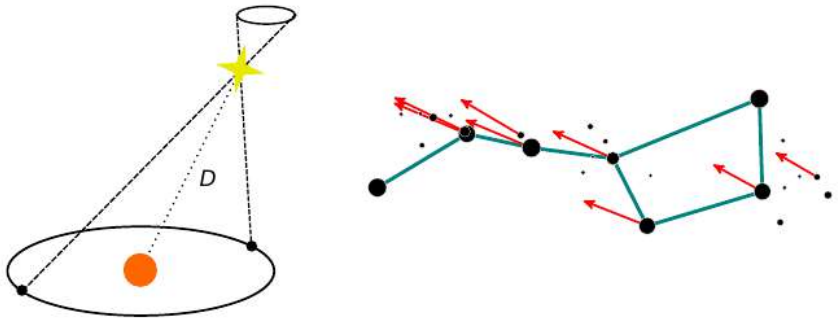


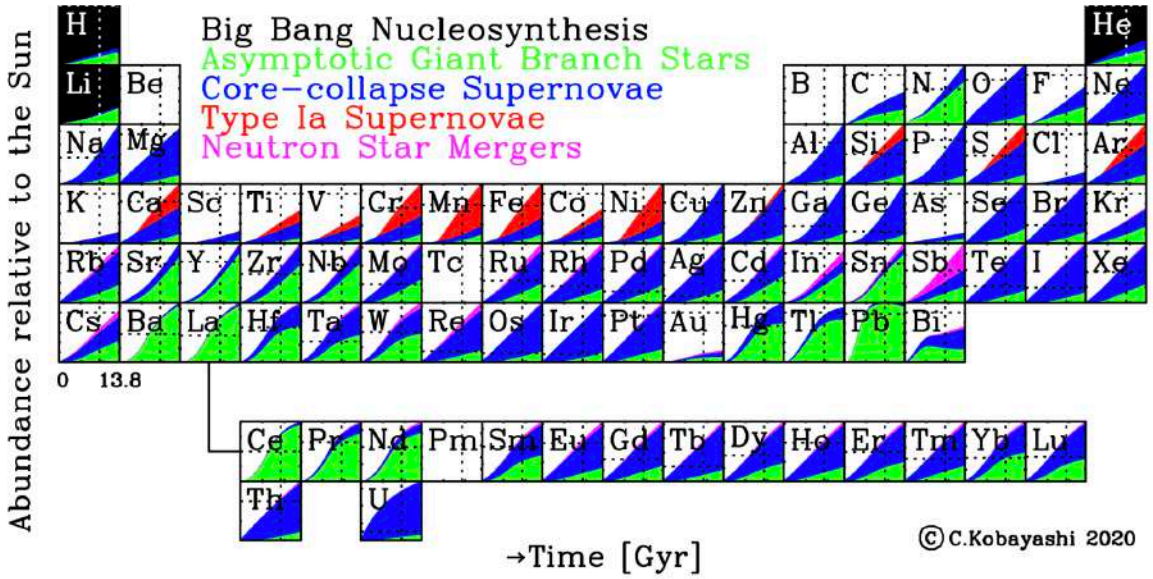
Gaia EDR3



How did our galaxy and its components form?

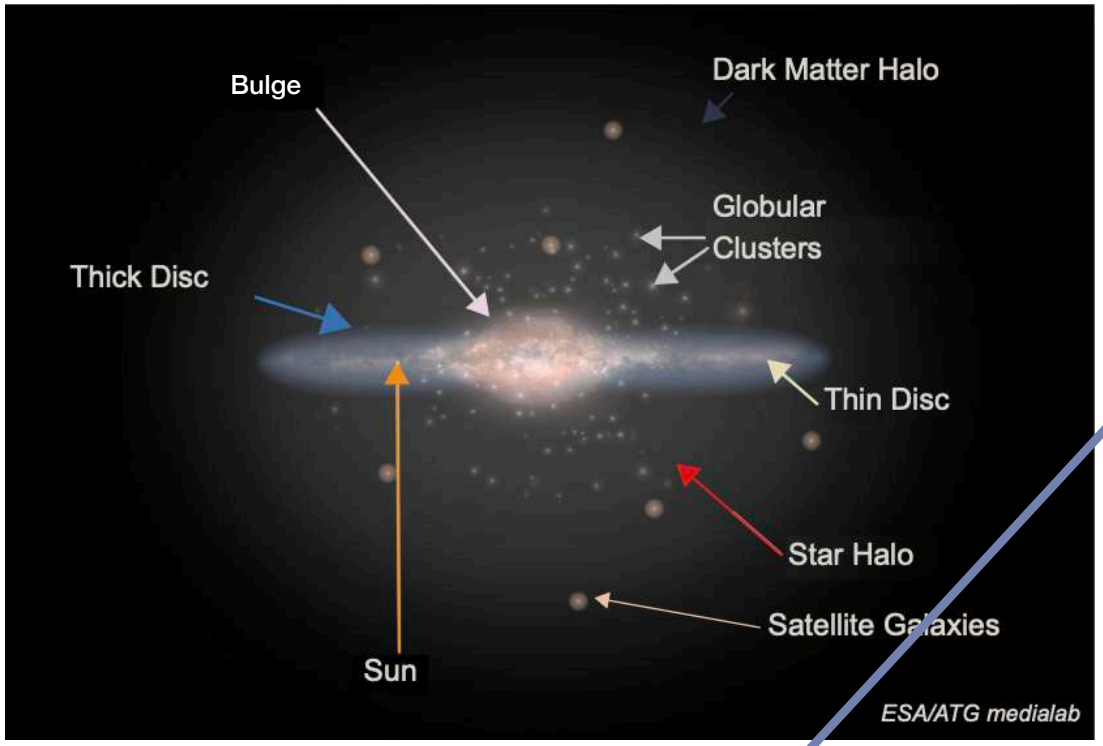
Astronomical measurements in Galactic Astronomy

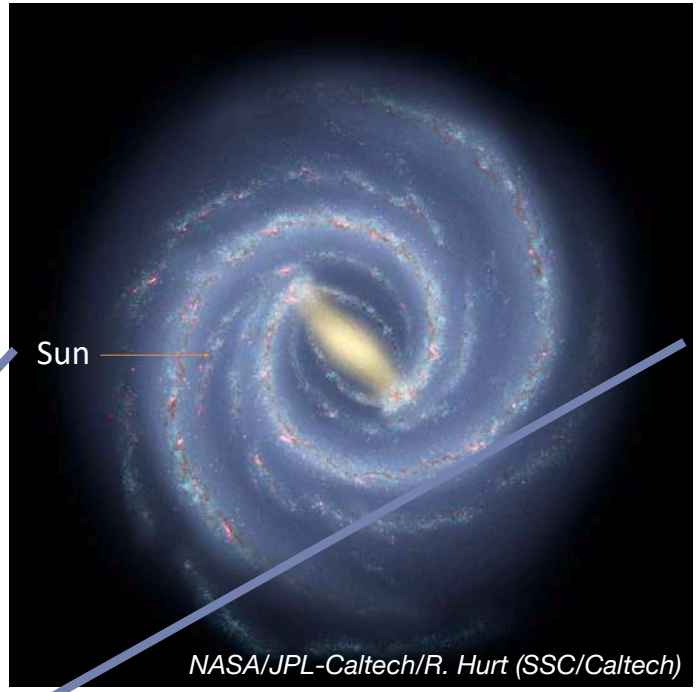


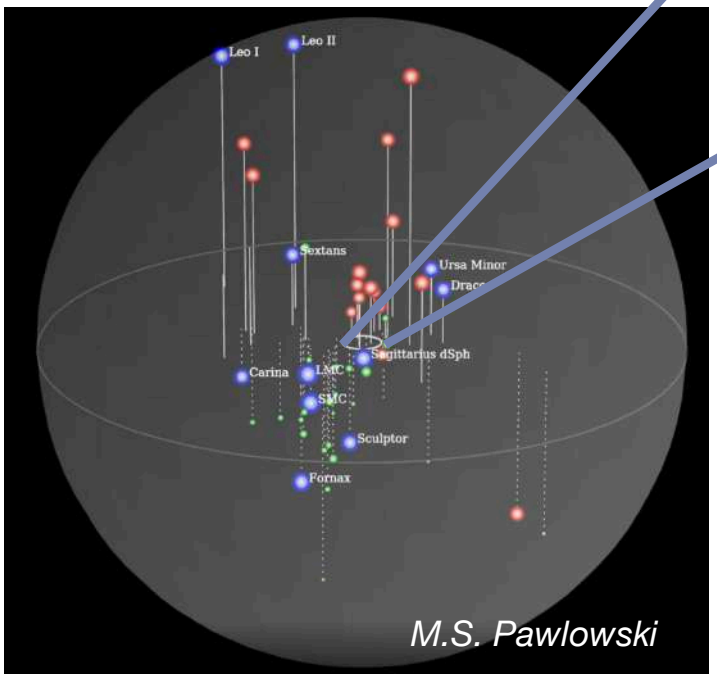


- Galaxy gravitational potential (mass distribution)
- History and evolution

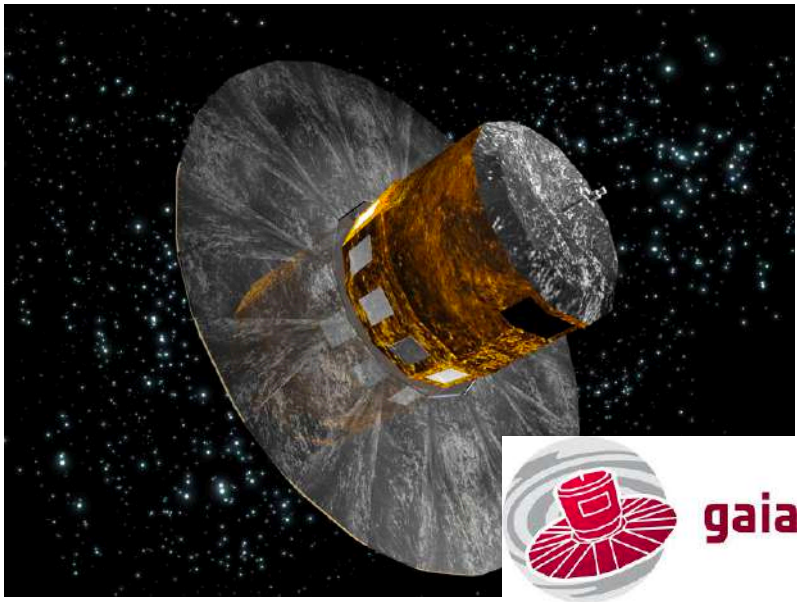
What we think the MW looks like







Measurements: Gaia mission



December 19th, 2013
10:12 CET

5 themes:

- Astronomical measurements
- Statistical galactic astronomy
- Galactic kinematics
- Galactic dynamics
- Chemical evolution of the Milky Way

1. Introduction TERESA
   13 set
   - 1.1. Galaxies and their role in the Universe
   - 1.2. Galactic astronomy history
   - 1.3. Global description of the Milky Way: our present knowledge
2. Astronomical measurements FRIEDRICH
   14,18,19 set
   - 2.1. Astrometry
   - 2.2. Photometry
   - 2.3. Spectroscopy
3. Statistical astronomy FRIEDRICH
   20, 21, 26, 27 set
   - 3.1. Apparent distribution of stars
   - 3.2. Stellar statistics fundamental equation
   - 3.3. Stellar luminosity function
   - 3.4. Initial Mass Function and Star formation History
   - 3.5. Galactic models for star count predictions
4. Galactic kinematics TERESA
   28 set, 2, 3, 4 oct
   - 4.1. Galactocentric reference systems
   - 4.2. Kinematics of solar neighbourhood stars
   - 4.3. Large scale kinematics
   - 4.4. Rotation curve and Oort constants

+2h Exercises measurements FRIEDRICH *5,9 oct*

5. Galactic Dynamics I: basic concepts
   - 5.1. Gravitational potentials & Poisson equation TERESA *10, 11, 16, 17 oct*
   - 5.2. Orbits TERESA *18,19,23, 24 oct*
   - 5.3. Collisionless dynamics MERCE *25, 26, 30, 31, 2*
   - 5.4. Collisions and encounters of stellar systems 4h MARK *6 7, 8, 9 nov*
6. Chemical evolution of the Milky Way FRIEDRICH
   13, 14, 15, 16 nov
   - 6.1. Observational evidence
   - 6.2. Surface gas density, supernova explosion rate and metal enrichment
7. Galactic dynamics II: advanced
   - 7.1. Dynamics of spiral structure and bars MERCE *20, 21, 22, 23 nov*
8. Chemical evolution of the Milky Way (continuation) FRIEDRICH
   27, 28, 29, 30 nov
   - 8.1. Basic elements of a model of chemical evolution
   - 8.2. Some simple models

+2h hands-on kinematics TERESA *11, 12 nov*
+2h hands-on orbits MERCE, *13, 14 dec*

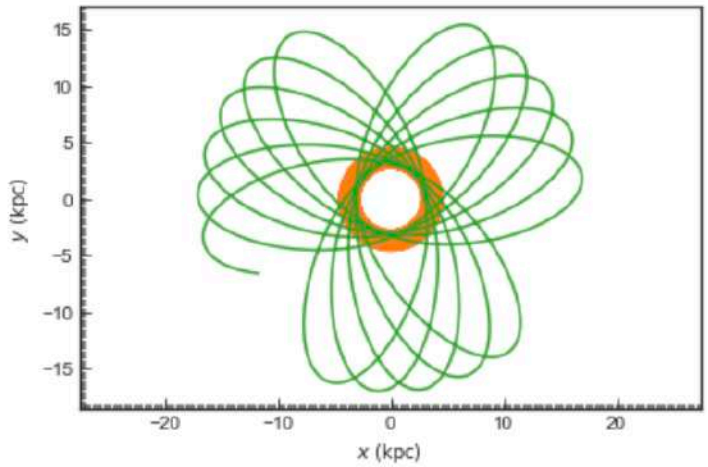
- 8.3. Extra MERCE *18 dec*
- 8.4. Galaxy interactions, non-axisymmetry, Gaia TERESA *10, 20 dec*

+1h Journal Club TERESA *21 dec*

Not 100% definitive

- **Hand-on exercises**
  - Analysis of *Gaia* data
  - Orbits in Galactic potentials

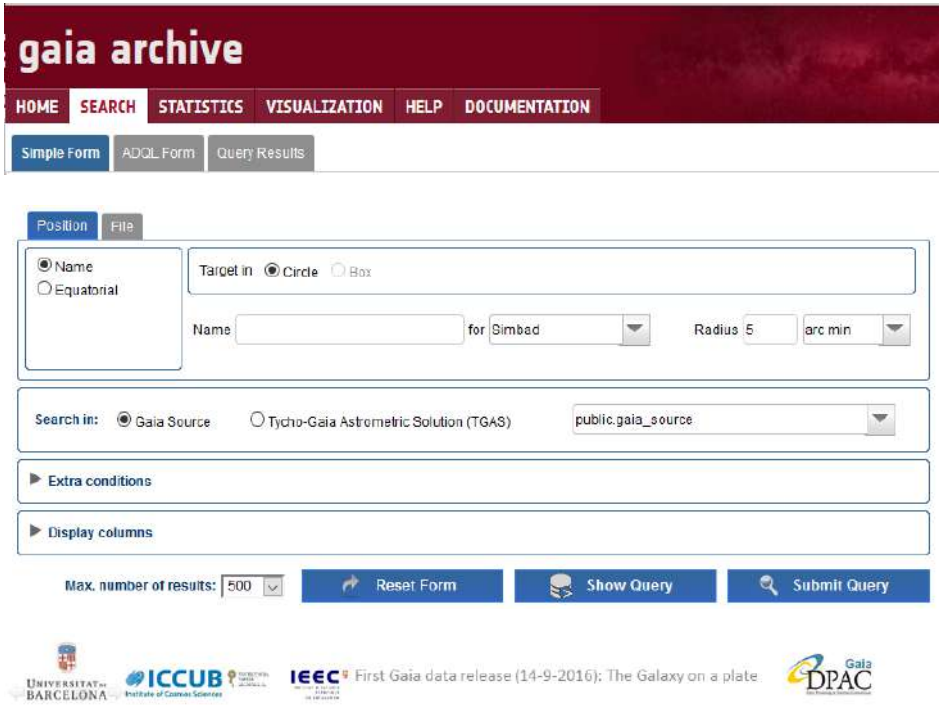
In [25]:
```
omw1.plot(d1='x',d2='y')
omw2.plot(d1='x',d2='y',overplot=True)
omw3.plot(d1='x',d2='y',overplot=True)

plt.axis('equal')
plt.show()
```



- **Paper reading and discussion (journal club)**

- **Short tasks TBD**

1. TBD: Gaia Archive & Gaia measurements / Statistical astronomy, Besançon mode



HTTP://
ARCHIVES.ESA
C.ESA.INT/
GAIA/

- **Lectures from invited professors**

Dr. Mark Gieles
(ICCUB-ICREA)

Collisional dynamics

- Basic concepts for collisional systems: relaxation, core collapse, etc
- Dynamics of Globular Clusters

Nov 2023

Evaluation

Short tasks + presentations
Hands-on work
Participation
40%

Exam

5/10 required

60%

Exam date: to be agreed with you

https://campusvirtual.ub.edu/

- Detailed calendar
- Pdfs of lectures
- Material for hands-on, exercises, etc
- Additional material, papers, etc

Master's thesis

- Open clusters
- Galactic Disk dynamics
- Satellite galaxies
- Stellar evolution
- Population synthesis
- White dwarfs

- Big Data and Machine learning
- Galaxy formation and cosmology
- Spectroscopic stellar surveys
- Globular clusters
- Light pollution
- Chemical evolution of the MW

F. Anders, T. Antoja, L. Balaguer, J. M. Carrasco, F. Figueras, M. Gieles, X. Luri, E. Masana, M. Romero-Gomez, M. Semcsuk