Galactic archaeology in the Gaia era



Alejandra Recio-Blanco

Galactic archaeology

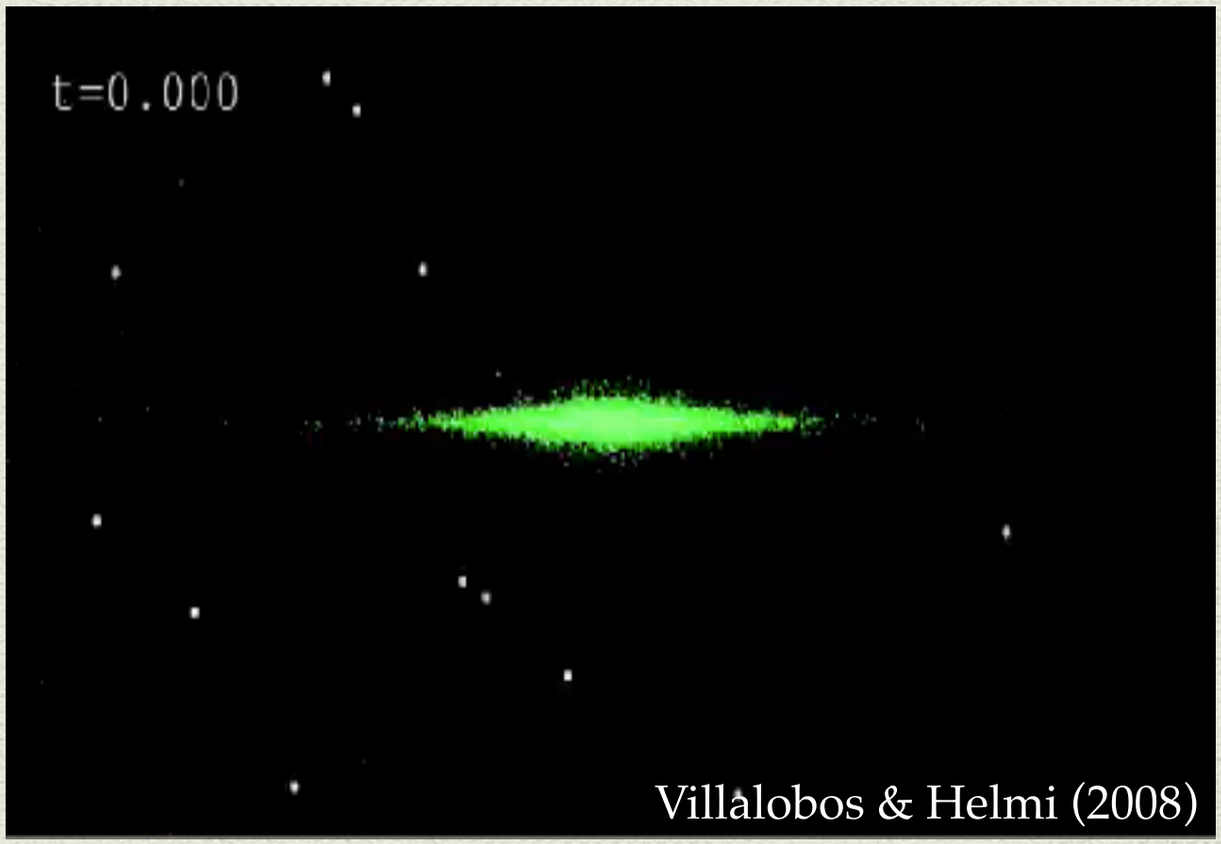
Objectives

How is our Galaxy?

How did it form?

What is its place in cosmic evolution?





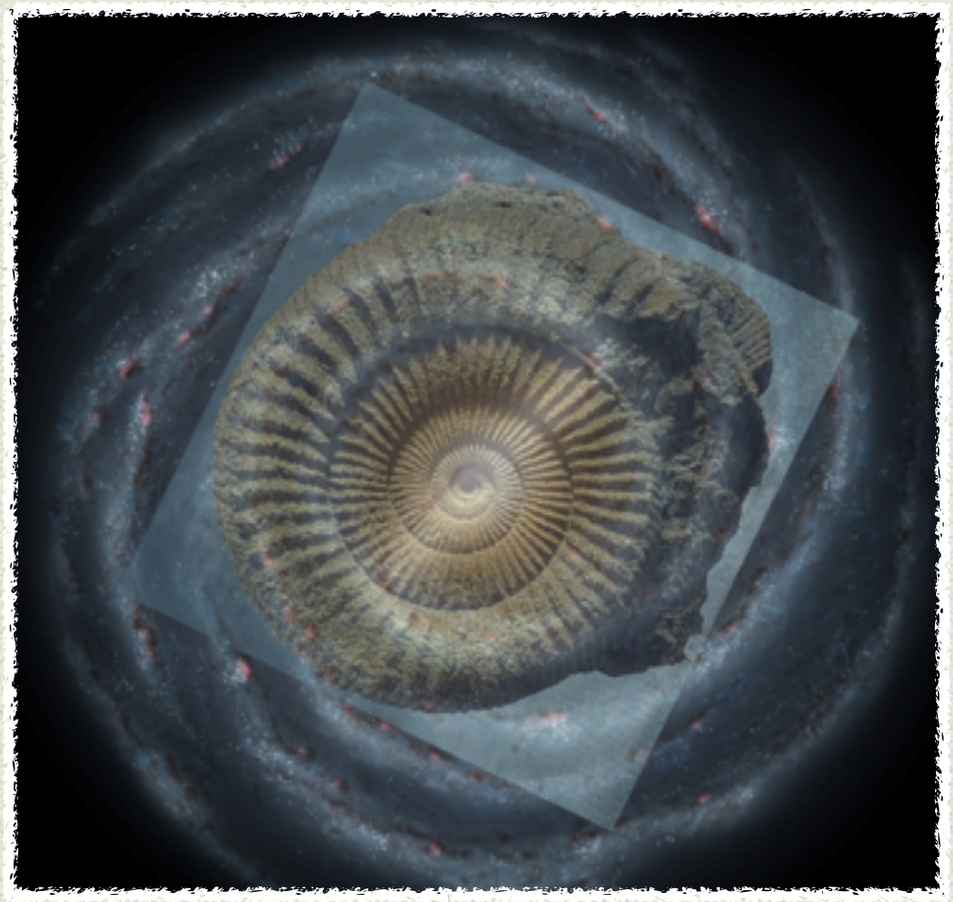
Villalobos & Helmi (2008)

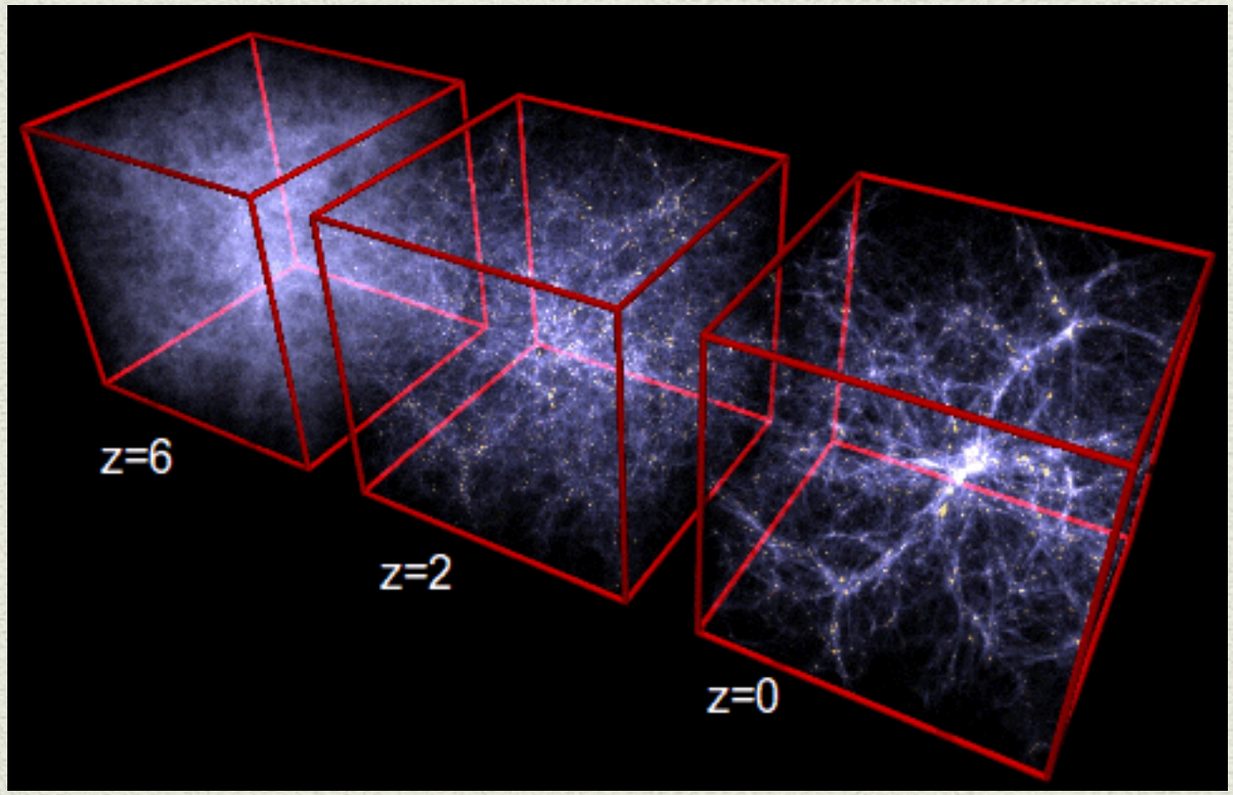
Galactic archaeology

Objectives

Stars are fossils we can work with:

- A star of 0.8 Mo lives more than 13 Gyr !
- Formation epoch $z \geq 2$



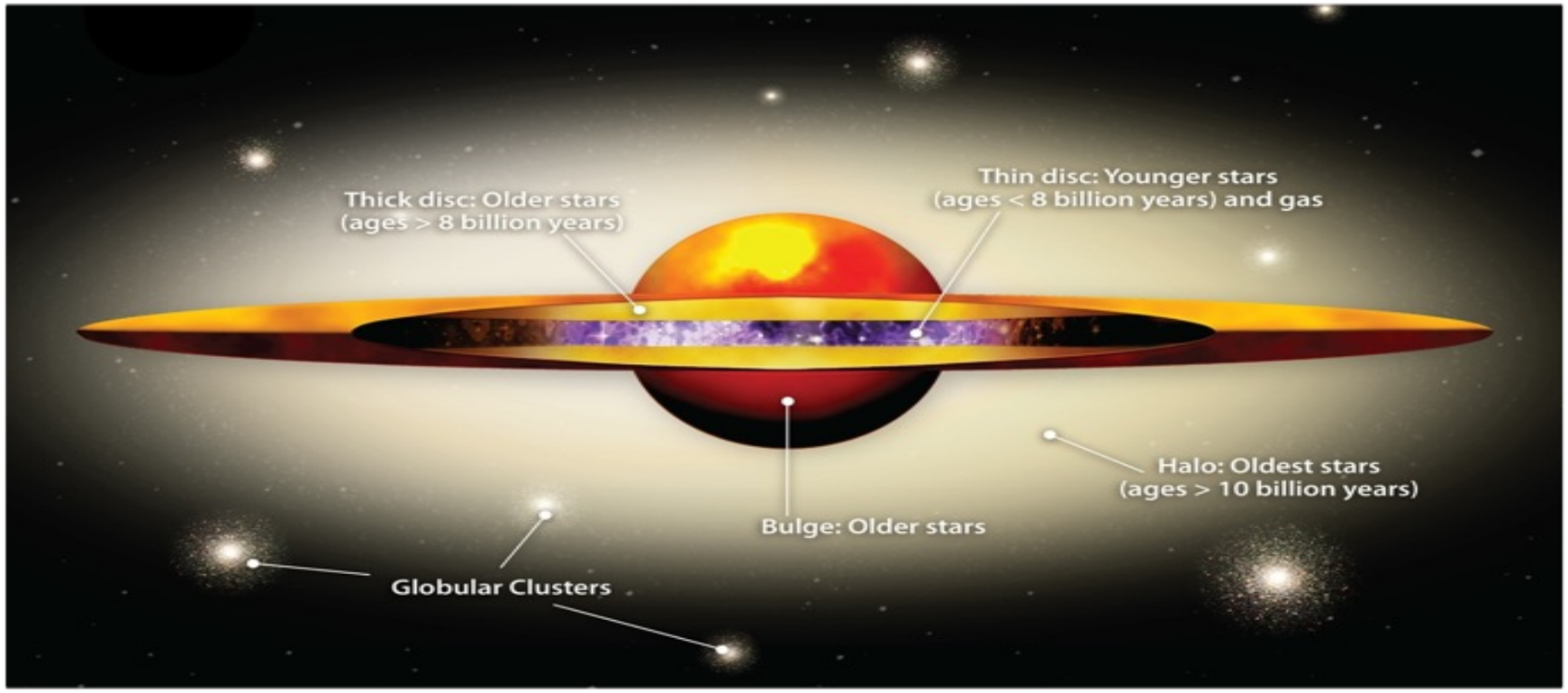


Galactic archaeology

Objectives

1. **Physical properties of the Galaxy**

   What we wish to know



Galactic archaeology

Galactic physical properties

- 3D morphology of components
- Chemical and kinematical properties
- Radial and vertical gradients
- Star formation efficiency (dependence with time, radius?)
- Star formation histories (single, multiple, radial dependence?)



Galactic archaeology

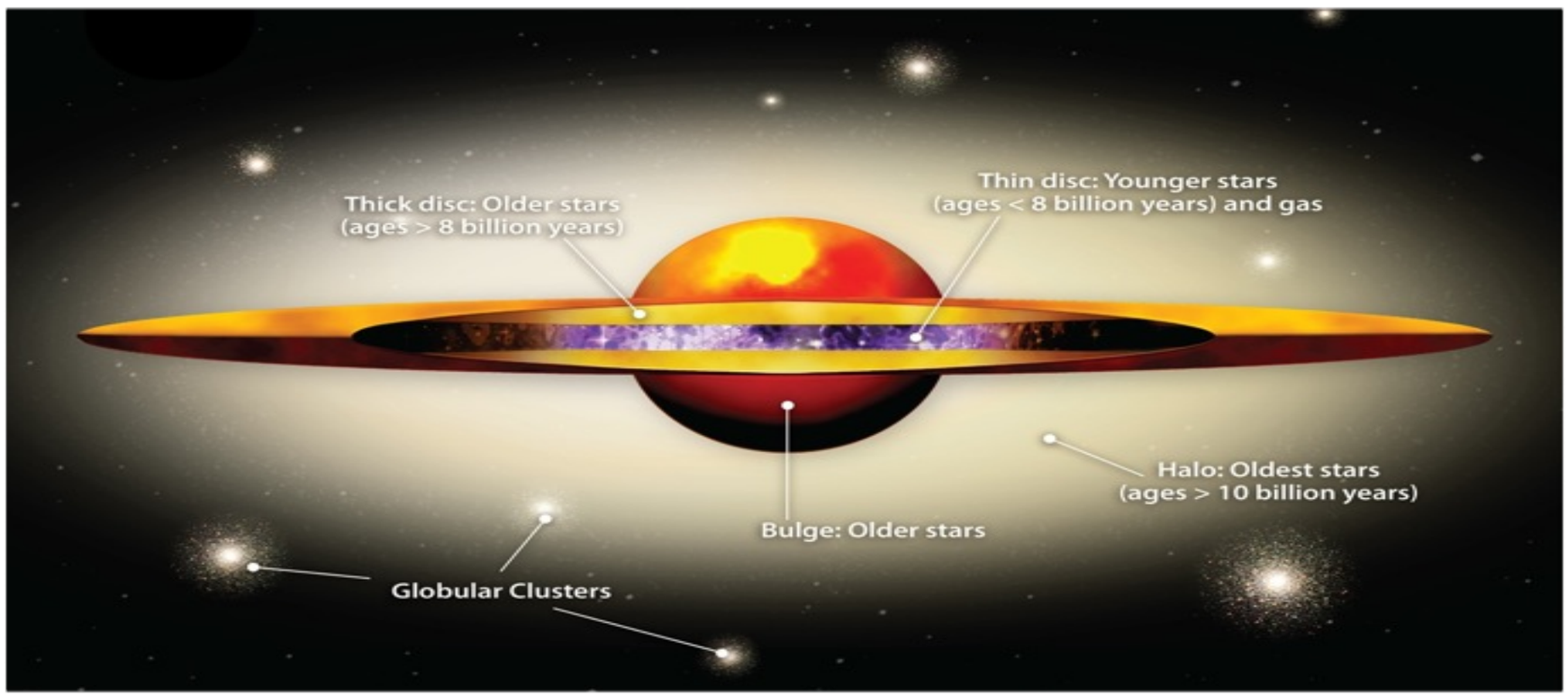
Objectives

1. **Physical properties of the Galaxy**

   What we wish to know

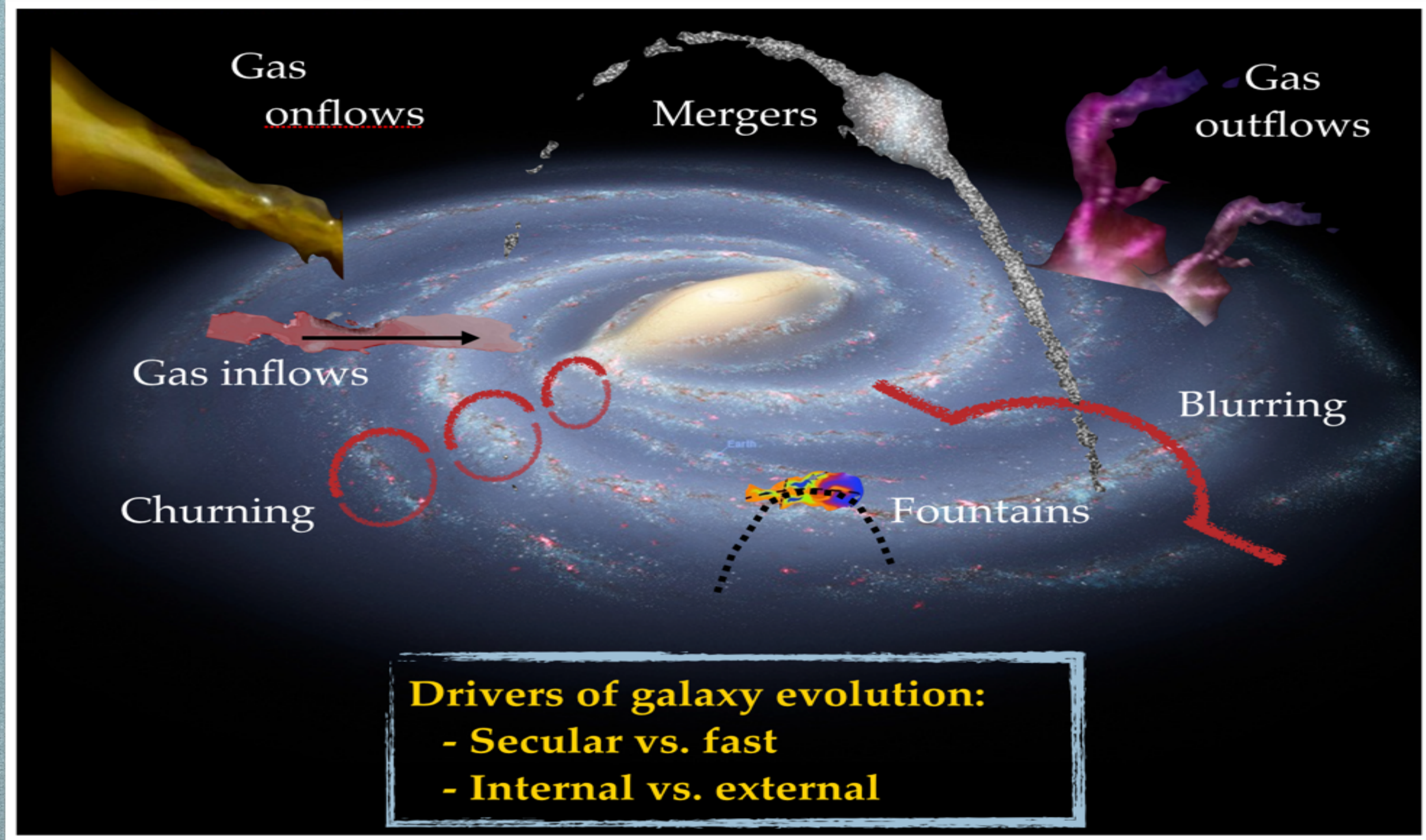
2. **Physical processes drivers of galactic evolution**

   What we wish to understand



Galactic archaeology

Physical processes drivers of evolution



Drivers of galaxy evolution:
- **Secular vs. fast**
- **Internal vs. external**

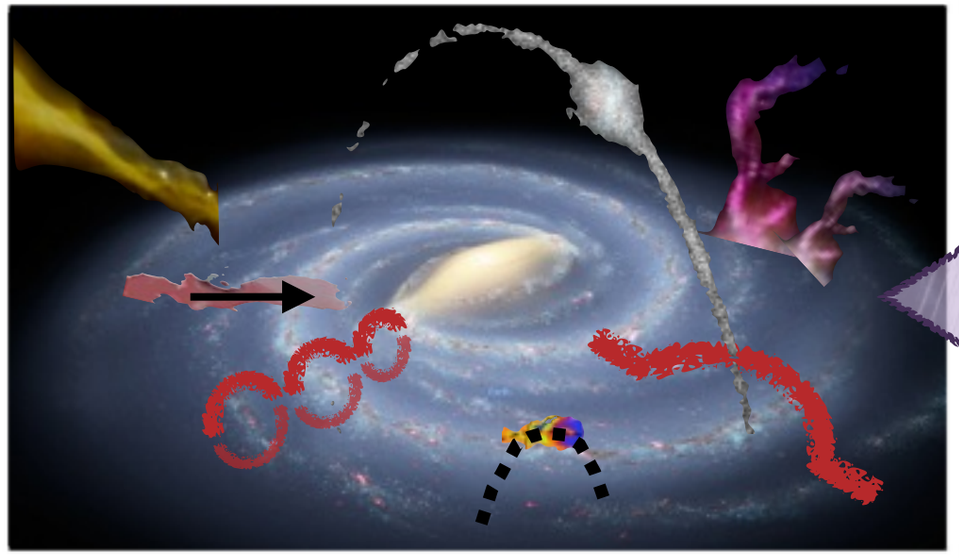
Galactic archaeology

Methodology

Observations



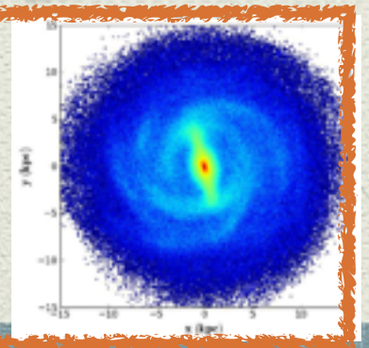
Physical processes



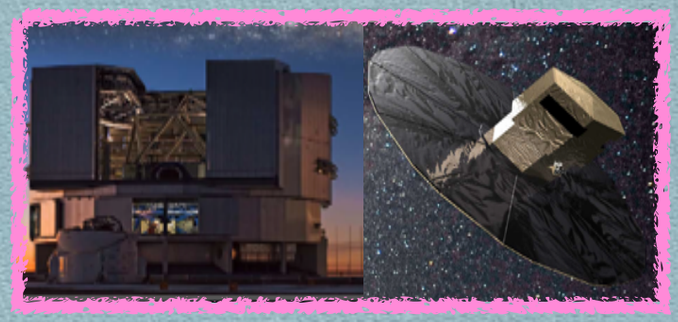
Galactic properties



Models & simulations



Galactic archaeology

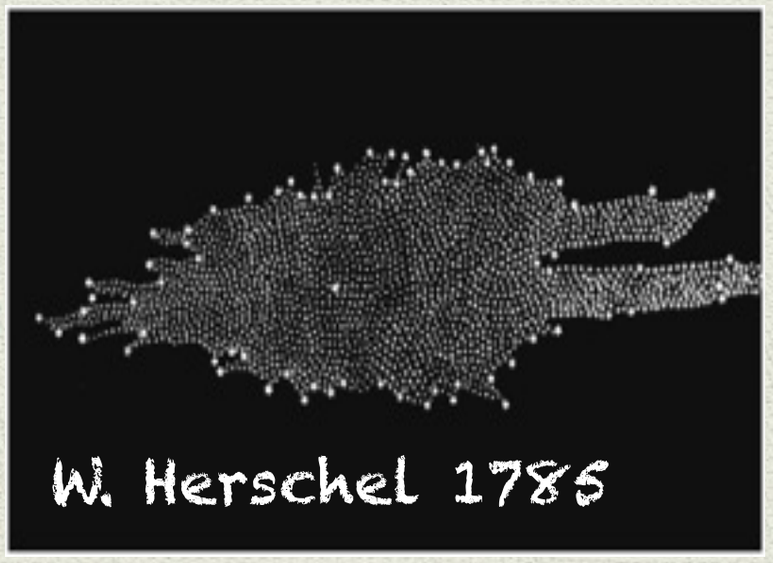


Methodology: Observations

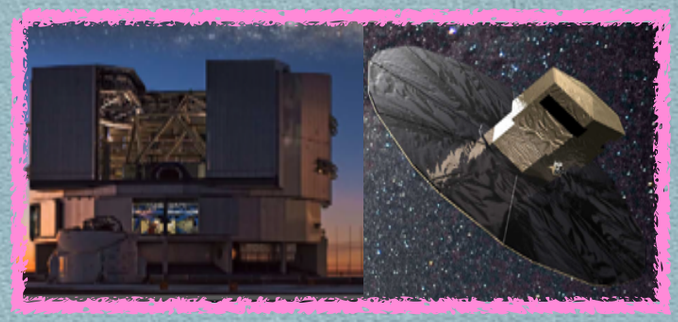
Trying to <u>measure</u> the Galaxy

Physical parameters of Milky Way stellar populations

- Positions and magnitudes



Galactic archaeology

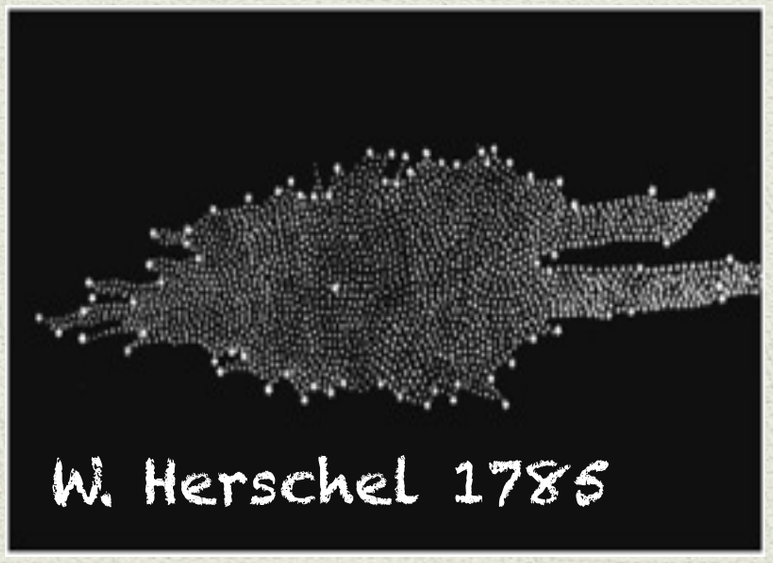


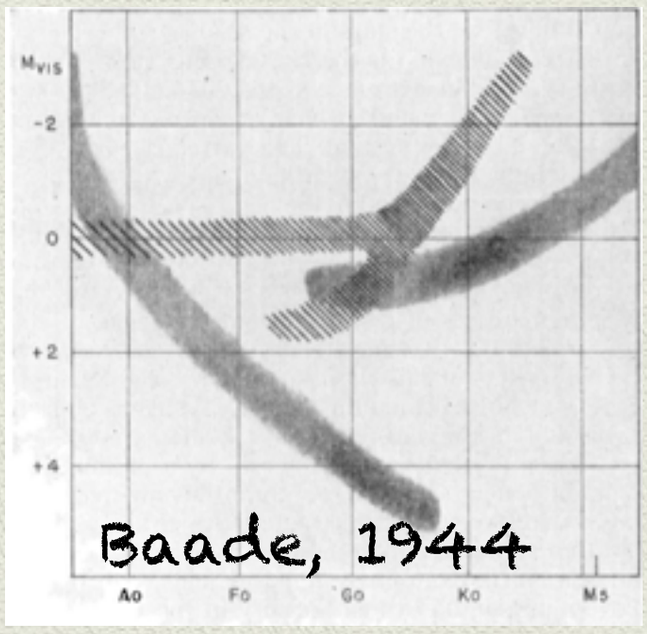
Methodology: Observations

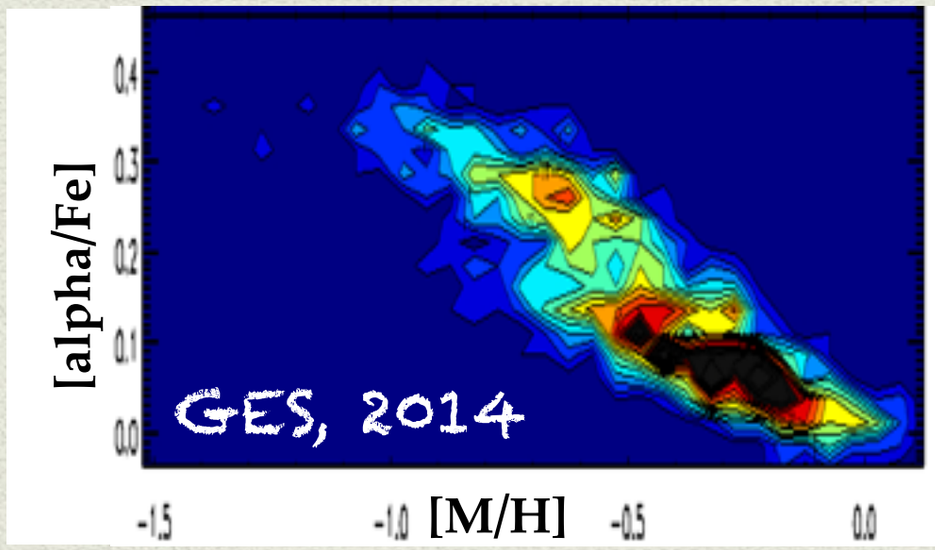
Trying to **measure** the Galaxy

Physical parameters of Milky Way stellar populations

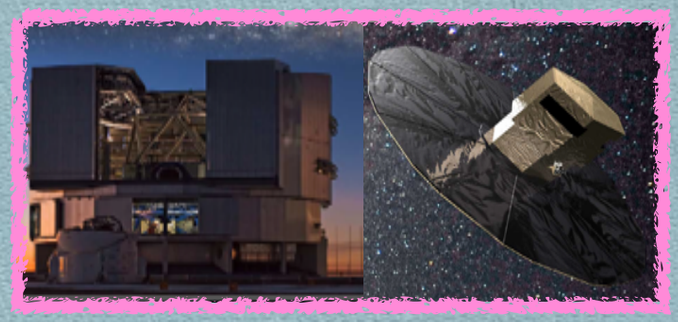
- Positions and magnitudes
- Distances and kinematics
- Individual chemical abundances
- Ages







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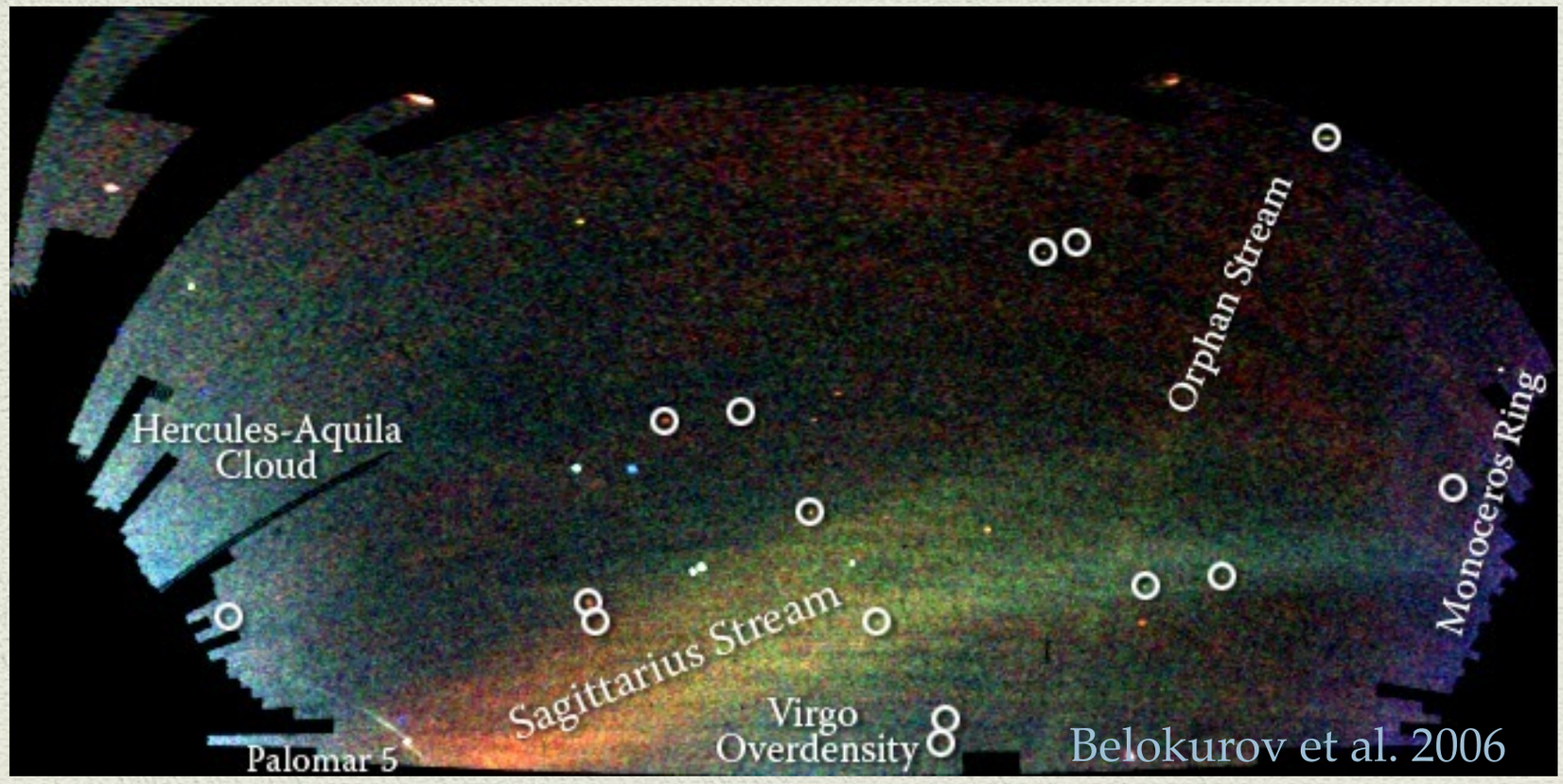


Methodology: Observations

Milky Way surveys

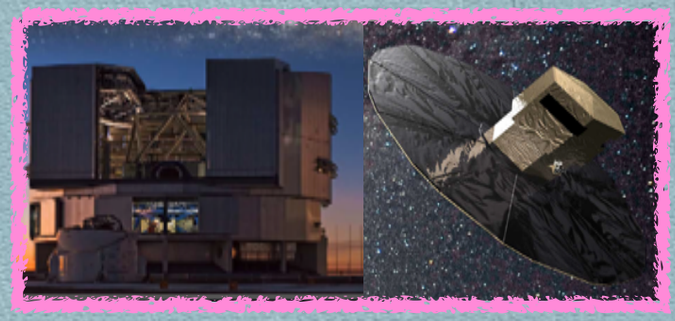
Photometric surveys

- GCS, SDSS, 2MASS, VISTA,…



Belokurov et al. 2006

Galactic archaeology



Methodology: Observations

Milky Way surveys

Photometric surveys

- GCS, SDSS, 2MASS, VISTA,…

Spectroscopic surveys

- **Low resolution:** SEGUE, RAVE, LAMOST
- **High resolution:** Gaia-ESO Survey, APOGEE, GALAH,…

Archival data : AMBRE project on ESO stellar HR spectra

Gaia mission : RVS survey

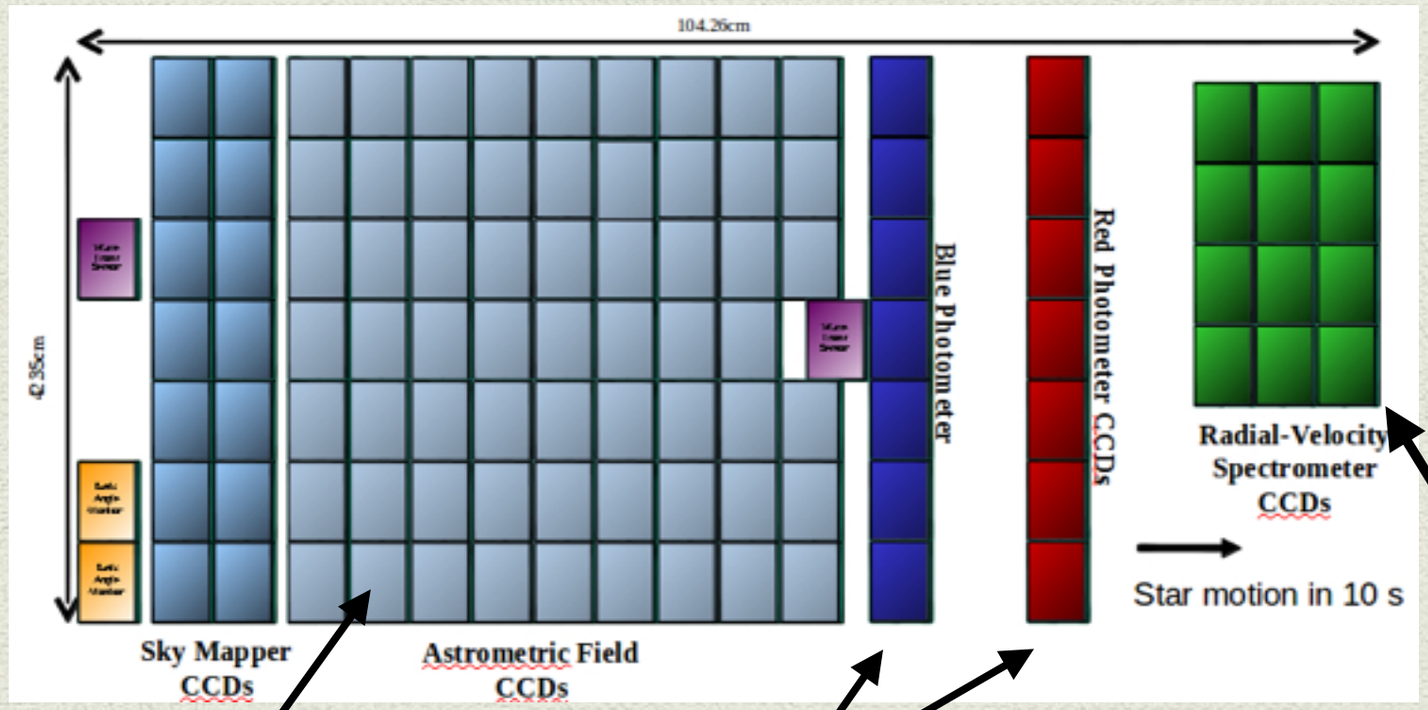
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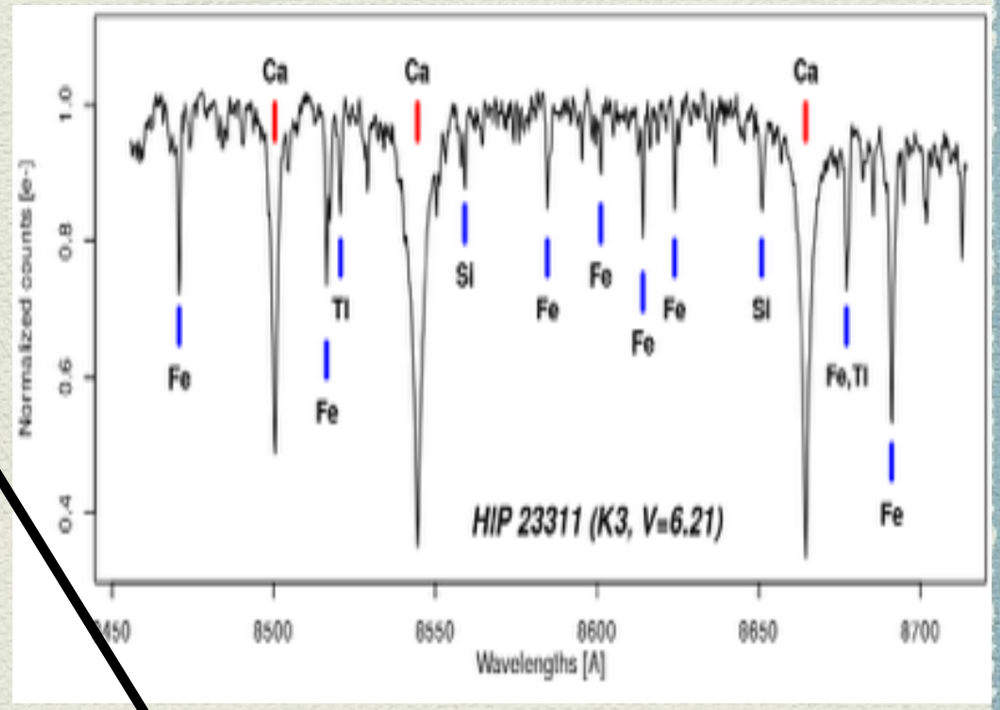


Methodology: Observations

Gaia mission (Launched in Dec. 2013, 5 years mission)

Astrometric, photometric and spectroscopic survey





Astrometry
G<20 mag
Since DR1 (mid-2016)

BP/RP spectro-photometry
G<20 mag, 1 billion stars
Since DR2 (early 2017)

RVS spectroscopy
G<16 mag ~150 million stars
Since DR2 (early 2017)

Galactic archaeology



Methodology: Observations

The Gaia-ESO Survey (GES)

High-resolution spectroscopic survey with VLT

UVES (R~40000) 10^4 stars in the solar neighbourhood

GIRAFFE (R~20000) 10^5 field and open cluster stars

Start: 2012, 5 years of observations

P.I.s G. Gilmore & S. Randich

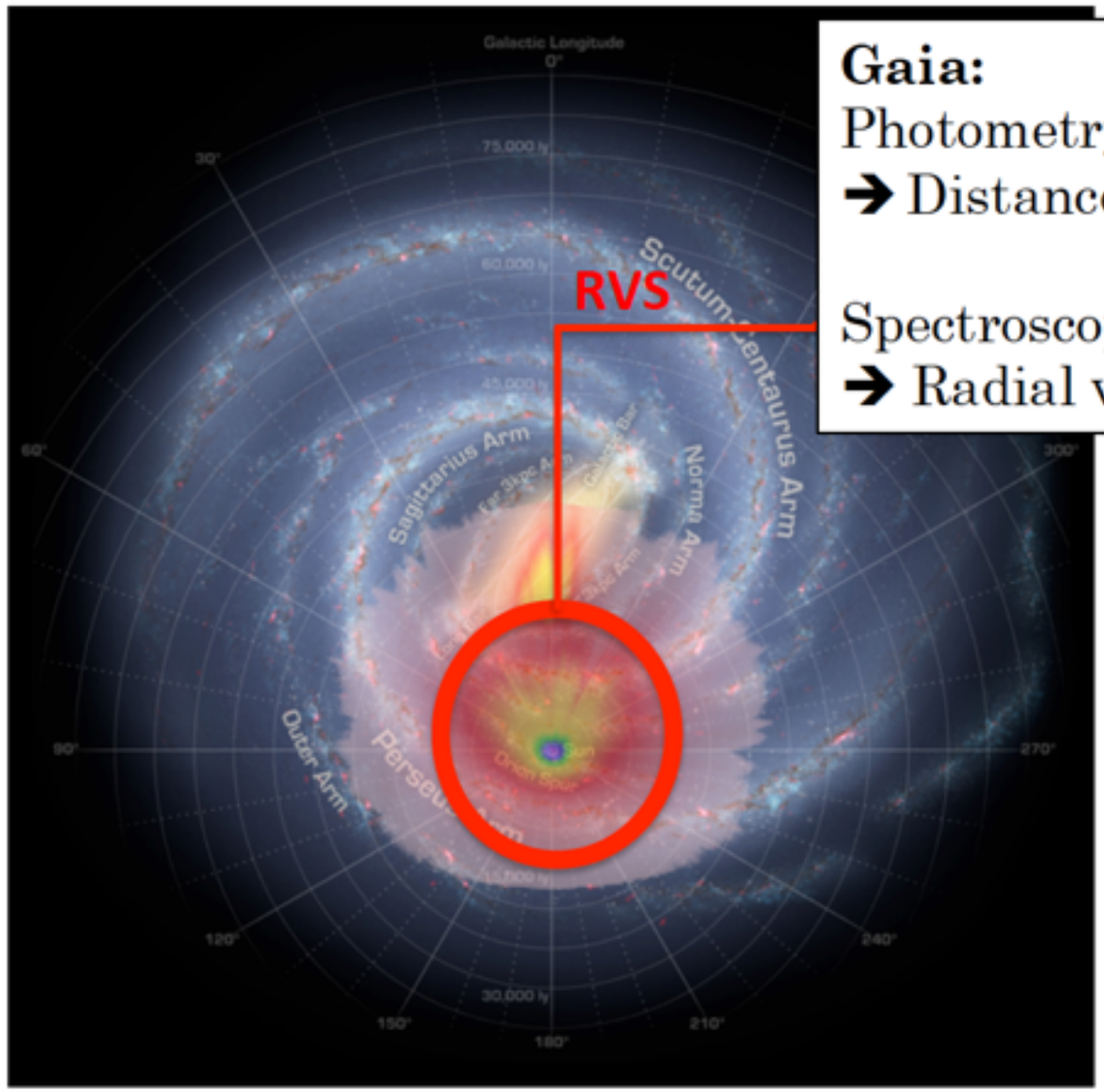


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Methodology: Observations

The Gaia-ESO Survey (GES)



Gaia:
Photometry, astrometry: V<19
➔ Distances, proper motions

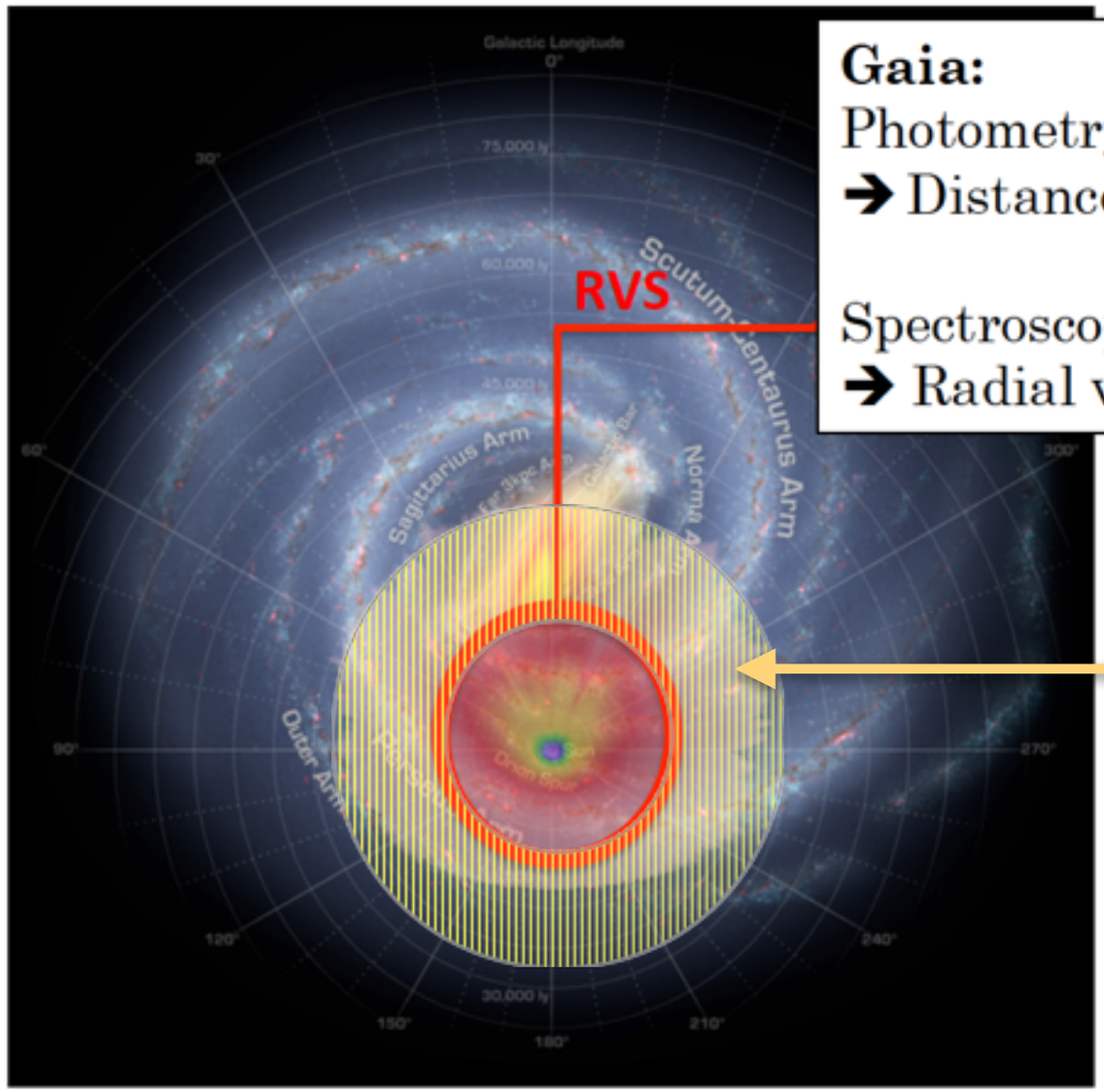
Spectroscopy: V<16
➔ Radial velocity, abundances

Galactic archaeology



Methodology: Observations

The Gaia-ESO Survey (GES)



Gaia:
Photometry, astrometry: V<19
➔ Distances, proper motions

Spectroscopy: V<16
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GES spectroscopy