

Galactic Astronomy

2019-2020

Professors:

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Teresa Antoja (Gaia Team Researchers)

Course: **Galactic Astronomy**

Master: Astrophysics, Physical Particles and Cosmology

Course: 2019-2020

Programme:

1. Introduction
2. Astronomical measurements
3. Statistical astronomy
4. Galactic Structure
5. Galactic Kinematics
6. Fundamental equations of stellar dynamics
7. Stellar orbits in the Milky Way potential
8. Collisions and encounters of stellar systems
9. An introduction to the chemical evolution of the Milky Way
10. Formation and evolution of galaxies



What we observe

molecular hydrogen

infrared

mid-infrared

near infrared

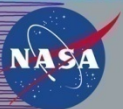
optical

x-ray

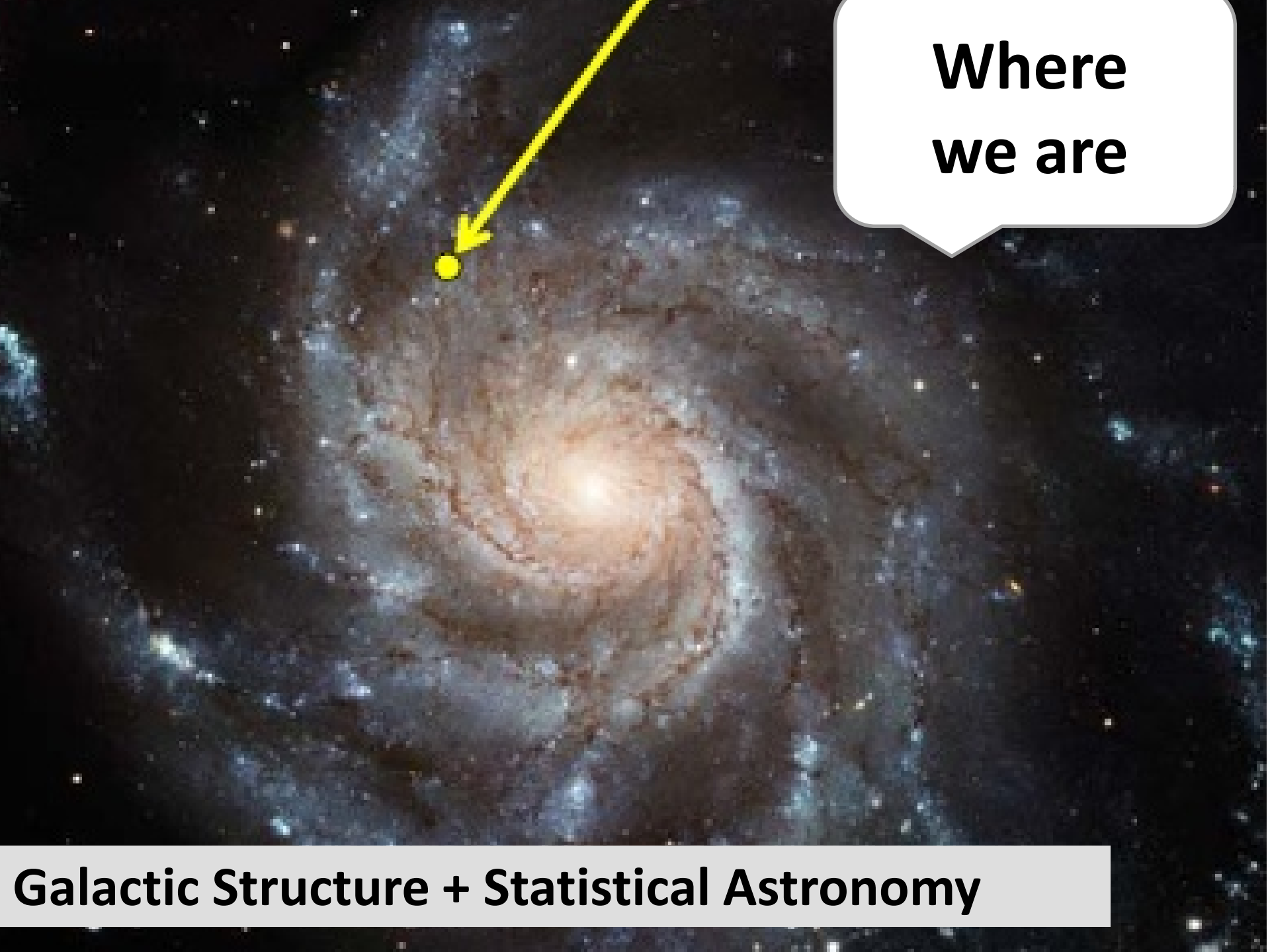
gamma ray

MW: Stellar constituents, gas, dust & (DM)

<http://adc.gsfc.nasa.gov/mw>



Multiwavelength Milky Way

A photograph of a spiral galaxy, likely the Milky Way, showing its central bulge and spiral arms. A yellow dot is placed on the outer edge of the galaxy, with a yellow arrow pointing to it from the top. A white speech bubble with a black border is located in the upper right corner, containing the text "Where we are".

**Where
we are**

Galactic Structure + Statistical Astronomy

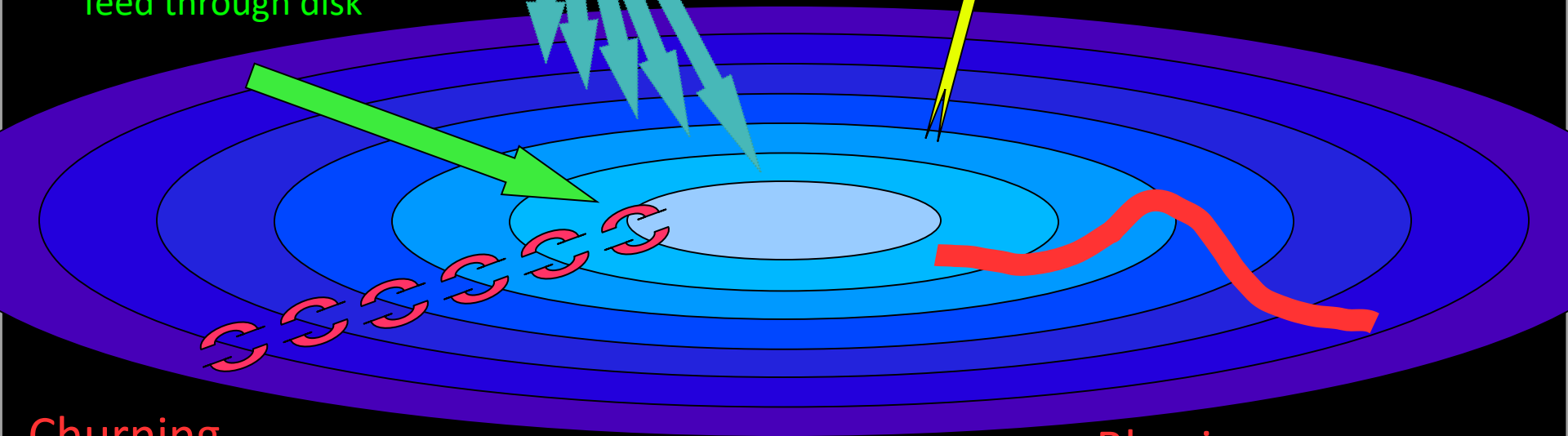
Schoenrich & Binney M

Chemo-
dynamical
models

direct onflow ~ 75% of feed
slightly preenriched

outflow/processed

Inflow ~ 25% of
feed through disk



Churning

- mass exchange between neighbouring rings
- cold gas and stars
- no heating of the disc

radial spacing 0.25 kpc

Blurring

- stars on increasingly
eccentric orbits
(heating of the disc)

Structure → Kinematics → Dynamics → MW Mass Model

disc and
nt

Towards a chemo-dynamical evolution of the MW



How did our galaxy and its components form?
XXI Century: the MW as a cosmological laboratory

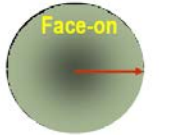
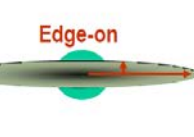


**Gaia + WEAVE +
large scale
surveys ...
a dream in 1962!**

**Galaxy formation and evolution are encoded in the
location, kinematics (6D) and chemistry of stars**

External Galaxies

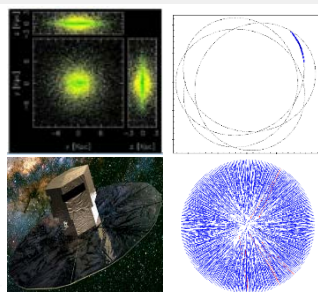
Galaxy outskirts, low-density regime: hard to observe and therefore often ignored

<p>1 - D (+ azimuthal symmetry)</p>	 <p>Face-on</p>	<p>Profiles = $f(R)$ Gas, Stars, SFR, SNR : Surface densities $\Sigma(R)$ Colour and abundance gradients Evolution = $f(t, R)$</p>
<p>2 - D (+ azimuthal + planar symmetry)</p>	 <p>Edge-on</p>	<p>Profiles as above + (assuming equilibrium): Vertical structure: Volume densities $\rho(R, z)$ Velocity dispersions, Thin and thick disks Evolution = $f(t, R, z)$</p>

Galaxy evolution:
from local Group to high-redshift systems

Milky Way

The MW: our cosmological laboratory, resolved stellar populations

<p>n-D</p>		<p>Phase-space DF $f(x, v)$ Mass model Origin and evolution IMF, SFH, Gas flows Abundance gradients</p>
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The MW and its satellites

Common goals: galaxy formation and evolution

A chemo-dynamical model, processes of gaseous and satellite accretion, radial migration, merging, disc formation (in-out)

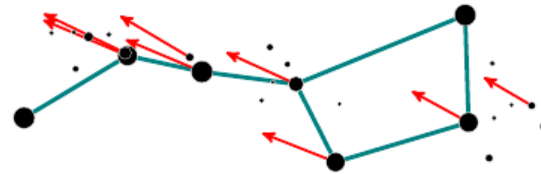
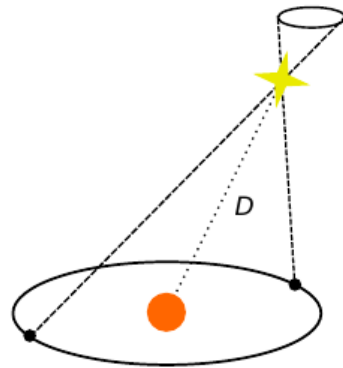
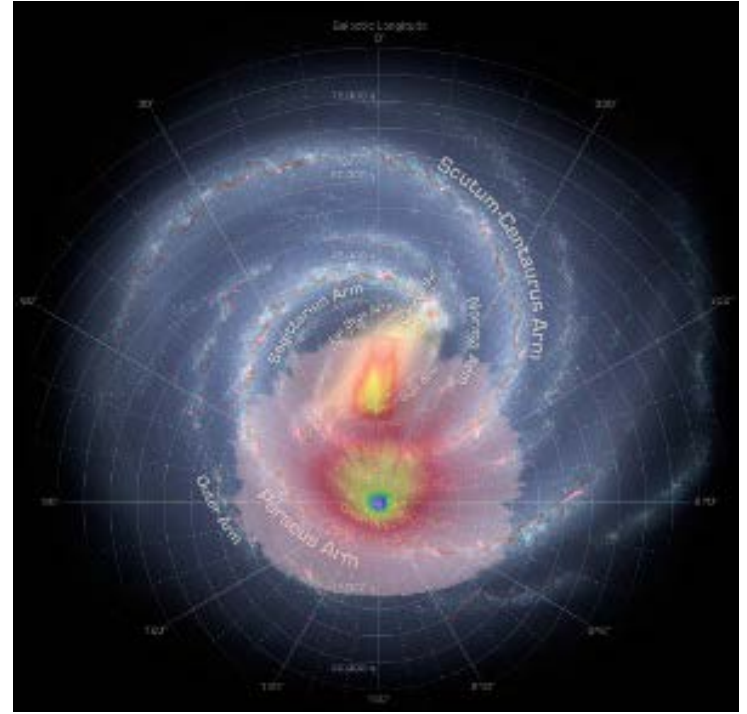
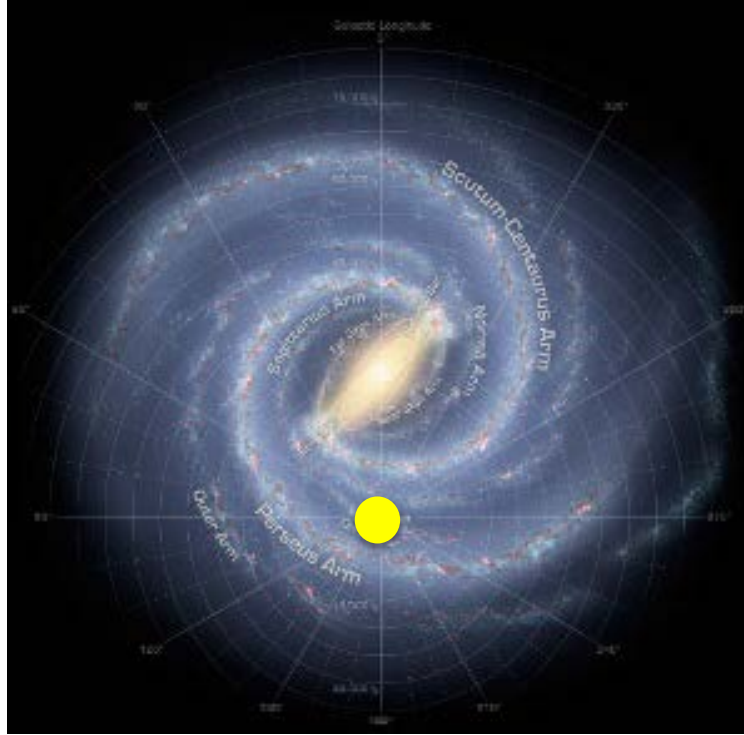
2 years of successful scientific operation



**December 19th,
2014
10:12 CET**

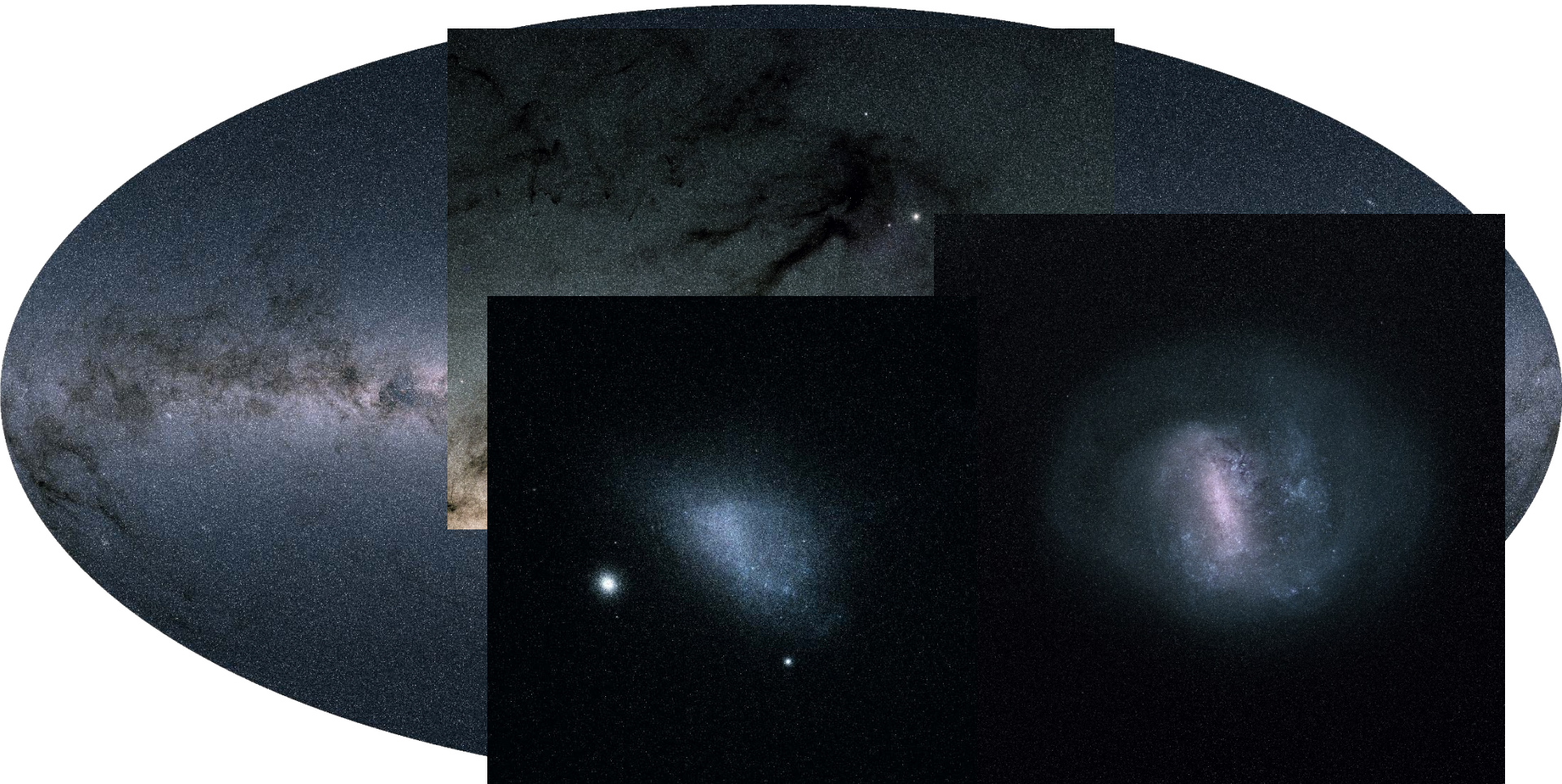
A screenshot of the Gaia Archive website interface. The page has a dark red header with the text "gaia archive" in white. Below the header is a navigation bar with tabs for "HOME", "SEARCH", "STATISTICS", "VISUALIZATION", and "HELP". Underneath the navigation bar are three tabs: "Simple Form" (highlighted in blue), "ADQL Form", and "Query Results". Below these tabs are two more tabs: "Position" (highlighted in blue) and "File". The "Position" tab is active, showing a form with two radio buttons: "Name" (selected) and "Equatorial". To the right of these radio buttons is a "Target in" section with two radio buttons: "Circle" (selected) and "Box". Below the "Name" radio button is a text input field labeled "Name".

**1st Release: Sep 14th, 2016
2nd Release: April, 2018**





Gaia Catalogue, DR2 25-April-2018



Goals of GA course:
from the observables to the population synthesis and chemodynamical models

Hand-on exercises:

- Characterization of open clusters
- Derivation of the DM local density (K_z)

Position File

- Name
- Equatorial

Target in Circle Box


Name for Radius


Search in: Gaia Source Tycho-Gaia Astrometric Solution (TGAS)


▶ Extra conditions

▶ Display columns

Max. number of results:

 Reset Form

 Show Query

 Submit Query

Lectures from visiting professors

Course: **Galactic dynamics**

Invited professor :

Dr. Mark Gieles
(ICCUB-ICREA)



In this course, the basic principles on Galactic Dynamics learned during the school will be applied to some key stellar systems in the Galactic halo. Examples of them are:

- Dynamics of Globular Clusters
- tidal streams
- Potential theory

December, 2019

Campus Virtual de la UB

cursos ▶ Curs acadèmic 13/14 ▶ Màsters ▶ Astrofísica, Física de Partícules i Cosmologia ▶ 1314AGC ▶

Course info: Evaluation, dates, ...

Marks:

- 60 % Exam (short questions)
- 40 % Exercises (short exercises and oral presentations)

Dates for the evaluation:

- Exam: 2nd week of January
- Exercises: to be presented before the end of January
- Oral presentation of exercises: during the course



Milky Way size galaxy formation and high performance computing

© E. Rodríguez-Fabrigas / Gaia/ESA simulations

COST WG1 Milky Way Gaia School

14-17 January 2020

Institute of Cosmos Sciences (ICCUB-IEEC)

Europe/Madrid timezone

Topics and Lecturers

Organizing Committee

Important dates

Registration

Grants

Participants

Timetable

Materials for the course

Venue and Accommodation

Poster

Acknowledgements

Contacte

✉ secretariacientifica@icc...

Outline of the school

This is the first school of the WG1 *The Milky Way as a Galaxy* of the EU COST action MW-GAIA. The objective of this working group is the exploitation of Gaia data in combination with other survey data to address some of the most important questions in the formation and evolution of our Galaxy.

Being N-body and hydrodynamic simulations key tools to undertake the structure, star formation history, and dynamical evolution of the Milky Way, the goal of the school is to provide a general view of the current state of the art and challenges in simulating the formation of Milky Way size galaxies.

Currently, High Performance computing and Data Science tools are key to perform and analyze these simulations and to do a fair comparison with observations. With this in mind, it is a key goal of the school to provide to skills the students need to deal with such simulation/real data.



Starts 14 Jan 2020, 08:30

Ends 17 Jan 2020, 18:00

Europe/Madrid



Institute of Cosmos Sciences (ICCUB-IEEC)
University of Barcelona

Martí i Franqués, 1
08028 Barcelona



Poster_GaiaSchool2020.png

