A close up view on galaxies' infighting

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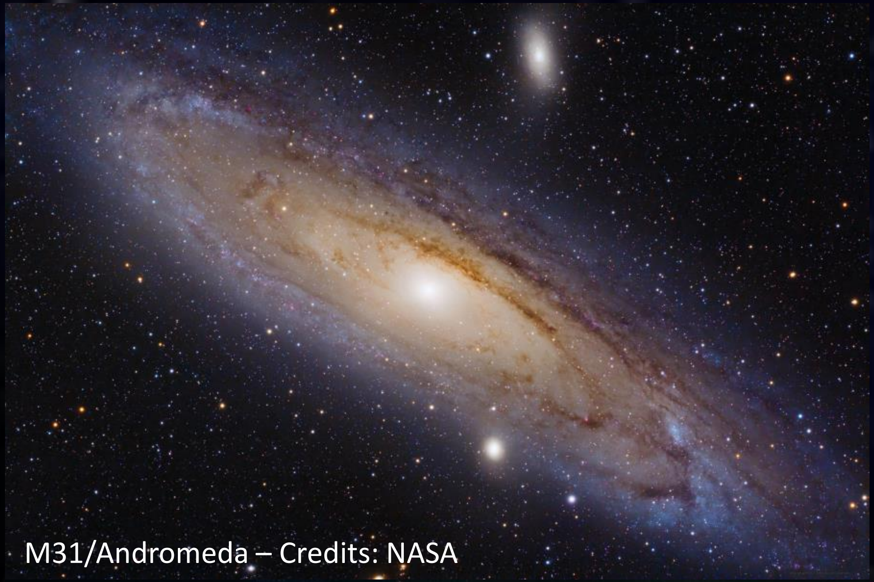


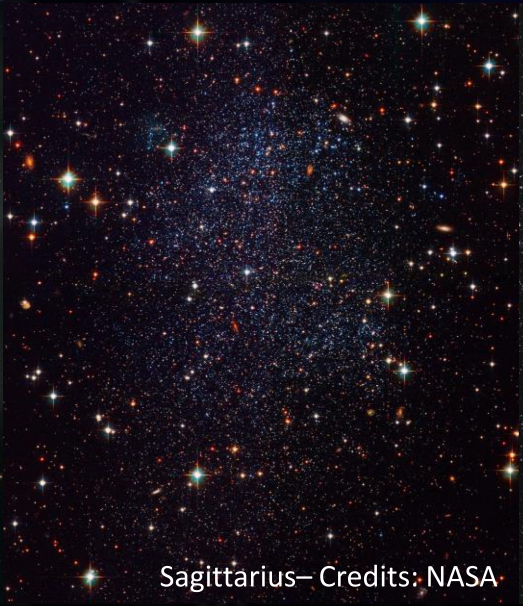
M31/Andromeda – Credits: NASA

Why do we care about galaxies? Well … without them we would not be here!

Their large gravitational pull holds the heavy elements created during supernovae explosions, allowing the formation of stars, planets, and thus life as we know it.

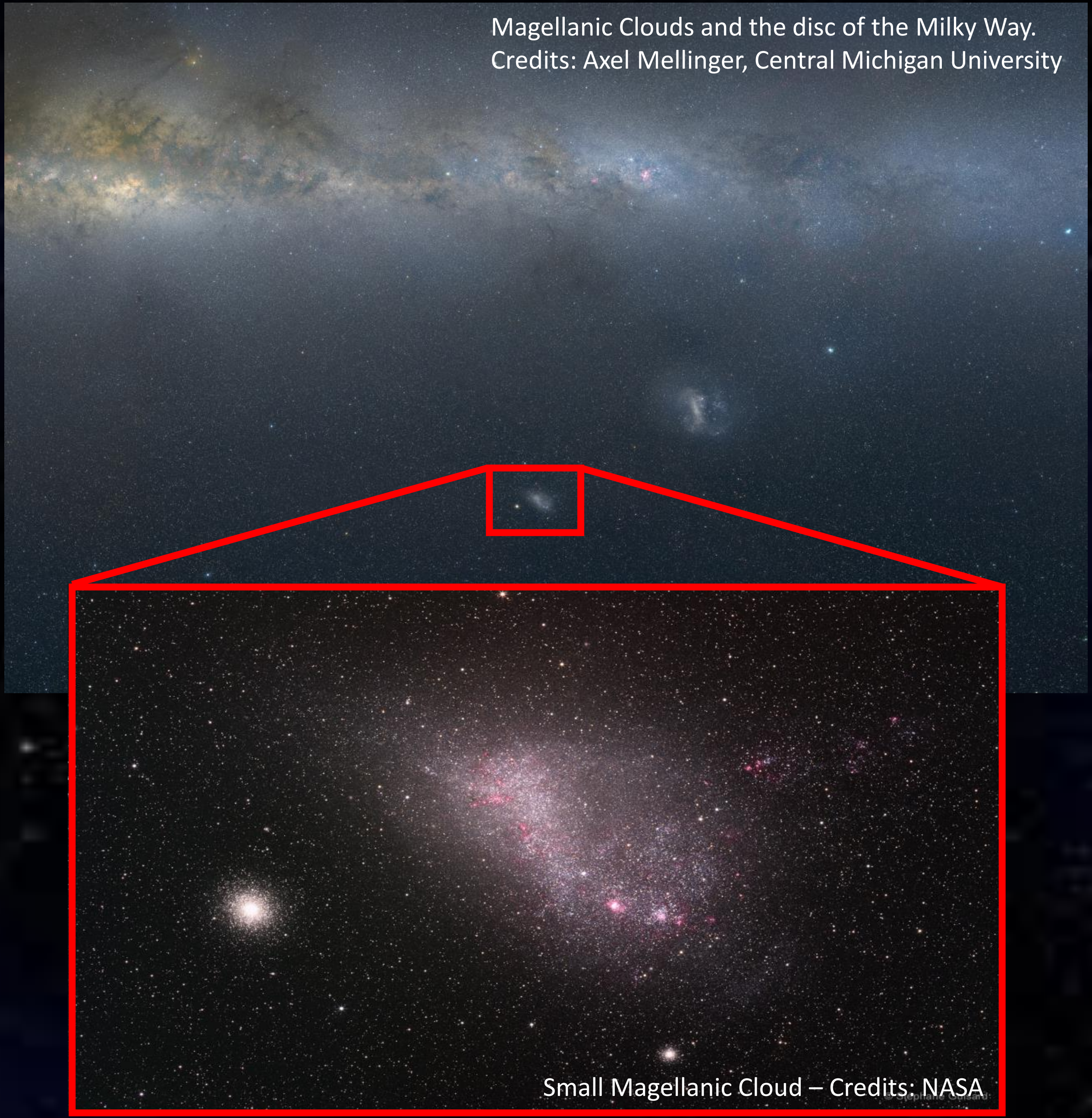
Big galaxies, like Andromeda and our own Milky Way, have formed over billions of years by "devouring" smaller galaxies. These little systems called "dwarf galaxies" come in all shapes and sizes and constitute essential "building blocks" of larger galaxies.
Studying the dwarf galaxies is key to understand the evolution of all types of galaxies.

M51/Whirlpool – Credits: NASA



Sagittarius– Credits: NASA

Small Magellanic Cloud – Credits: NASA



Magellanic Clouds and the disc of the Milky Way.
Credits: Axel Mellinger, Central Michigan University

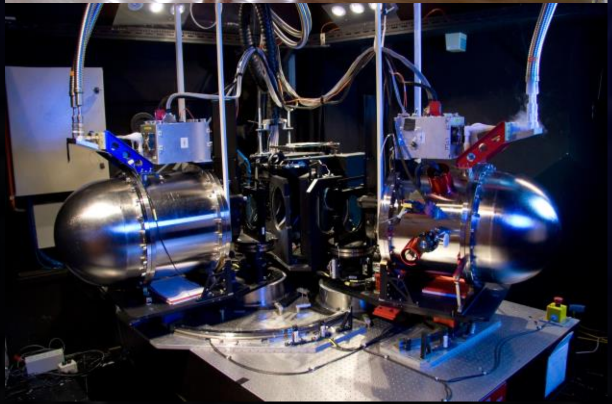
Small Magellanic Cloud – Credits: NASA

The two biggest satellites of the Milky Way are the **Large and the Small Magellanic Clouds**. Only visible from the Southern Hemisphere, these two galaxies were known to humans for millennia, in particular to indigenous inhabitants in Australia, South America and Southern Arabia.

Due to their **proximity, we can resolve individual stars inside the Magellanic Clouds using ground-based telescopes. Both galaxies have been interacting with each other for at least 4 billion years … the age of our Earth!**
The above **make the Magellanic Clouds optimal laboratories to study the composition and evolution of galaxies in exquisite detail.**

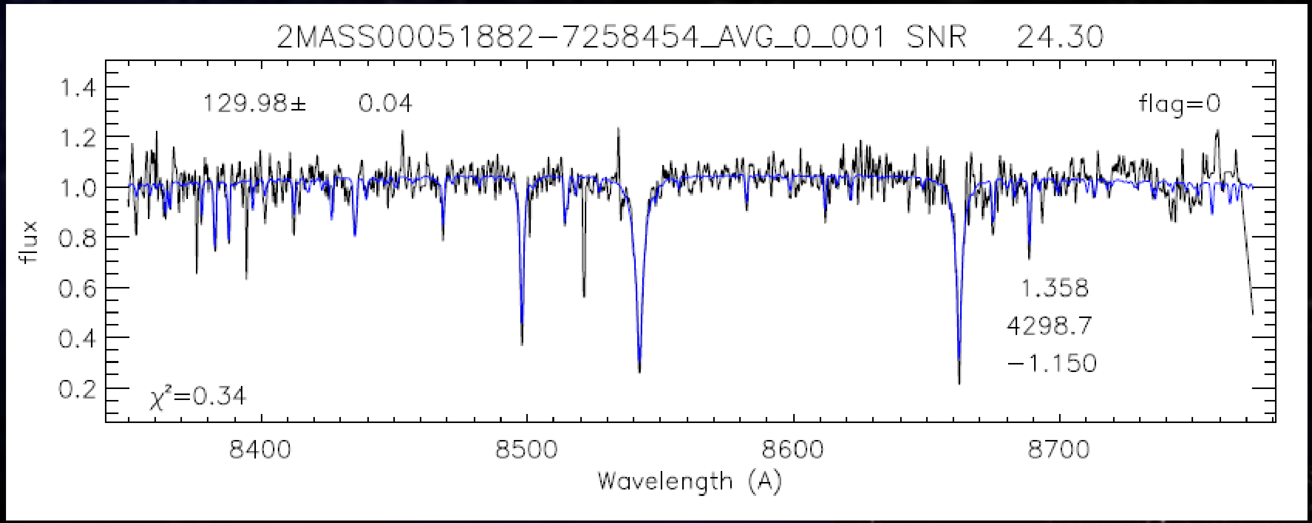
In particular the **Small Magellanic Cloud**, being less massive than the Large Magellanic Cloud, has suffered the most from the encounters with its larger sibling.

Credits: AAT



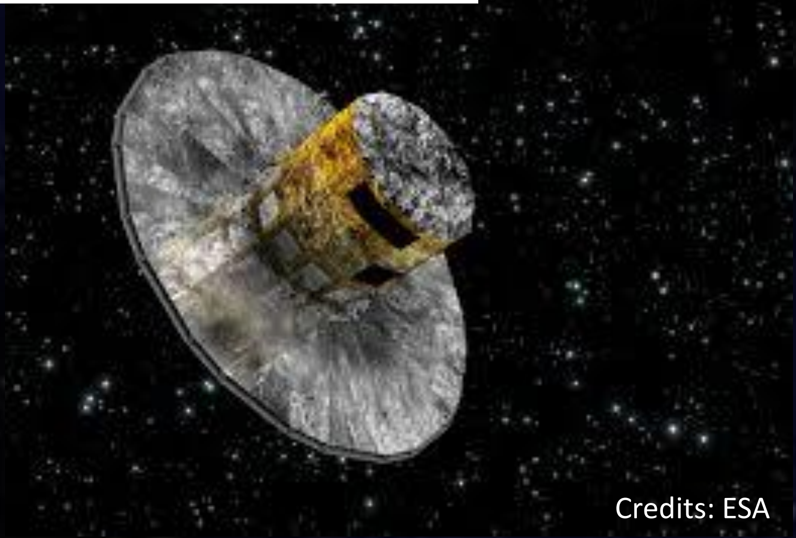
In order to understand more about galactic evolutionary processes, I combined data taken from the ground-based Anglo-Australian Telescope (AAT) located at Siding Spring Observatory with data released from the ESA satellite mission Gaia.

I analysed the spectroscopic data from the AAT to **derive the velocity with which the stars move away or towards us, called radial velocities**. These radial velocities are extracted from the luminosity fluxes of individual stars, as seen in the figure below.



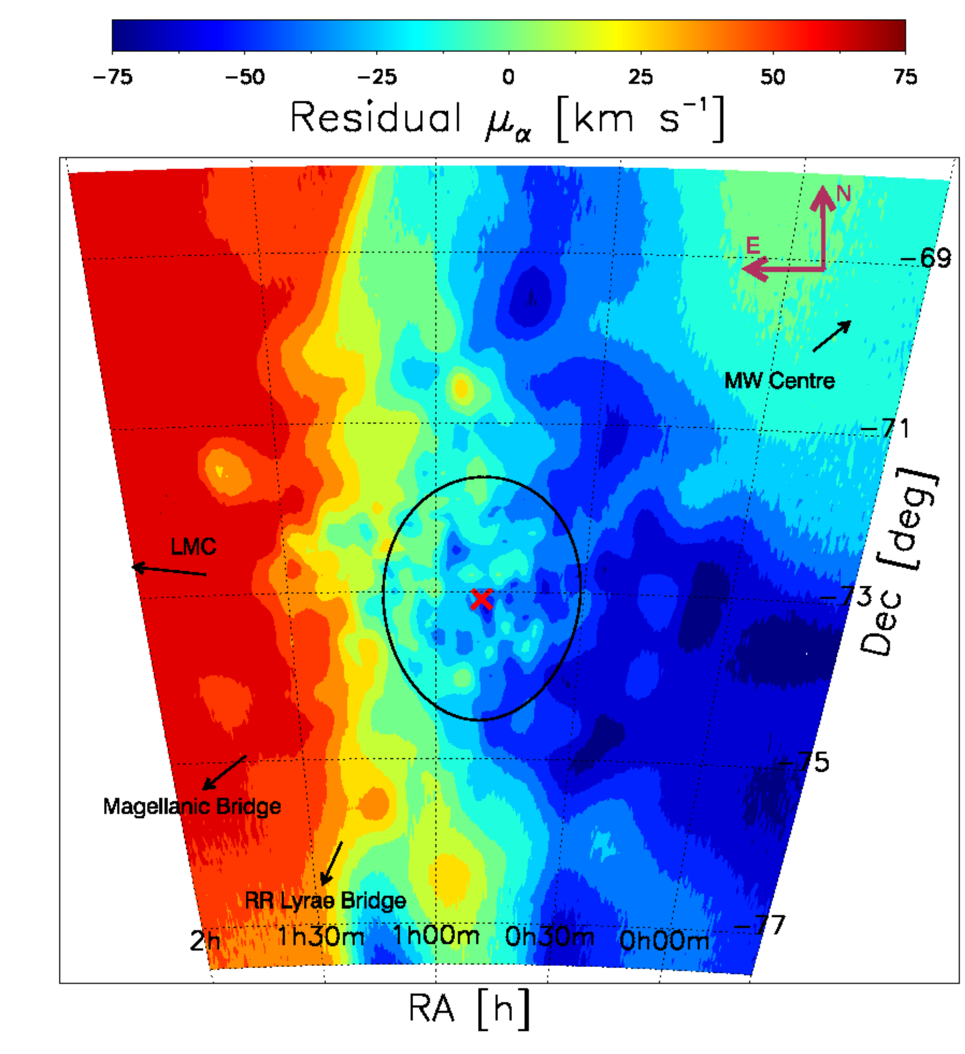
I also analysed photometric data from Gaia, from which I obtained the **velocities on the plane of the sky, providing information on whether a star is moving right or left, up or down.**

Using this 3D information, I studied the motions of several thousands of stars in the Small Magellanic Cloud.

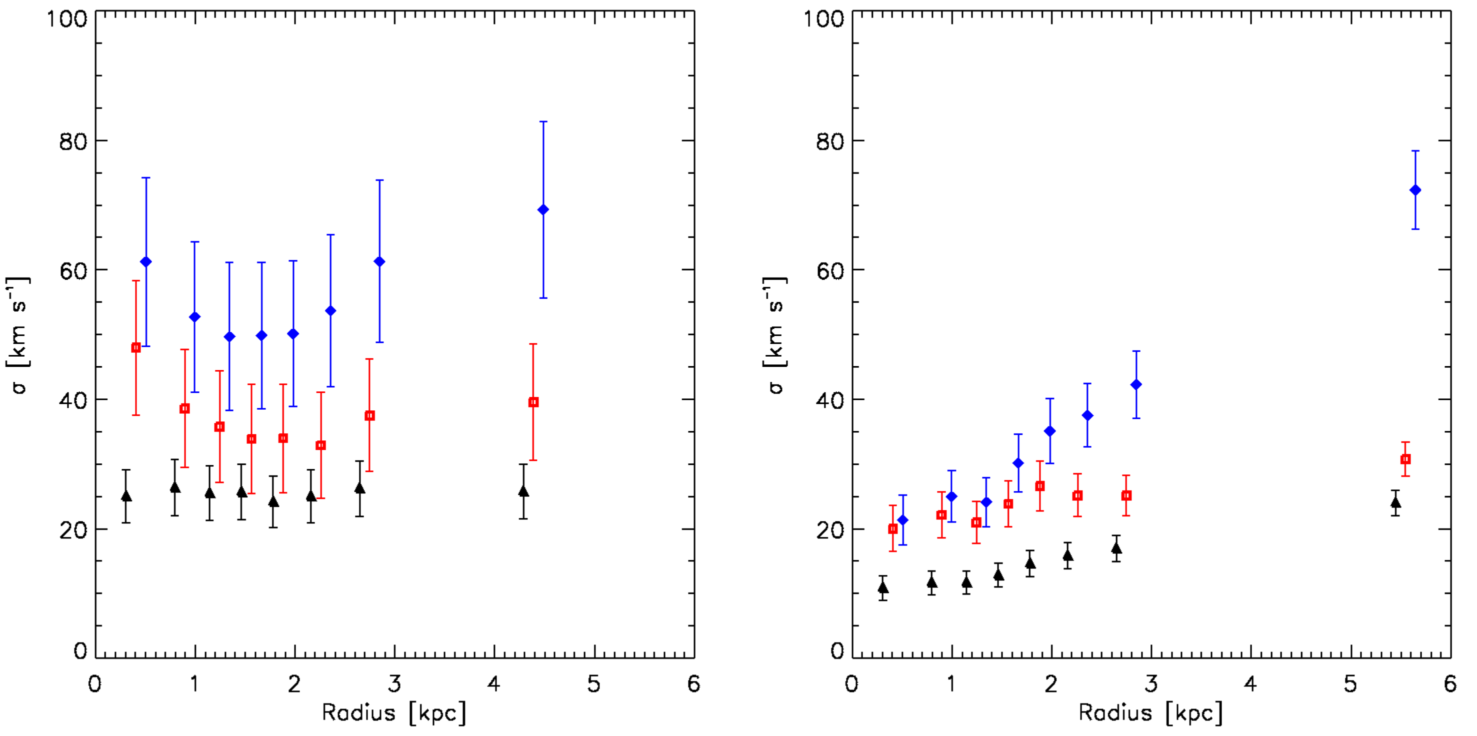


Credits: ESA

The figure on the left shows a map of the motion of stars in the Small Magellanic Cloud. **In red we see the stars moving towards the Large Magellanic Cloud while in blue we observe the stars moving away from it.** From the figure I conclude that **the Small Magellanic Cloud is being torn apart by the Large Magellanic Cloud.**



I ran computer simulations of the Magellanic Clouds orbiting each other and the Milky Way. The graph below shows the **anisotropic behaviour (the difference between the black and coloured points) which is an indicator of the equilibrium and bound state of a system. The left panel shows the observational data, the right one shows the simulation of a disrupting Small Magellanic Cloud. We can see the same anisotropy in both panels.**



The stars in the Small Magellanic Cloud have been stripped from their orbits and are dragged by the tidal influence of the Large Magellanic Cloud.
The Small Magellanic Cloud is heavily disrupted.