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The Milky Way : an unusual galaxy and an exceptionnally calm formation

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Astrophysicists generally consider our Galaxy as an ordinary spiral galaxy, and even use its properties to characterize models of numerical simulation to trace the formation of galaxies at the first epochs of the Universe. This assumption is today called into question by the last results of a team of astrophysicists of the GEPI laboratory from the Paris Observatory.

The team of astronomers (1) has just compared our Galaxy with other spiral galaxies (or galaxies with discs). This shows that for the Milky Way, the star content and the disc radius are quite lower than than is observed for the other galaxies. The halo of our Galaxy is also exceptional : its stars are particularly poor in heavy elements. The team explains these characteristics by the fact that our Galaxy underwent very few encounters or mergers with other galaxies since the last 10-11 billion years.

Today, the majority of large galaxies are spiral galaxies, i.e. large discs in rotation around a bulge of relative small size. For example, our Sun is a star of the disc of our Galaxy, the Milky Way, orbiting at a speed of 220 km/s around the galactic center. The galaxies are characterized by fundamental quantities like the rotation velocity of disc stars around the center, the disc radius and finally the star content, commonly called "stellar mass". It is rather easy to measure these quantities for external galaxies, since we have a global vision of them. The difficulty to make these measurements for the Milky Way is due to the fact that we live in it : for example, the extinction by interstellar dust can hide part of the Galaxy and thus distort measurements. Enormous progress was made these last years, with in particular very detailed measurements in near and far infrared which are not affected by dust.

The Milky Way has an unusual mass and radius

By comparing these measurements with those done on nearby galaxies, the astrophysicists of Paris Observatory realized with great surprise that our Galaxy was rather particular. Indeed, for a given rotational velocity of the disc, its radius and its stellar mass are twice smaller than the average for other galaxies. Thus, only 7% of nearby spiral galaxies have properties similar to the Milky Way. On the other hand, the large Andromeda galaxy has average properties.

The particularly intact environment of our Galaxy

Spiral galaxies do not contain only a disc and a bulge : they are also surrounded by a halo, generally known to contain the invisible matter necessary to their stability. This halo, contains visible matter, including stars, whose properties are particularly affected by mergers between galaxies. For example, when a galaxy absorbs another one, the effects of the collision are so violent that the surroundings are considerably affected by the tidal debris, and moreover, enriched by the new stars formed in the merger. Again, the Milky Way is very particular : its environment contains only old stars, poor in heavy elements, contrary to other galaxies, in particular Andromeda.

Is the Milky Way particularly favorable to the emergence of life ?

We know in addition that the Milky Way did not undergo major mergers with other galaxies since nearly 11 billion years. We also know that Andromeda underwent many mergers in a recent past (a few billion years). These recent mergers "pollute" the environment of the galaxies by dispersed material or lately formed stars. By generating new stars, the stellar mass and the radius of galaxies increase. The particular properties of the Milky Way - small disc radius, low stellar mass, stars little enriched in the halo - are thus explained by the exceptionally calm history of our Galaxy. The absence of galaxy encounters during more than ten billion years could be a condition particularly favorable to the emergence of life. Indeed, collisions between galaxies are in general very violent, and imply very powerful emissions of energy (for example supernovae) which are very harmful to complex molecules at the origin of the living bodies.

(1) The team is composed of : François Hammer, Mathieu Puech, Laurent Chemin, Hector Flores et Matthew Lehnert, GEPI-Observatoire de Paris, unité mixte de recherche du CNRS, associé à l'Université Paris Diderot.