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COULD A COLLISION BETWEEN A GHOST GALAXY AND THE MILKY WAY BE THE ORIGIN OF THE VPOS OR DOS?

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RESUMEN

En la actualidad dentro del área de la astrofísica se presentan un número de problemas sin resolver, entre ellos el problema del origen de las galaxias satélite de la Vía Láctea. Estas galaxias se caracterizan por ser galaxias de tipo enana esferoidal. La mayoría de estas se encuentran distribuidas en una estructura tipo disco que se encuentra dispuesta de forma casi perpendicular al plano de la galaxia, conocida con el nombre de disco de satélites (DoS) o gran estructura polar de galaxias satelitales (VPOS). Hasta el momento no se ha podido encontrar un modelo que dé cuenta de la cantidad y de la distribución espacial de estas galaxias. Sin embargo se han presentado varias propuestas de solución, una de las cuales propone que estas tuvieron origen en la colisión de dos galaxias de disco hace miles de millones de años. En este trabajo se llevaron a cabo simulaciones numéricas de N-cuerpos con el software Gadget2 para colisiones entre dos galaxias de disco que pudieron dar origen al disco de satélites de la Vía Láctea.

ABSTRACT

At present within the area of astrophysics there are a number of unresolved problems, including the origin of the satellite galaxies of the Milky Way. Most of these galaxies are characterized as dwarf spheroidal galaxies. The large majority of them is distributed in a disk-like structure which is arranged almost perpendicular to the plane of the Galaxy, this structure is known as disk of satellites (DoS) or Vast Polar structure of Satellite galaxies (VPoS). So far there is not a model that fully reproduces the amount and spatial distribution of these galaxies. However there have been several proposed for the solutions, one of which suggests that these originated in the collision of two disk galaxies billions of years ago. Using the Gadget2 software, we have performed N-bodies numerical simulations of the collision between two disk galaxies that could give rise to disk of Milky Way satellites.

Key Words: galaxies: dwarf — Galaxies: general — Local Group

1. THEORETICAL FRAMEWORK

Pawlowski et al. (2011) present a scenario describing the formation of contra-orbiting material that emerges from the collision of two disc galaxies. For the scale of these galaxies, they used the characteristics that the MW had about 10 Gyr ago. It is shown how collisions of two galaxies, using mixture and fly-by models in mass ratios 1 to 1 and 4 to 1 for the target and projectile galaxy respectively, result in populations of prograde and retrograde particles that occupy a certain region of space similar to that occupied by satellite dwarf galaxies of the MW - this way supporting the scenario in which the satellite dwarf system of our galaxy is the result of a collision between the young MW and another galaxy, in which during the collision formed gas tide debris that later became the small satellite galaxies it possesses today. For the reasons explained in this section, the objective of this study is to perform a simulation with the GADGET2 N-body simulation software (Springel et al., 2005) in order to determine if the spatial distribution and number of satellite galaxies of the MW originates through a collision between two disc galaxies. This work is based on the model in whicGhosth the MW billions of years ago interacted with another disc galaxy, here called "Ghost galaxy", which is considered to be much less massive than the MW, generating tidal tails that are considered as the origin of the satellite galaxies of the MW. After the collision, the tidal debris is analyzed for groups of particles that behave similarly to the satellite galaxies of the MW in both their spatial distribution and number.

2. RESULTS AND ANALYSIS

Numerical simulations of N-Bodies with mass ratios 8 to 1 show that compared to the results of Kroupa (2014), the simulations and the observations coincide in the average mass of the satellite dwarfs of the MW, which is $\sim 10^7$ $M_\odot$, and in the number of fragments, which at the moment of the simulation is around 35. However, they do *not* coincide in

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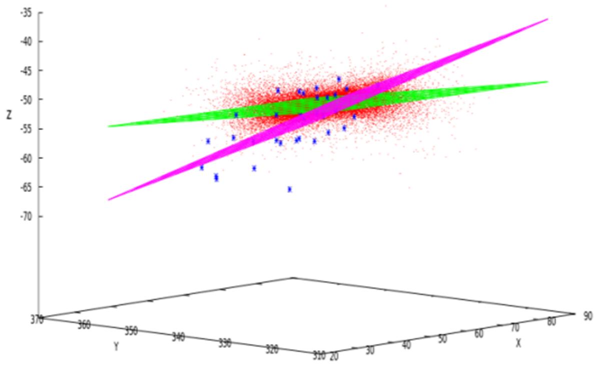

Fig. 1. Red particles represent the Milky Way, blue dots the individual remnant groups, the green plane indicates the Galactic plane and the purple plane shows the major axes of the distribution of the groups. The angle between the two planes is 17.4°. The scale is given in kpc

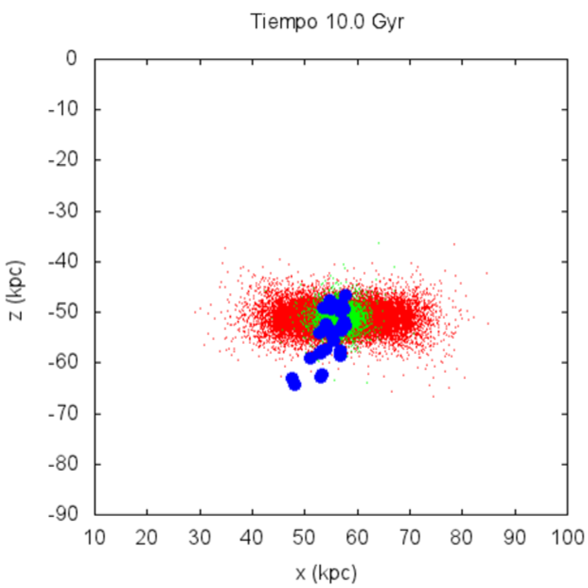

Fig. 2. simulation with mass ratios 8-1, although we can see in the simulation a structure that seems to be a disk, the satellite galaxies are very crowded on the plane of the MW, in the observations we can see distances from Up to 200 kpc with respect to the MW disk (Kroupa 2014). In the simulation this distance reaches a maximum of 20 kpc with respect to the disk.

the velocity dispersion of the satellite galaxies, since the observed ones are of the order of 10 km/s to 15 km/s and those found in this study are of the order of 240 km/s. The distribution of the satellite galaxy disk forms an angle with respect to the plane of the MW of about 88° in the observations; in this study an angle of approximately 17.4° was found. The distance of the satellite galaxies from the plane of the MW has a maximum of 220 kpc and are distributed along this distance, while in the simulation it is found that the maximum distance of these galaxies with respect to the plane of the MW is of 20 kpc and all are concentrated on the disc of the host galaxy.

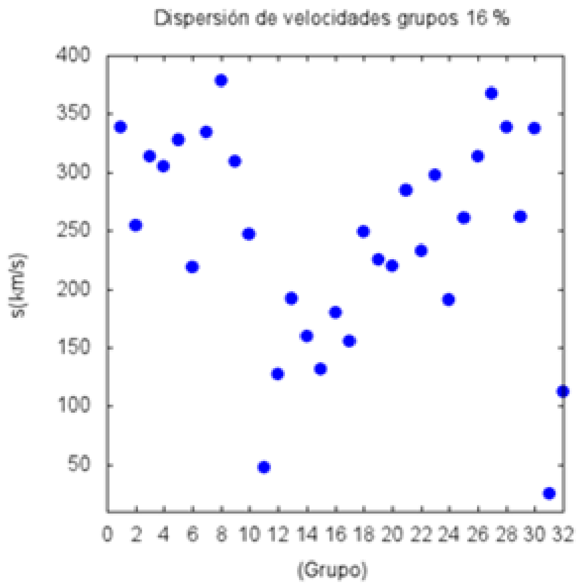

Fig. 3. This graph shows the average dispersion of the 32 groups found in the remnants of the satellite galaxy left after the collision, the average of these dispersions is 242 km/s.

3. CONCLUSIONS

It can be said that under the initial conditions proposed for these simulations it is not possible to generate the dynamic and spatial characteristics of what is called the satellite galaxy disk MW (DoS), however, this does not completely rule out the proposed model. Although it does not reflect the expected results, it is possible to propose future work to carry out simulations and to modify the parameters of impact and mass relations to be able to frame the physical conditions under which this event is possible. The results of this work allow to further limit the space of initial orbital and mass conditions of possible progenitors of the DoS of the MW.

REFERENCES

Kroupa, P. 2014, arXiv:1409.6302v1
Mateo, M. L. 1998, ARA&A, 36, 435
Pawlowski, M. S., Kroupa, P., & de Boer, K. S. 2011, A&A, 532, A118
Springel, V., Yoshida, N., & White, S. D. M. 2001, NewA, 6, 79