Galaxy Evolution and Feedback across Different Environments
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The role of internal feedback in the evolution of the dwarf spheroidal galaxy Leo II

Roberto Hazenfratz[1], **Gustavo A. Lanfranchi**[1] **and Anderson Caproni**[1]

[1]Núcleo de Astrofísica, Universidade Cidade de São Paulo, Zip Code 01506-000,
Rua Galvão Bueno 868, São Paulo, Brasil
email: robertohm@usp.br

Abstract. This work aims to explore the different processes of formation and evolution of dwarf spheroidal galaxies in the Local Group analyzing internal and external feedbacks, taking Leo II as a model of parametrization due to its adequate large distance to the Milky Way, in order to minimize potential external effects. We present a discussion of the first results regarding the processes of formation and galactic evolution from the gas hydrodynamics. Combined with previous studies for other similar systems, such results have the potential to establish strong links for the elaboration of a consistent and coherent scenario of formation and evolution of the dwarf spheroidal galaxies in the Local Group.

Keywords. Dwarf Galaxies, Internal Feedback, Hydrodynamic Simulations, Leo II

1. Introduction

The dwarf spheroidal galaxy (DSG) Leo II (Harrington & Wilson 1950) is one of the most distant Milky Way satellite galaxies (233 ± 15 kpc) and therefore suitable for studying the role of internal feedback in the hydrodynamic evolution of its gaseous content. Like all other local dwarf spheroidal galaxies, there is no sign of neutral gas and the detailed mechanisms responsible for its material loss over time are still unknown. This work has as its main objective the hydrodynamic study of the gaseous content of the DSG Leo II, using chemical evolution models combined with a three-dimensional hydrodynamic simulation code as main tools.

Leo II has a total mass of $\approx 4.3 \times 10^7 M_{sun}$ Walker *et al.* (2009), a stellar population with a mean age of 9 Gyr, formed between approximately 14 and 7 Gyr ago, whose average metallicity is $[\mathrm{Fe/H}] = -1.59$ Kirby *et al.* (2011) and particular chemical abundance patterns. Its gaseous content could have been depleted by galactic winds due to stellar feedback (internal mechanisms) or removed by ram pressure or tidal forces (external mechanisms). Such a gas loss, in turn, would directly influence the observed patterns of chemical abundances and other properties of the galaxy.

2. Methods

The hydrodynamic simulations of galaxies, for the classical and non-magnetic regime, can be expressed in the conservative formulation of fluid dynamics equations. The hydrodynamic code used in this work was PLUTO v4.2, assuming a single star formation episode during 7 Gyr. The maximum resolution used in this simulation was 30 pc/cell.

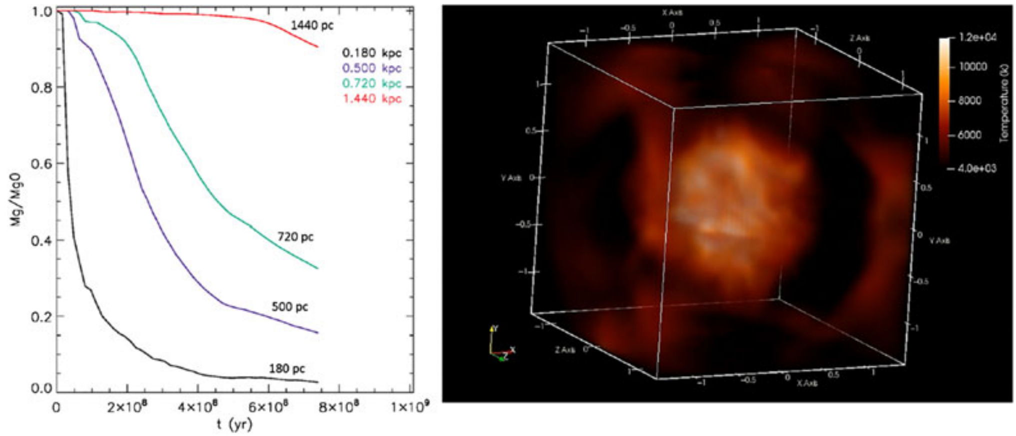

Figure 1. Residual gas mass over time and a 3D-temperature map of Leo II for ≈400 Myr.

Cosmological effects were not considered in a static cartesian grid over time. Further details can be found in Caproni *et al.* (2015, 2017).

3. Preliminary results and Perspectives

The induced gas loss by supernovae (SNe) feedback varies with respect to the galactic radius and time (Fig. 1). The gas loss is the most intense in the first 200 Myr of simulation, considering the radius of 180 pc (core radius of the galaxy), and in the first 400 Myr, considering the radius of 500 and 720 pc. It was also observed that the gas loss was higher in the radius of 180 pc (core radius), for which the residual gas mass achieved the minimum value of ≈5% around 400 Myr and ≈35% for 720 pc around 750 Myr. The latter radius represents a value that contains the tidal radius of the galaxy, estimated as 632 ± 32 Coleman *et al.* (2007).

The location and distribution of supernovae over space and time were observed by spatial distribution histograms. It was observed that SNe Ia explode in more peripheral regions since the beginning of the gas evolution. On the other hand, SNe II explode initially only in the central and denser region. However, the explosions occur in progressively larger radius over time, due to the feedback of the first supernovae, which spread the gas accross the galaxy. The difference in the patterns regarding the two types of supernovae can be explained by the fact that the progenitors of SNe II are stars of higher masses ($> 8M_{sun}$), which occur with higher frequency in high-density regions. In turn, the SNe Ia explosions are more randomly distributed due to the fact that their progenitors are stars of lower mass, which do not necessarily need high-density regions to form.

Regarding the future simulations, the resolution will be increased in order to model the detailed hydrodynamics of Leo II in higher accuracy; the chemical evolution of Leo II will be remodeled with new available data (metallicities, bynary fraction); the mechanical feedback of an intermediate mass black hole will be parameterized; and the time of simulation will be increased to comprise the main star formation duration (7 Gyr).

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