Simulating Pegasus: a Rotationally-Supported Dwarf Irregular Galaxy

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Introduction

We simulate a dwarf galaxy that resembles the observed Pegasus galaxy, a Local Group dwarf. For this aim, we run idealized (non-cosmological) controlled simulations with GIZMO, a mesh-free hydro-solver (Hopkins 2014).

This simulated galaxy will be put under a series of numerical tests that emulate the removal of gas via ram pressure. Each scenario will be analyzed in order to determine the role that the removal of gas plays in rotational vs. dispersion support (Vrot/σ) of our simulated galaxy.

Project : To simulate an isolated dwarf galaxy similar to Pegasus, a nearby dwarf irregular.

The Dwarf Morphology-Density Relation

Observations suggest that for the general galaxy population, a morphology-relation exists. This relation states that galaxies with a predominant spheroidal component are found in crowded environments, whilst disk dominated galaxies tend to live in low density regions (Oemler 1974, Dressler 1980, Bluck et al. 2014, 2016).

An analogous morphology-density exists for the dwarf galaxy regime: dwarf spheroidals (dSphs) are preferentially found in the proximity of their host massive galaxies, whilst dwarf irregulars (dIrrs) tend to inhabit the field (Matteo 1998, Grebel 1999). Figure 1 illustrates this.

Dwarf Irregulars (dIrr)	Dwarf Spheroidals (dSph)
Gas-rich, star forming, exhibit some rotational support, found in isolated environments	Gas-poor, non-star forming, exhibit little to no rotation, found near massive galaxies.

Figure 1: Schematic depiction of the bimodal morphological distribution of dwarf galaxies in the local volume. Dwarf spheroidals are found in the proximity of massive galaxies while dwarf irregulars tend to exist in isolation.

Kinematic measurements offer a new window into the nature of dwarf galaxies (Kirby et al., 2014). Specifically, Wheeler et al. (2016) find little evidence of a (Vrot/σ)-environment relation (Figure 2). Instead, data suggest that the majority of dwarf galaxies (both dSphs and isolated dIrrs) are pressure-supported. Interestingly, only three isolated dIrrs are rotationally-supported. We select ***Pegasus***, the nearest of the three, for further numerical examination.

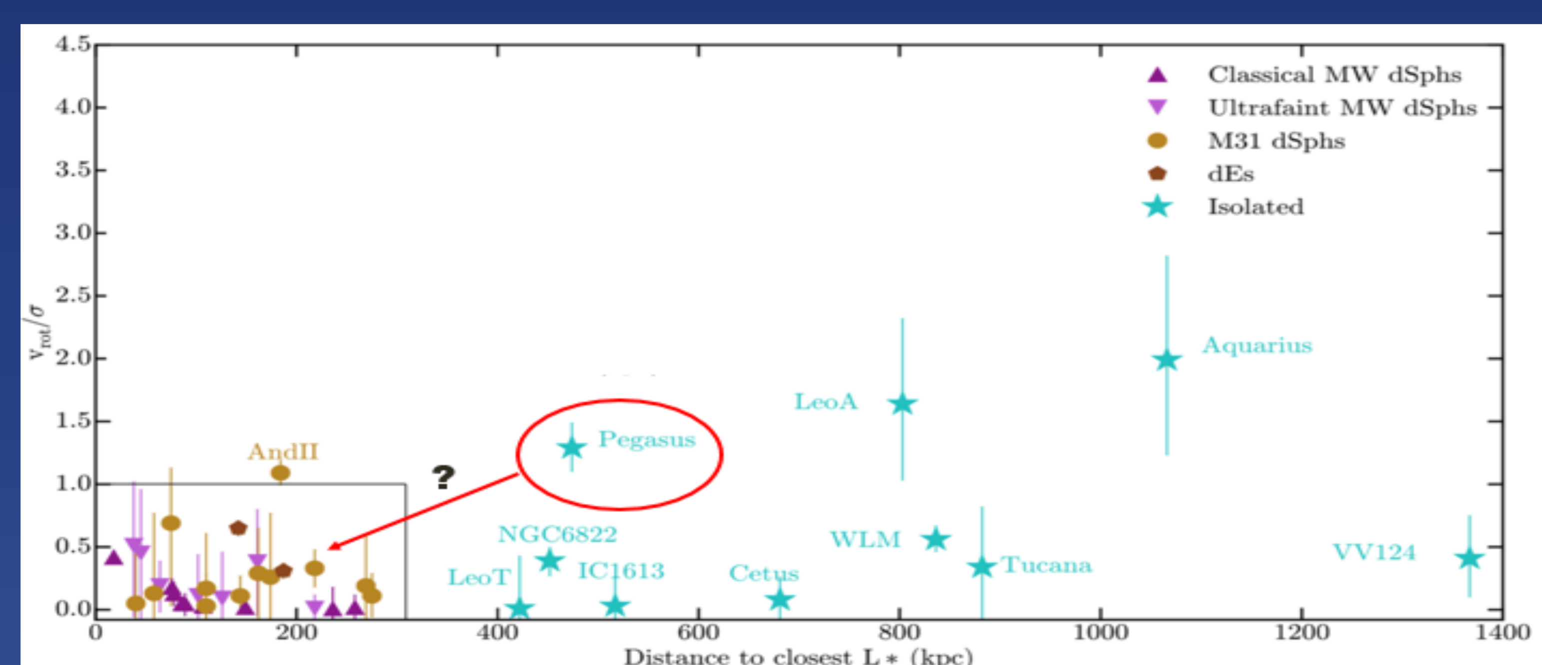

Figure 2: Measured Vrot/σ values of the local group dwarfs as a function of the distance to the closest L* galaxy. The majority, including isolated dIrrs, are pressure-supported. We select Pegasus, the nearest of the three rotation-supported dIrrs, for additional numerical experimentation. Figure adapted from Wheeler et al. (2016).

The majority of local dwarf galaxies are pressure-supported, including isolated dIrrs. Only three dIrrs are rotation-supported, including Pegasus.

Results: The Simulated Pegasus Dwarf Galaxy

To recreate our simulated Pegasus, we use SpherIC to generate the initial distribution of gas, stars and dark matter. As a first step, we performed runs without feedback. Figure 3 shows an image of our simulated galaxy, and the time evolution of its Vrot/σ.

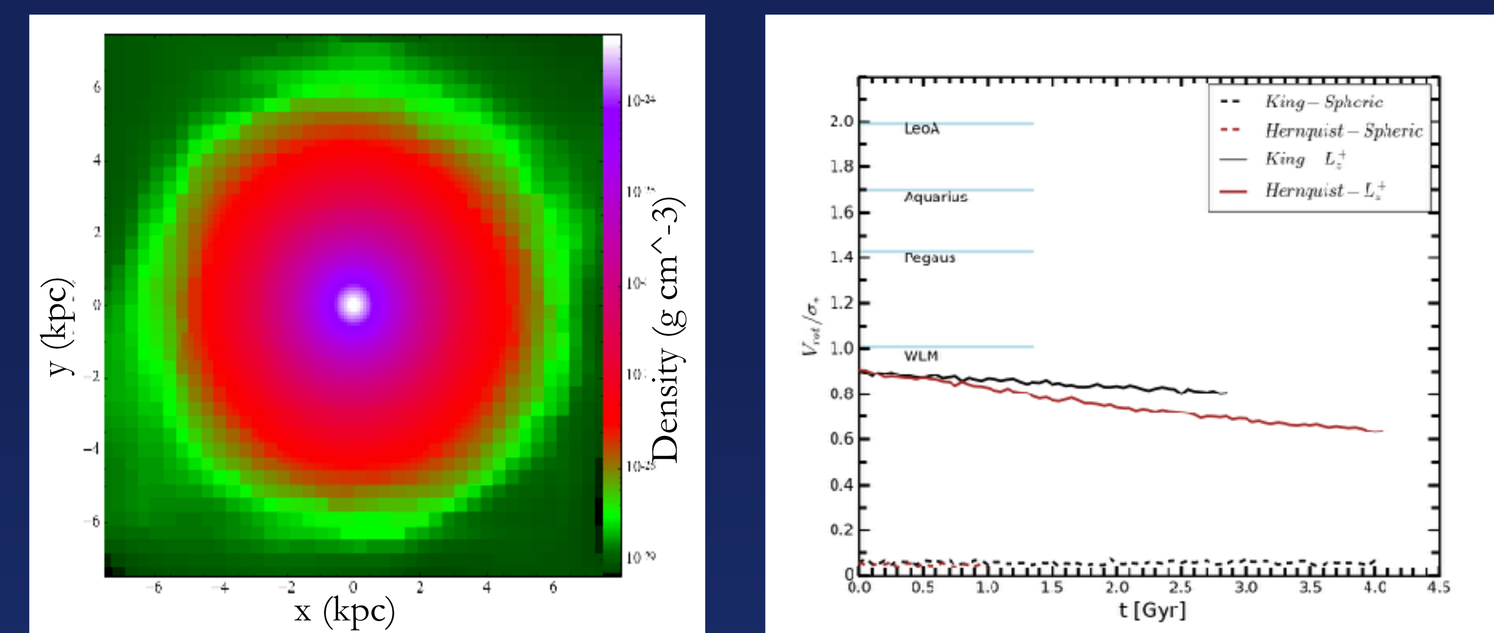

Figure 3: *Left Panel:* Gas surface density of our simulated. ***Right Panel:*** The time evolution of Vrot/σ for initial conditions with different stellar distributions.

Future work:

We plan to refine our match to the observed Pegasus galaxy. With this framework in place, we will run a battery of wind-tunnel numerical tests that mimic external ram-pressure stripping (Gunn & Gott 1972), with and without feedback (Hopkins et al., 2014). After testing in the presence of a live host dark matter halo, we will incorporate our findings into a full-box Local Group run.

Science Goal: To track the evolution of our simulated Pegasus dwarf galaxy in a controlled way, in order to understand the creation of dwarf spheroidals.

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