Abstract

Late type galaxies are the most common type of galaxies in the Local Universe. Their characteristics are rotationally supported disk, the abundance of gas, star formation and young blue stars. Disks of late type galaxies often possess several morphological features like spiral arms, bars, warps, rings or bulges. Frequency of occurrence of these features in galactic disks suggests that either they are stable long-lived structures or they are being frequently reignited. In this thesis, we investigate the formation and nature of two of these features, namely spiral arms and warps in a scenario where tidal interactions with external bodies are responsible for their evolution.

In the first part of this thesis, we discuss an investigation of a possibility that double grand-design spiral arms of galaxies orbiting a cluster could have been tidally induced by the cluster potential. We used N-body simulations to find that a galaxy resembling a Milky Way passing through a close pericenter around a Virgo-like cluster dark matter halo develops two spiral arms due to tidal forcing. These arms, however, are not stable and wind up and dissolve within 2 Gyr. Recurrent nature of the orbit makes sure that in the following pericenters the spiral structure is restored and can be seen for a long time. We also found a few examples of galaxies from the observed Virgo cluster that could have undergone such a scenario.

In the second part, we describe our hydrodynamical model of a hypothetical interaction between the Triangulum Galaxy (M33) and the Andromeda Galaxy (M31). Such interaction was previously hypothesized in the literature to be responsible for gaseous warp and the stellar stream of M33 as well as for increased star formation rate in the two galaxies around 2 Gyr ago. In our simulations, we show that these features of M33 could have indeed been induced by tidal interaction with M31. Our simulations were constrained with observationally derived orbital and structural parameters of the two galaxies. We showed that these constraints combined with an approximation of the laws of physics embodied in simulations allow for this mutual history of M33 and M31. We have also shown that the interaction of a cold gas disk of M33 with a hot gas halo of M31 also played an important role in the shaping of M33's gas warp jointly with tidal forces originating from the gravitational potential of M31. An additional result of our model was also tidal induction of two-fold spiral arms of M33, that are qualitatively and quantitatively similar to the observed spiral structure.

Third and last part of this thesis describes our results on warped gaseous disks of

galaxies from IllustrisTNG simulations. We used this state-of-the-art magnetohydrodynamical cosmological simulations to look for warped gas disks having a characteristic letter S shape and to investigate how relevant the scenario of the tidal evolution is for their formation. We found that roughly half of the gaseous disks have some kind of warp, which is in agreement with observational findings. Around 30% of these distorted disks had the desired S-shape and $\sim 35\%$ of them were induced in some sort of interactions with external galaxies. These interactions often comprised of both tidal forcing and gas accretion helped by a satellite galaxy. Half of these interactions that resulted in S-shaped warps ended with an accretion of a perturber while in the other half the perturber retained its identity.