Boletim da Sociedade Astronômica Brasileira, **33**, no. 1, 87-88

Rotation curves and dark matter profile of Lyman Break Galaxy Analogs

Amanda Evelyn de Araujo Carvalho & Thiago Signorini Gonçalves

[1] Observatório do Valongo, UFRJ; e-mail: amanda@astro.ufrj.br, tsg@astro.ufrj.br

Abstract. Understanding the presence of dark matter in galactic halos is paramount for studying the formation and evolution of galaxies. In particular, we are investigating whether interactions and mergers of galaxies might affect galaxy's structure and dynamics, leading to a drop in galaxy's rotation curve without the need for lower dark matter fractions in the galactic halo.

Resumo. Compreender a presença de matéria escura em halos galácticos é fundamental para estudar a formação e evolução das galáxias. Em particular, estamos investigando se as interações e fusões de galáxias podem afetar a estrutura e dinâmica da galáxia, levando a uma queda na curva de rotação da mesma sem necessariamente implicar uma diminuição da fração de matéria escura presente no halo.

Keywords. Galaxy – kinematics – dynamics

1. Introduction

Over the last three decades our understanding of galaxy formation and structure has improved with the advent of new physics and technologies. In particular, observations with integral-field spectrographs using adaptative optics has brought forth new information about galactic dynamics and internal structures. In this context, observations of galaxies at earlier times has shown that the structure of an elevated fraction of these objects show clumy and irregular morphologies (Bournaud et al. 2008), which according to the Λ-Cold Dark Matter (ΛCDM) model, may be caused by galaxy mergers.

In the ΛCDM model, the dark matter is embbeded in the galaxy halo and constitutes most of the total mass of the system. The dynamical mass, which is assumed to be a composite of all individual components, can be derived by measuring the galaxy's rotation curve and it has been confirmed that rotation curves of disk galaxies are flat in their outskirts (e.g., Sofue & Rubin 2001), revealing that galaxies are dominated by the dark matter in their outer regions. However, recent studies (Genzel et al. 2017; Lang et al. 2017) targeted star-forming galaxies at high redshift and showed that the rotation curve of these objects drops after reaching the peak R_{max}, concluding there is a decrease in the abundance of dark matter in galactic halos at earlier times. Nevertheless, we argue that observational effects such as cosmological surface brightness dimming could bias the data, making those results more challenging to interpret.

2. LBA's Sample

In this work we use a sample of 19 star forming galaxies at low redshift(z ∼ 0.2), observed with Keck/OSIRIS, from Gonçalves et al. (2010). We use the observed line emission of Pa-α at rest wavelength 1.875 μm as a proxy for the gas kinematics within the galaxy. The ultraviolet morphologies of these galaxies are dominated by clumpy features, indicating compact regions of star formation and signs of recent mergers in a similar manner to LBGs (Lyman Break Galaxies). These objects, however, are at smaller cosmological distances and therefore these observations do not suffer from cosmological surface bright dimming as strongly. In the study of Lang et al. (2017), the authors attempted to counter the effects of cosmological brightness dimming by coadding the signal of a larger sample of galaxies, but the effect of interactions at the galaxy outskirts may strongly affect the total signal of random motion in different objects.

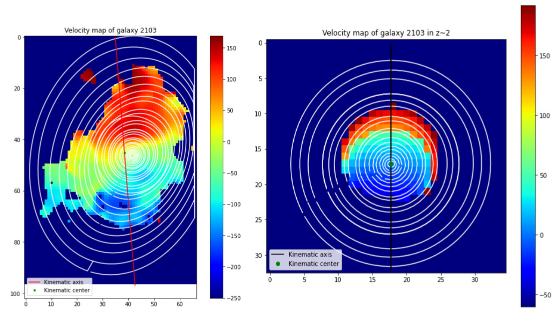


Figure 1. Velmap of galaxy 210358. Left: at z∼ 0.2 Right: at z ∼ 2.2

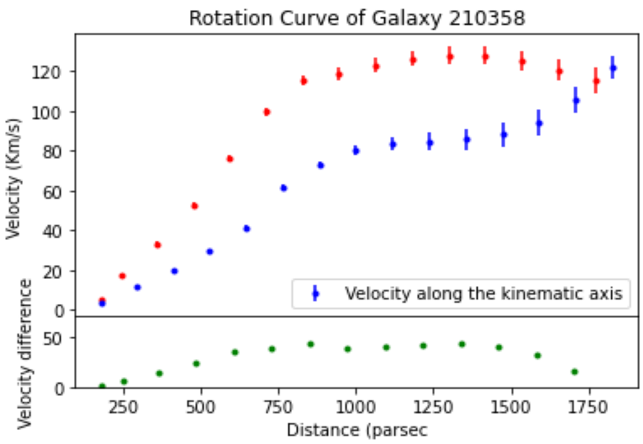
3. Preliminary Results

Asymmetries in galaxy rotation curves can be described considering how much the galaxy velocity profile differs from the one of an ideal rotating disk, which exhibits a perfectly antisymmetric profile. In this sense, in studies such as Shapiro et al. (2008) and Gonçalves et al. (2010), asymmetries were used to distinguish the rotating curves of well behaved galaxies against the rotation curve of disturbed ones as a consequence of mergers and interactions. Moreover, Gonçalves et al. (2010) found that in high redshift galaxy asymmetries are artificially lower due to observational effects; in other words, this means that the galaxies appear more symmetrical than they actually are.

We show here premilinary results from the observation of one of the objects present in our sample. 1 and 2 which depicts a galaxy with strong asymmetries in its rotation curve at large radii. The right panel of Figure 1 shows the simulated observation of the same object at $z = 2.2$, in order to infer how any observational bias can impact our conclusions.

4. Discussion

Comparing both sides of the galaxy rotation curves as shown in Figure 2, it is possible to confirm that the observed rotation



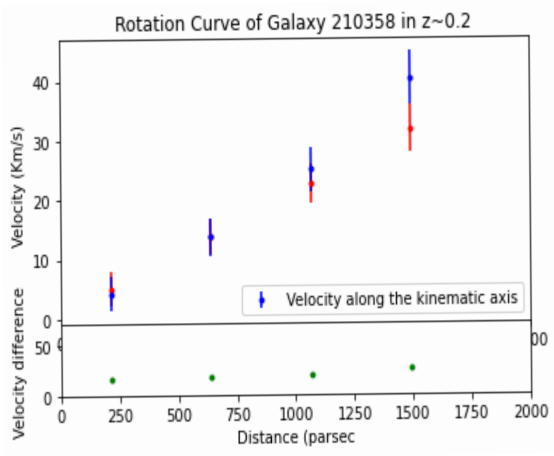


Figure 2. Rotation Curve of galaxy 210358. Left: at z~ 0.2 Right: at z ~ 2

curve is strongly asymmetric, especially at the galaxy outskirts. The right panel of Figure 2 also shows that the galaxy shows weaker asymmetries at the artificially redshifted data, indicating how this might affect conclusions from real observations at theses distances. Figure 1 indeed shows that the galaxy morphology loses a lot of detail such as clumps and/or merger indications, appearing to be one large well-behaved disk. This implies that studies of distant galaxies such as (Lang et al. 2017) and (Genzel et al. 2017) should take into account these effects, considering that they might lead to misinterpreting galactic structure and dynamics.

We are currently in the process of reproducing this analysis by using kinemetry– a more complete algorithm for study kinematics of galaxies (Krajnović et al. 2006). In a simple way, Kinemetry performs a decomposition of the 2D galaxy velocity maps into Fourier components for every ellipse that best fits the map, in a similar manner as isophotes would in photometric decomposition. This will help us to access the dynamical components of the galaxies as well as trace they morphologies and intrinsic structures, given that the algorithm does not make any assumptions about the nature of the galaxy itself, relying instead on the properties of the observable parameters.

References

Gonçalves, T. S., Basu-Zych, A., Overzier, R., et al. 2010, ApJ, 724, 1373. doi:10.1088/0004-637X/724/2/1373
Genzel, R., Förster Schreiber, N. M., Übler, H., et al. 2017, Nature, 543, 397. doi:10.1038/nature21685
Lang, P., Förster Schreiber, N. M., Genzel, R., et al. 2017, ApJ, 840, 92. doi:10.3847/1538-4357/aa6d82
Bournaud, F., Daddi, E., Elmegreen, B. G., et al. 2008, A&A, 486, 741. doi:10.1051/0004-6361:20079250
Sofue, Y. & Rubin, V. 2001, ARA&A, 39, 137. doi:10.1146/annurev.astro.39.1.137
Krajnović, D., Cappellari, M., de Zeeuw, P. T., et al. 2006, MNRAS, 366, 787. doi:10.1111/j.1365-2966.2005.09902.x
Shapiro, K. L., Genzel, R., Förster Schreiber, N. M., et al. 2008, ApJ, 682, 231. doi:10.1086/587133