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Tidal Evolution of M33's Dark Matter Halo—Mass loss of Dark Matter and changes to internal dark matter profile

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1. INTRODUCTION

The spiral galaxy M33, which located in the constellation Triangulum, is the third largest member of our Local Group of galaxies. Also, M33 and M31 are the closest galaxies to the Milky Way, and all of these galaxies(MW,M31,M33) are massive spiral galaxy. Thus, there are the large amounts of dark matter in their outer parts, based on the optical measurements of the rotation of spiral galaxies.(Blok 2010) Otherwise, based on van der Marel et al.(2012)'result, M31 and MW will start to merging process at t = 5.86 Gyr.(Marel et al. 2012) So, during the process, it will give strong tidal force to MW, M31,and M33; the inner and outer instructions will change. In addition, except merger situation, the mass of galaxies are tend to decrease, after years.(Boylan-Kolchin et al. 2011) Therefore, the proposed topic of the project is to study and analyze the tidal evolution of M33's dark matter halo, and put emphasis on two points: 1.mass loss of dark matter. 2.change of internal dark matter profile.

'Dark matter' is always the controversial and hot topic in the area of science. Based on general knowledge for a physics side student, scientist only find that the dark matter could interact with gravitational force. And the majority mass in universe is dark matter. If galaxies would lose part of dark matter, then scientists have to re-consider or update the evolution of galaxy. If most galaxies would loss dark in their own evolution, then what happened to those galaxies or universe? Therefore this topic is quite important to understanding of galaxy evolution, whatever in the future or nowadays.

After t = 10 Gyr, the MW and M31 have formed a merged remnant, and M33 would lose 23.5percent of its stars into tidal streams. (Marel et al. 2012) The estimation simulation graph is showing on figure1. This result indicate that the mass of M33 will lost, due to the tidal evolution beside MW and M31 merger process. Otherwise, in Boylan Kolchin et al.(2012)'s research, the dark matter will 'expired' and disappear itself, scientist called this phenomenon as 'dark matter annihilation'. And Boylan had given the example that the massive dark sub-halos are expected to produce a larger dark matter annihilation flux than Draco. (Boylan-Kolchin et al. 2011) Boylan's result also express that the loss of dark matter and change of dark matter profile, due to the tidal influence from or inside galaxies.Then, the questions comes to M33.

The evidence and simulation model of Boylan Kolchin et al.(2012) is good, but are there enough dark matter subhalos in M33 is still the open question. The another open question, why dark matter is annihilation in galaxies? Everything related to dark matter is still a open question, in this field. However in this project, the mainly focus is studying and understanding the tidal evolution of M33's dark matter halo through Mass loss of Dark Matter and changes to internal dark matter profile based on the limited evidence we have.

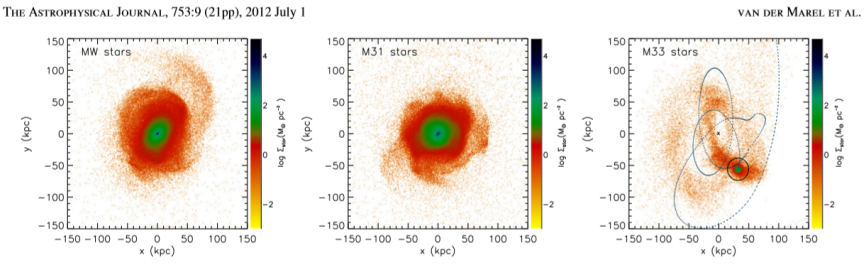

Figure 1. evidence of M33, 23.5 percent stars of M33 lost into tidal streamsMarel et al. (2012).

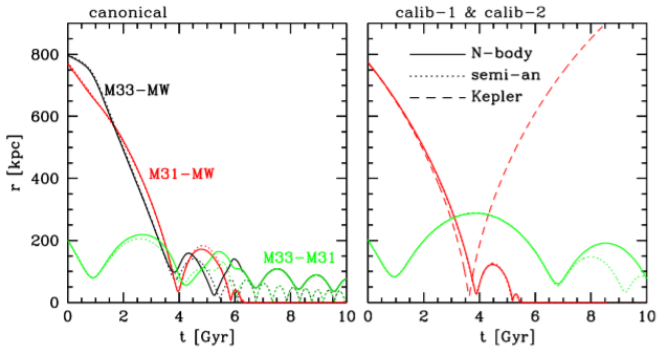

Figure 2. simulation methodologyMarel et al. (2012).

2. PROPOSAL

The specific question of this proposal is to prove that dark mass will lose, due to the tidal influence from M31 and M33. Also, it is important to prove, what happened to internal dark matter profile of M33, will it change. So I have to create a program to simulate how total mass(halo and disk mass) of M33 changed, after M31 and MW starting to merge. I think during this period, the tidal influence to M33 is also strong. And also, I would use the Boylan's theories and result to support my hypothesis of change of internal dark mass profile.

Outline the coding step:

1.First, simulate the merger of MW and M31, and add M33's mass profile into the program. In this program, I have considered about the impact of gravity from N-bodies.

2.Next, choose time step for the program, and test the program to make sure it works.

3.Then, record the data of mass from the output of program, and make them in one plot.

4.Finally, calculating the final mass of these galaxies, and compared with initial mass.

The figure2 illustrates my methodology.

I think the total mass of M33 will become smaller, and the amount of dark matter will decrease in dark matter halo of M33, due to the tidal influence from MW and M31 .And the internal dark matter of M33 will also decrease, because stars of M33 went into tidal streams that the internal gravitational balance between dark matter and stars has broken. Thus, part of internal dark matter of M33, will toward out M33' disk.

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