Hello good morning/good afternoon, my name is Pedro Henrique, I am 18 years old and I am a student at the Instituto Federal Fluminense Campus Bom Jesus do Itabapoana, in the interior of the State of Rio de Janeiro, thank you for coming to the stand, today I will present the my work which is about “Dynamic Simulations Analysis of Cluster of Merging Galaxies” (pausedly).

Well, before talking about the project I wanted to tell you how I started it. I always wanted to study and work with astronomy because I always liked it, but I didn't have a reference on how to start, until I found out that at my Institute there was a teacher who worked in this area and had a research project, so I went to find out if there was anything I could do and she helped me to write this junior scientific initiation and start my studies and work.

Back to my work, what are Galaxies Clusters? They are giant structures of the Universe and are basically composed of galaxies (visible), gas and something we cannot see, the dark matter. As this matter does not emit, reflect or absorb light, we can only detect it through gravitational interactions. For this, we use the collisions of galaxy clusters, as they are very energetic events and function as study laboratories for various concepts of Physics, as they are extreme.

But what do you understand by Dark Matter?

*Experiment model of gravitationally bound system

“Well, for that I'm going to remind you a little bit about circular motion. Everything in the Universe revolves around something because of the gravitational force, here I have a model of a gravitationally bound system, and what makes it rotate is the mass at the bottom (representing the Sun), and the radius that the ball (representing the planet) is from the center. For the ball not to fall or simply go far away, it is necessary to maintain the BALANCE, but how? the speed at which I am rotating has to be in accordance with the radius and mass present there, because the closer it is (the orbital radius), the faster it has to rotate, and the more mass (of what makes it rotate) the faster it rotates. ”

*Try graphics (sketch)

“And that's what happens in the solar system, as you can see here in the graph I made to exemplify, the closer to the center of mass the greater the speed to maintain balance. (TURN SHEET). But in galaxies this does not happen, if the distance is not decreasing the speed as in the solar system, then we know that there is a Mass that we do not know increasing its speed and therefore maintains a “line” on the graph.”

And here I brought an image of a Cluster of Galaxies, the Bullet Cluster, in red would be the gas that is very interacting, in blue would be the dark matter and the galaxies (little interacting) are visible around, the Colors used are representative only. It is an example of a collision for the 1:10 mass range (when one cluster is 10 times larger than the other).

The model uses what you see as galaxies to understand what you don't see (dark matter). By understanding how dark matter behaves during a collision, you can understand a little more about it.

Well, the problem is that these events take billions of years to happen and we don't have that much time to wait to happen to study them, so we have two ways of studying clusters in fusion: Analyzing Dynamic Equations, Dawson, or using Simulation, ZuHone, Analyzing these equations is very complex but the computational cost is easier than doing a simulation that uses a lot of heavy computing (and I understand that, I am from the area of information technology), but it is more accurate.

And with that, we set out to analyze the effectiveness of the analytical code provided by Dawson in 2013 using the high-precision simulations made by ZuHone in 2017 as a reference. of other scenarios for greater confidence in your model. It's worth remembering that Dawson used his code when there weren't so many simulations available and maybe that's why he didn't test it in other scenarios as well. He proposed for that range of masses only.

The first step in this work was to learn about astronomy and become familiar with the project and its problems, then we started to understand the Dawson Code and its inputs, such as the Cluster Masses, their Redshifts and the projected distance. We subsequently obtain and understand data from ZuHone. And after that we apply the analytical code to the available simulations and analyze the result that I will show below.

MONTE CARLO EXPLANATION:
It's a statistical method for equations without an analytical solution, it takes values and calculates the probability of being the answer. Here each line of the database ran the method 1000 times, that is, it tried 1000 values to answer the proposed equation.

And as a result, we have here graphs of the comparison of the simulation (in orange) with the analytical code (in blue) for the different mass intervals (1:1, 1:3 and 1:10). The X-axis is time (in Giga Years or billions of years) and the Y-axis is the separation in MPc. At the top, the original output, and at the bottom, highlighting the area of greatest interest between the minimum and maximum distance points of the clusters, the bars in blue represent the error margins of the time since the first collision for all scenarios.

Well, the code shows good efficiency and reliability within the time error margins in the interval between the first collision and the departure for the different mass intervals. There is a tendency to present data that are inferior to reality, which should be better studied later.

In the future we will apply the methodology to the other ZuHone data sets, using the impact parameters inclined in relation to the plane of the sky, this project was used as impact 0, that is, in the plane of the sky. There are 500 kpc and 1000 kpc impacts for each mass range (1:1, 1:3, 1:10)

Well, that was my work. That was my contribution to the science of galaxy clusters; many people have been using this code without these tests being carried out and this will certainly contribute to increasingly better and more accurate work, which will make us understand more and more about dark matter. Knowledge is made up of small parts and that was mine, I hope you liked it, if you have any questions I'm at your disposal and here's a little souvenir, the bookmark is to know some curiosities about dark matter and to vote (vote for me please!), while the card is for access to the material used to develop the project. Thank you for your attention!