

# Warm or Cold Dark Matter: A Love-Heat Relationship

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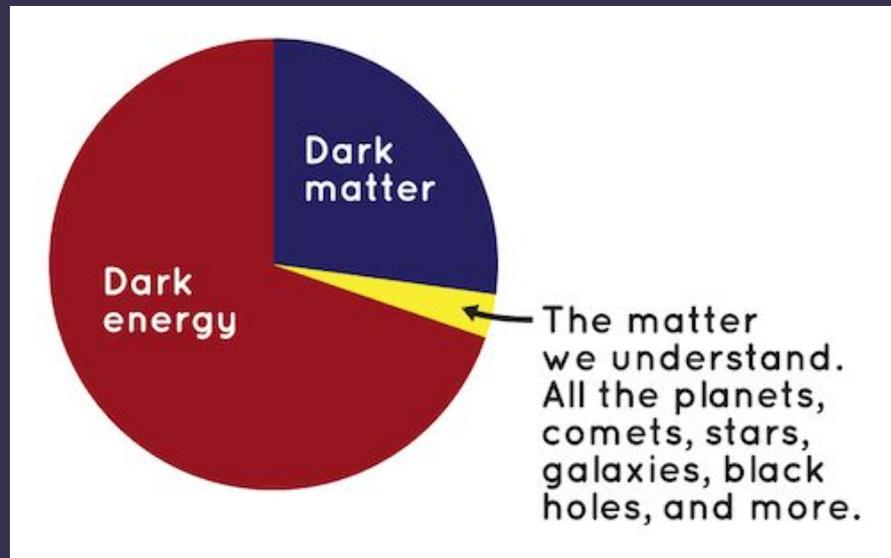
# What is Dark Matter?



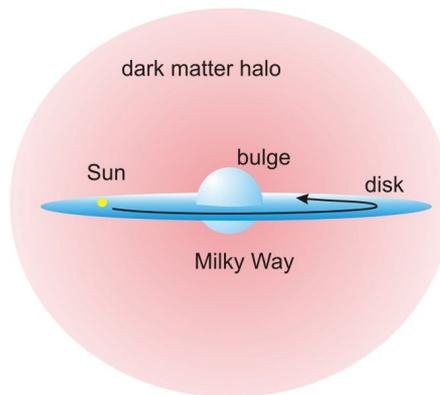


# 27% Dark Matter

Our universe is comprised mostly of dark matter and dark energy. The rest of the total mass is regular baryonic matter, that makes up you and me.



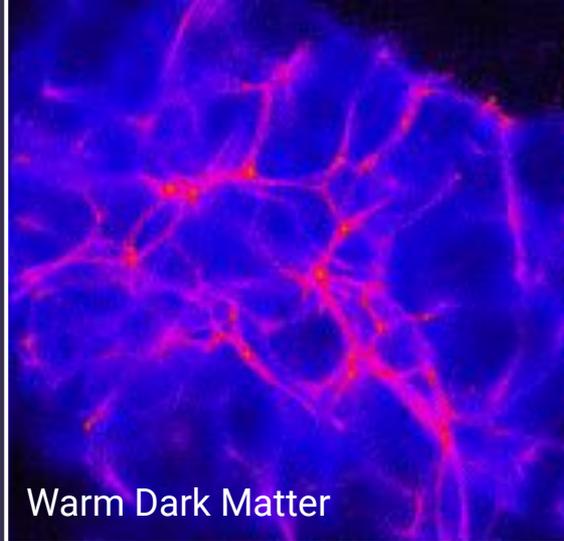
# The Short Answer: We Don't Know



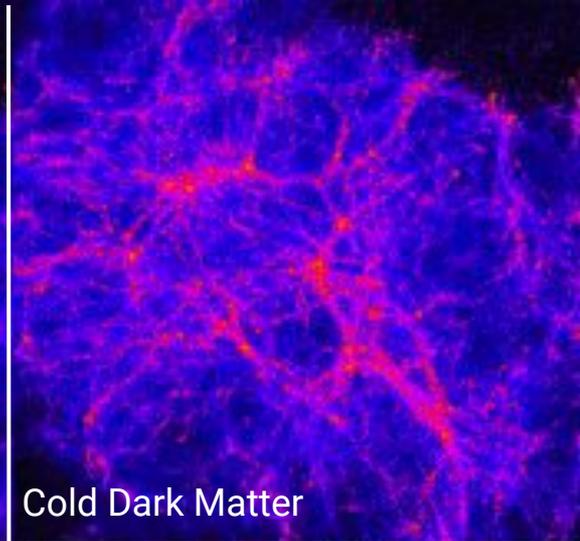
- Dark Matter is essentially invisible, and can only be measured through gravitational interactions with regular matter (such as stars and planets).
- It was discovered by studying the rotations of galaxies, and finding that the galaxies measured to have much more mass than appeared.
- Clusters of Dark Matter are known as **Dark Matter Halos**
- The infalling of Dark Matter allows potential wells to form, causing regular matter, such as gas and dust, to collapse with it.
  - This is what created the first galaxies.

# Why do we care if it's warm or cold?

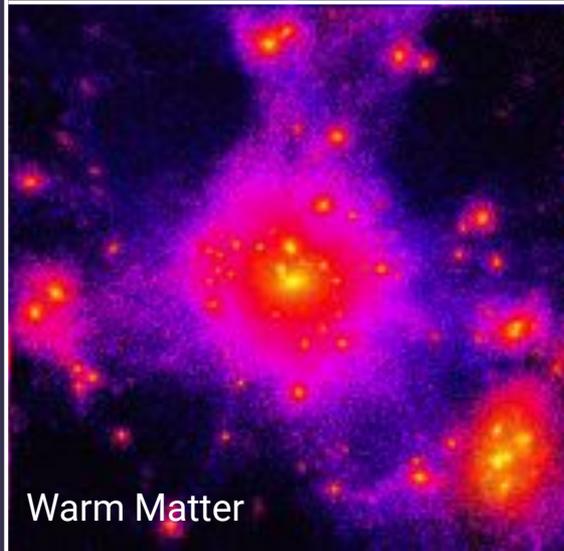
- Particles at a lower temperature have lower net kinetic energies – this allows them to collapse easier and quicker.
- Particles at higher temperatures have greater kinetic energies, and therefore do not collapse, or fall in as easily.
  - Think of it as outward pressure caused by temperature.
- If we examine ancient galaxies, we can measure how old they are and compare it to other galaxies to find if it is considered a warm or cold dark matter halo.



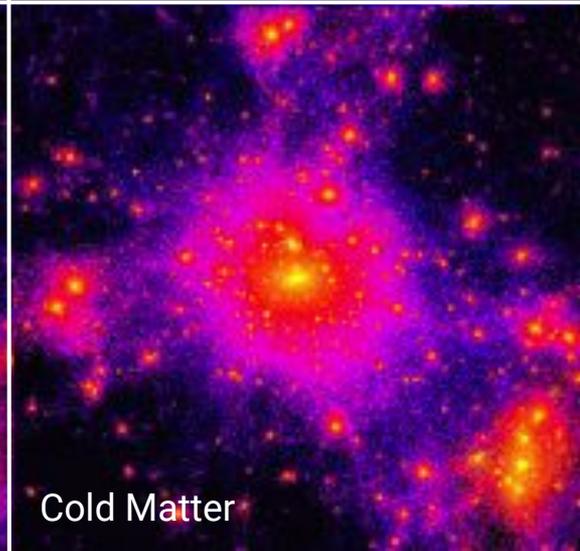
Warm Dark Matter



Cold Dark Matter



Warm Matter



Cold Matter

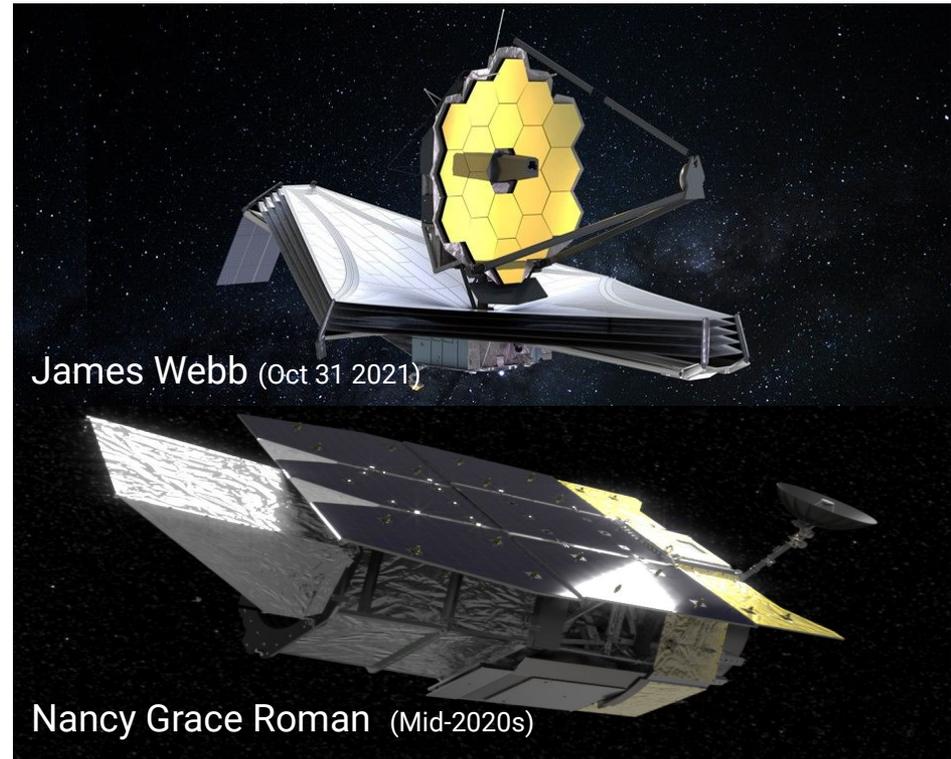
When did the first  
stars ignite?



# Our Research



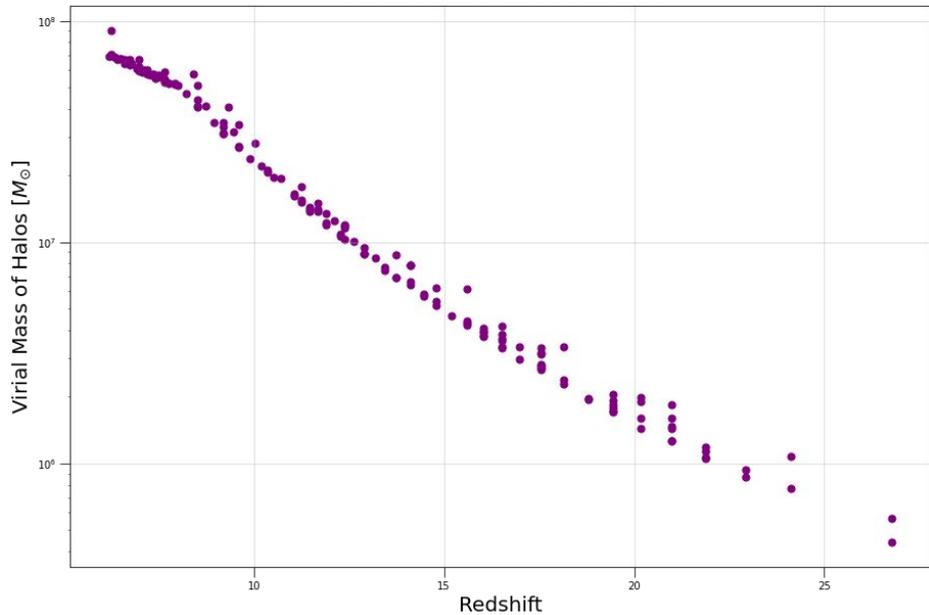
- We will be examining Dark Matter Halos that are old and extremely far away (at high redshifts)
- We will look at their ages, and their relative masses to determine when and how these Halos formed.
  - By doing this, we can make some inferences as to when the first stars were created via Dark Matter Halos
- We will then compare this to future observations through extremely large and high quality telescopes.
  - At this point, we can make solid inferences about the temperatures of Dark Matter Halos and when the first stars formed.



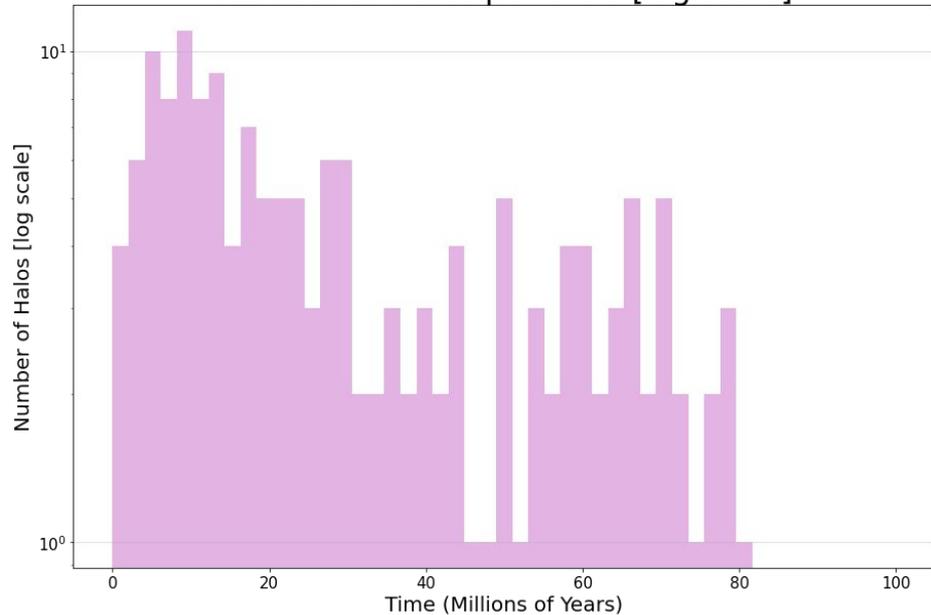
James Webb (Oct 31 2021)

Nancy Grace Roman (Mid-2020s)

Viral Mass v. Redshift

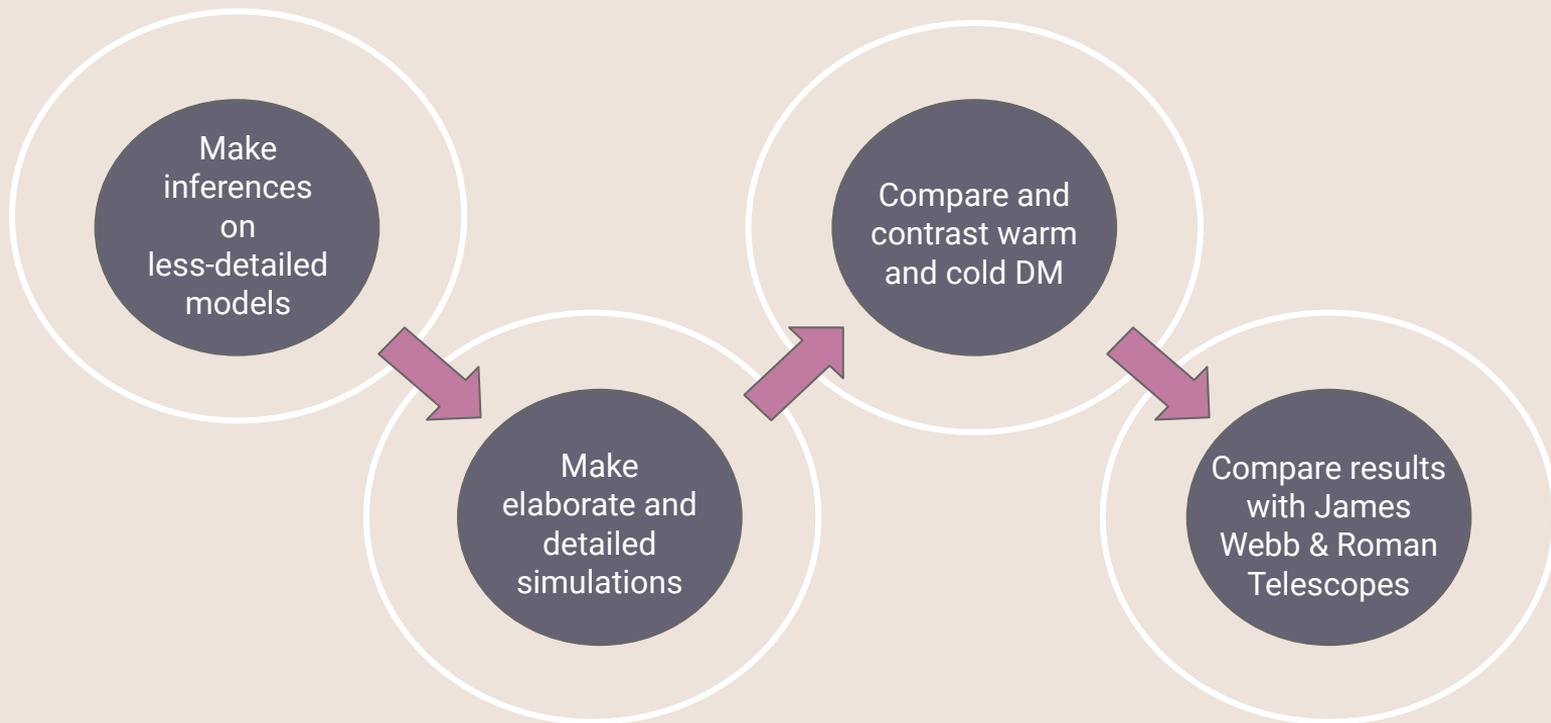


Number of Halos per Time [log scale]



Viral Mass v. Redshift and Number of Dark Matter Halos Over Time

# Moving Forward...



# Questions & SciCom Statement



Dark Matter is undetectable through modern technology, however, it does interact with regular visible matter through gravity. Large clusters of dark matter are responsible for causing gas and dust clouds to collapse in on themselves to create the first galaxies and stars. However, depending on the temperatures of the first clusters of dark matter, known as dark matter halos, galaxies could have begun forming at drastically different times. Using a series of simulations for extremely distant galaxies and halos, we will be combining theory and computation to determine if the universe is a warm or a cold dark matter environment.

