Building Dark Matter

Abstract

These are the corresponding notes and theory for the
"Building Dark Matter" Tutorial. Enjoy!

Theory

- In the previous tutorial we discussed what dark matter is, and how it forms The Cosmic Web in our universe.

- In this tutorial we are going to focus on dark matter on a smaller scale. Particularly, how it clumps together to form galaxies.

- "Cold" dark matter is referred to as the dark material that clumps together to form galaxies."Hot" dark matter clumps later on as it cools off. This helps dark matter spread farther about the universe.

- The larger the scale, or the more dark matter collects together, the harder it is to predict. Dark matter might be capable of changing phases at different sizes. This is because cold states of matter condense into a superfluid. It is thought that dark matter might form a superfluid at a galactic scale.

- The only observable superfluids we can create and observe are in labs. This is because they are super rare and unnaturally existing in our environment. The only known place they currently exist naturally in the universe is at the center of neutron stars.

- A dark galaxy is a hypothesized galaxy with no, or very few visible stars.They are mostly made of dark matter, and can exist anywhere in the universe. They have a strong gravitational pull on objects around them, and can edit the shape of other gaseous clouds.

- There are many types of observed "dark galaxies". Such as: HE0450-2958, HVC 127-41-330, Smith's Cloud, and VIRGOHI21.

- Scientists use different types of imaging techniques to try and observe the ranges of dark matter in galaxies. They primarily use imaging sources through using Röntgen radiation and gamma rays to create achromatic pictures of objects

- It is important to note that gravitational lenses(a field that distorts and magnifies light) can be observed at different optical wavelengths.

Goal of The Tutorial

- This tutorial will attempt to build a "Dark Galaxy", or a galaxy primarily made of dark matter. We will render the galaxy in two parts. One with a "dark matter" pass, and another with a regular star render.
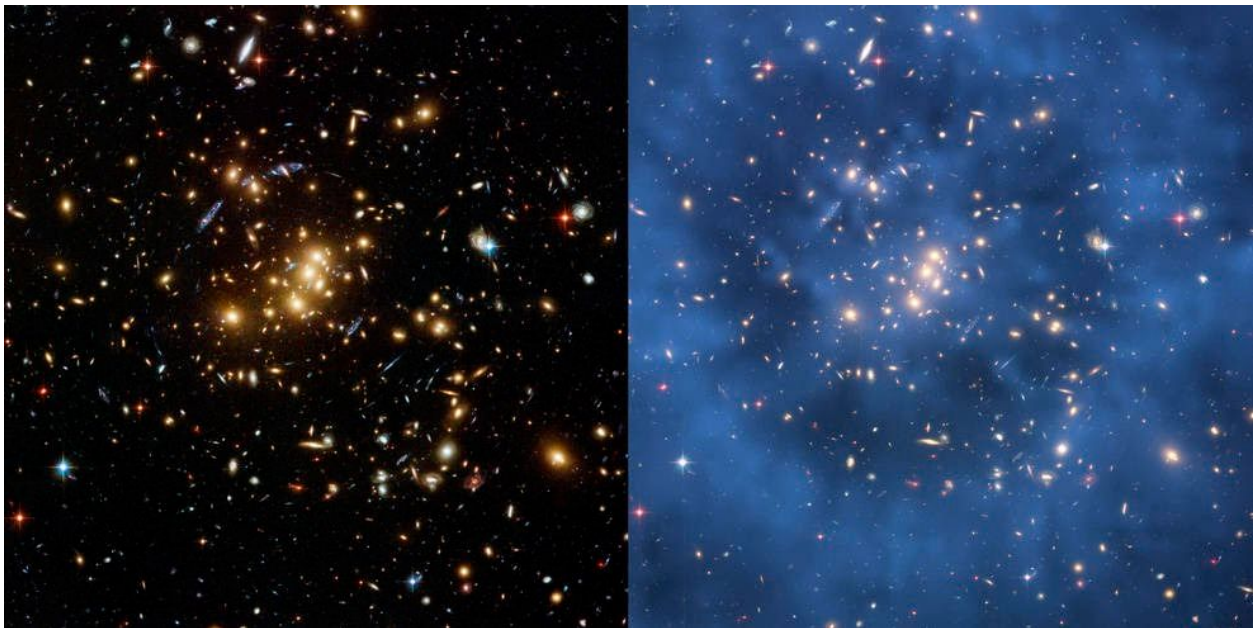

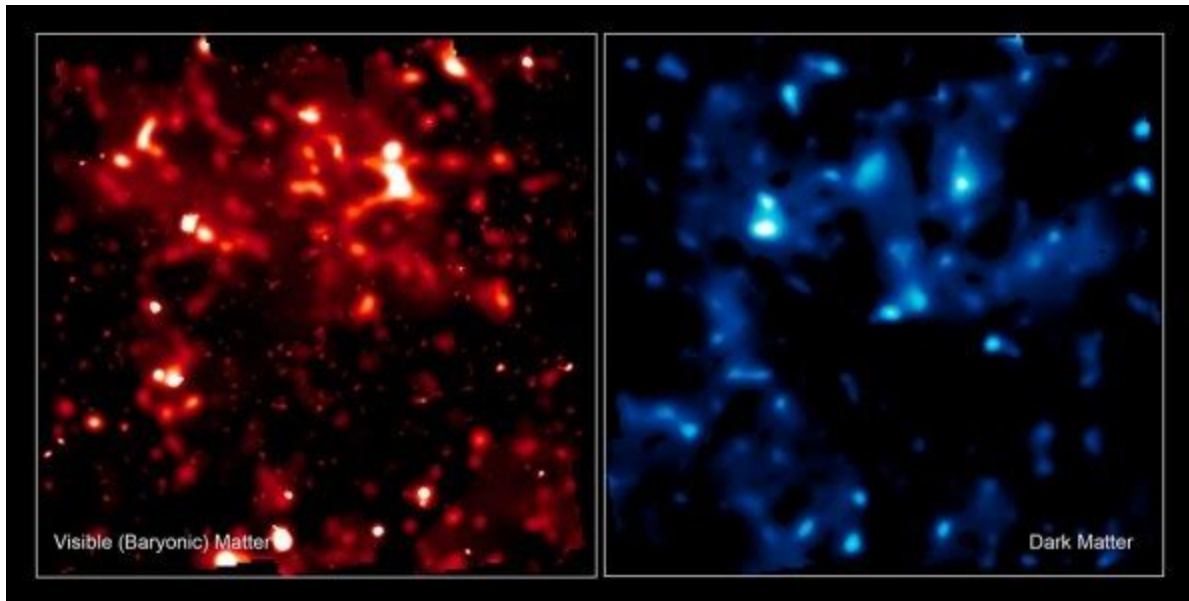(IC 2574: Coddington's Nebula. Courtesy NASA images)

Galaxy Mrk 1216. Dark Matter vs visible matter(Courtesy NASA Images)

https://www.cfa.harvard.edu/research/rg/dark-matter-galaxies

Two views from Hubble of the massive galaxy cluster Cl 0024+17 (ZwCl 0024+1652). (Courtesy of NASA images)

https://www.nasa.gov/content/discoveries-highlights-shining-a-light-on-dark-matter

Dark-matter map points to galaxy formation
(Courtesy image from Physics World)

https://physicsworld.com/a/dark-matter-map-points-to-galaxy-formation/

https://www.nasa.gov/image-feature/goddard/2020/hubble-views-a-galaxy-on-the-dark-side

https://www.spacetelescope.org/images/potw1926a/