iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** VIII **Month of publication:** August 2024

DOI: https://doi.org/10.22214/ijraset.2024.64113

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue VIII Aug 2024- Available at www.ijraset.com

Dark Matter: Existential Analysis

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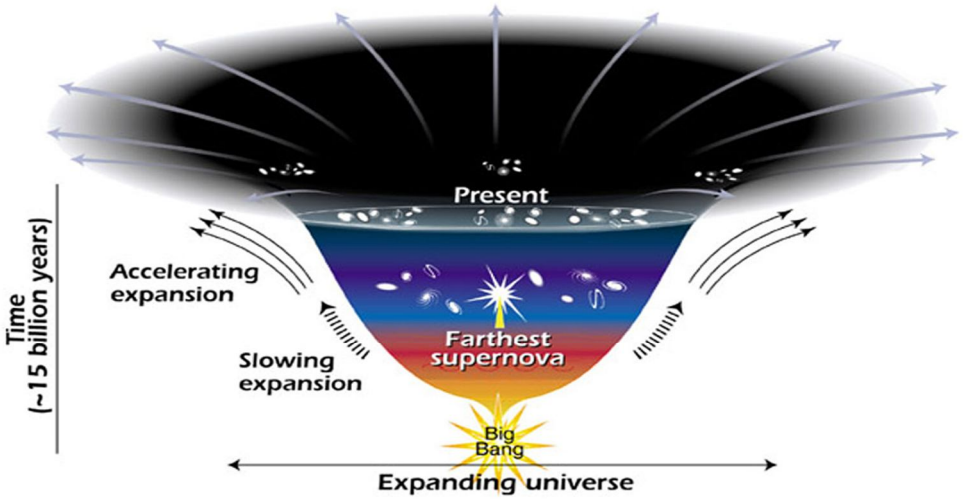
Abstract: The Existence of Dark Matter has remained a mystery till date due to its elusive nature of its unseen physical form and how the universe is in fact affected by Dark Matter. This research paper hopes to analyze the importance of Dark Matter despite not having direct proof of its existence.

I. INTRODUCTION

In simple terms, "matter" is anything that occupies space and as for "dark matter" which is still considered as a hypothetical form of matter, which does not reflect or emit light of its own due to no interaction with electromagnetic forces thus appearing "dark" which exists in the universe in clumps. It is claimed that around 95% of the universe is dark matter and without it, the behavior of stars and planets will be affected.

A. The Origin of Dark Matter

The origin of the term "dark matter" comes from Fritz Zwicky in 1933 who described the unseen matter which was responsible for the motion of galaxies. He had discovered that the stars in a coma cluster (which consists of 1000 galaxies) only needed 1% of the mass required to keep it in place from escaping the gravitational pull. The term "dark matter" refers to "missing mass," it was termed not out of scientific reasoning, simply because we did not know what it was. Around the 1920s, Edwin Hubble had discovered that galaxies move away from us with the combined theory of Albert Einstein theory of relativity which conveys about a four-dimensional pseudo-Riemannian manifold which represents Space-Time which showed the gravitational effect on masses on space warping. This is simplified in the diagram below.



This diagram reveals changes in the rate of expansion since the universe's birth 15 billion years ago. The more shallow the curve, the faster the rate of expansion. The curve changes noticeably about 7.5 billion years ago, when objects in the universe began flying apart at a faster rate. Astronomers theorize that the faster expansion rate is due to a mysterious, dark force that is pushing galaxies apart.

This dark force is known to be "dark energy" but this is different from "dark matter." "Dark energy" pushes apart the galaxies while "dark matter" pulls galaxies together. These two opposing forces are what causes the universe to expand its ever acceleration with "dark matter" slowing the process while "dark energy" speeding it up.

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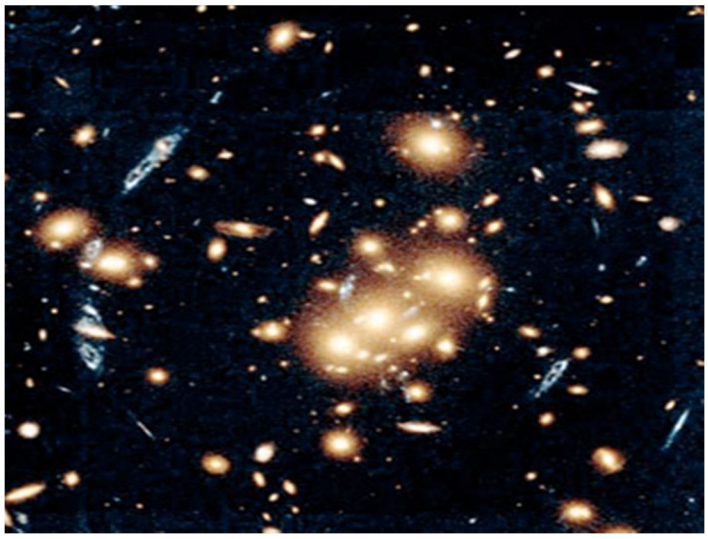
This discovery would have occurred much earlier around 1912 by Albert Einstein who introduced “cosmological constant” which was supposed to counterbalance gravity to make a static universe which was accepted however it was abandoned by himself to do the belief of a static universe when he found out the universe was indeed expanding once Edwin Hubble came into picture.

B. The Role of Dark Matter in the Universe

The role of dark matter in the universe might appear just to exist, however this unseen matter plays an important role in the balance of the universe despite it being mostly inert with our natural matter. The only exception so far is gravitational force which was found by Issac Newton in 1687 who proved that all matter is affected by gravity. It is believed that dark matter is made up of WIMPs (Weakly Interacting Massive Particles) which are 1000 times heavier than proton while another possibility can be axion a particle which is ten-trillionth mass of an electron which would convert into photons under the presence of strong electromagnetic fields. Dark matter has played a role in the motion of stars within a galaxy. It is shown around 1997, The Hubble Space Telescope captured this photo.

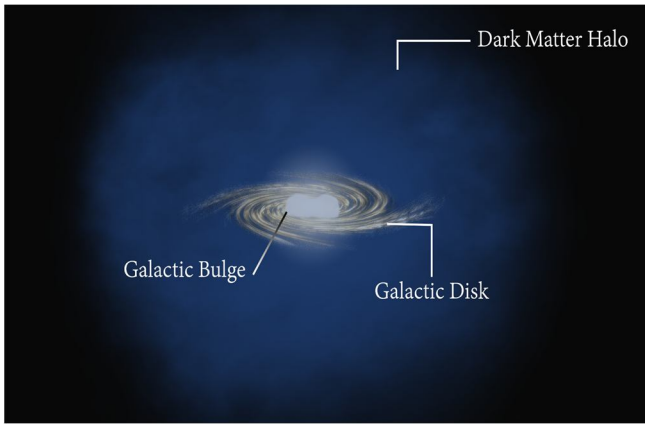
(Caption: Gravitational Lens Created by Galaxy Cluster Reveals Presence of Dark Matter)

Where it was revealed about a distant galaxy being bent by another cluster. From the bending from the light alone, scientists found out the mass of the foreground cluster is around 250 times more than visible matter in the cluster. The unexplainable mass present is what “dark matter” is which causes the light to bend and make the images appear distorted when taken. From this, the pull from the “dark matter” keeps the galaxies from flying apart and keeps them in place which allows certain galaxies to form from the gravity pull like the Milky way itself which is a spiral type galaxy.



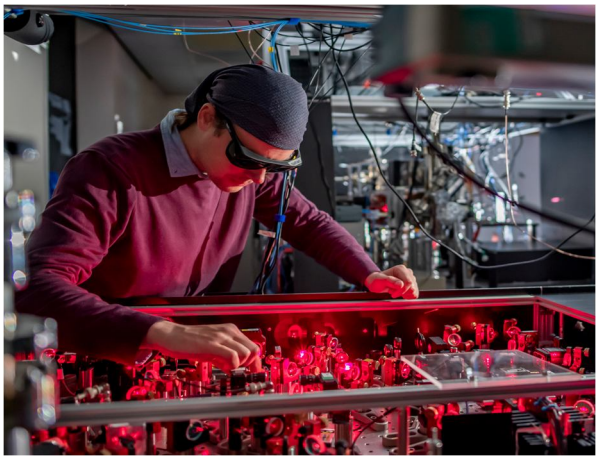
The Milky way’s origin is mainly known through the collapsing of enormous clouds of gas and dust which were pushed by gravity and this gravity pull occurs from the dark matter halo which is a massive elongated shape due to the pressure of the dark matter mass or gas flowing in a certain direction.

The dark matter halo is considered a hypothetical collection of particles which orbit at their own self-generated potential also known as gravitationally bound matter. Which is simply, matter held by gravity at long distances.



C. Future Understanding of Dark Matter

With Dark Matter already in the researching stage, there is potential for the introduction of Revolutionary Propulsion Technology, by using dark matter as fuel for space crafts instead. It is estimated to reduce the time taken to reach Proxima Centauri, which is known to be the closest star to the Sun, while being 4.2456 light years away which would be around 32,000 years to reach from current technology. This idea was brought up in a research paper in 2009 by Jia Liu, a physicist who assumed dark matter to be made up of "Neutralinos" unlike the previous ones mentioned like "WIMPS" or "Axions", Neutralinos also known as (antiparticles), do not possess any electric charge but they only collide in certain conditions leading to all their mass to be converted to energy. If this hypothesis were to be true, then dark matter would produce around 5 billion times the energy of a dynamite. Drawing back, The Revolutionary Propulsion Technology, Most commonly used is (RDRE: Rotating Detonation Rocket Engine) Here, the spacecraft uses supersonically "denotation" waves while rapidly burning fuel and oxidizer to generate the thrusting power. This is used in organizations such as NASA and DARPA for efficiency and emission reduction.



Recently on 17 June 2024, The University of Nottingham announced about scientists developing a 3D printed vacuum system to trap dark matter. This has taken around 3 years and they expect results next year itself. The 3D printed vacuum system aims to capture domain walls (boundary of "dark matter"), where the vacuum chamber being constructed from theoretical calculations of "dark walls", to keep the dark walls trapped, a cold atom cloud is passed through and then firing a laser photon at the atoms to reduce the energy. The results gained, shall be crucial to prove whether dark walls exist and shaping our understanding of the universe.

II. CONCLUSION

To conclude, Dark Matter is still being researched about what exactly it is made and from where does it originate from. This can serve as evidence from The Big Bang itself or entirely something else. Space around us truly remains elusive or there is a factor we might not be considering, such as the constant changes of our neighboring galaxy Andromeda, the rate of certain stars being born and dying at the same rate. Our universe once was believed from the beginning of The Big Bang, the gravity slowed down only after 9 billion years after The Big Bang, the acceleration began which resulted in the expansion of the universe. Which shows the mysterious relationship between "dark matter" and "dark energy" which only remains in predictions and hypotheses as of late. The answers we gain today shall shape our tomorrow.

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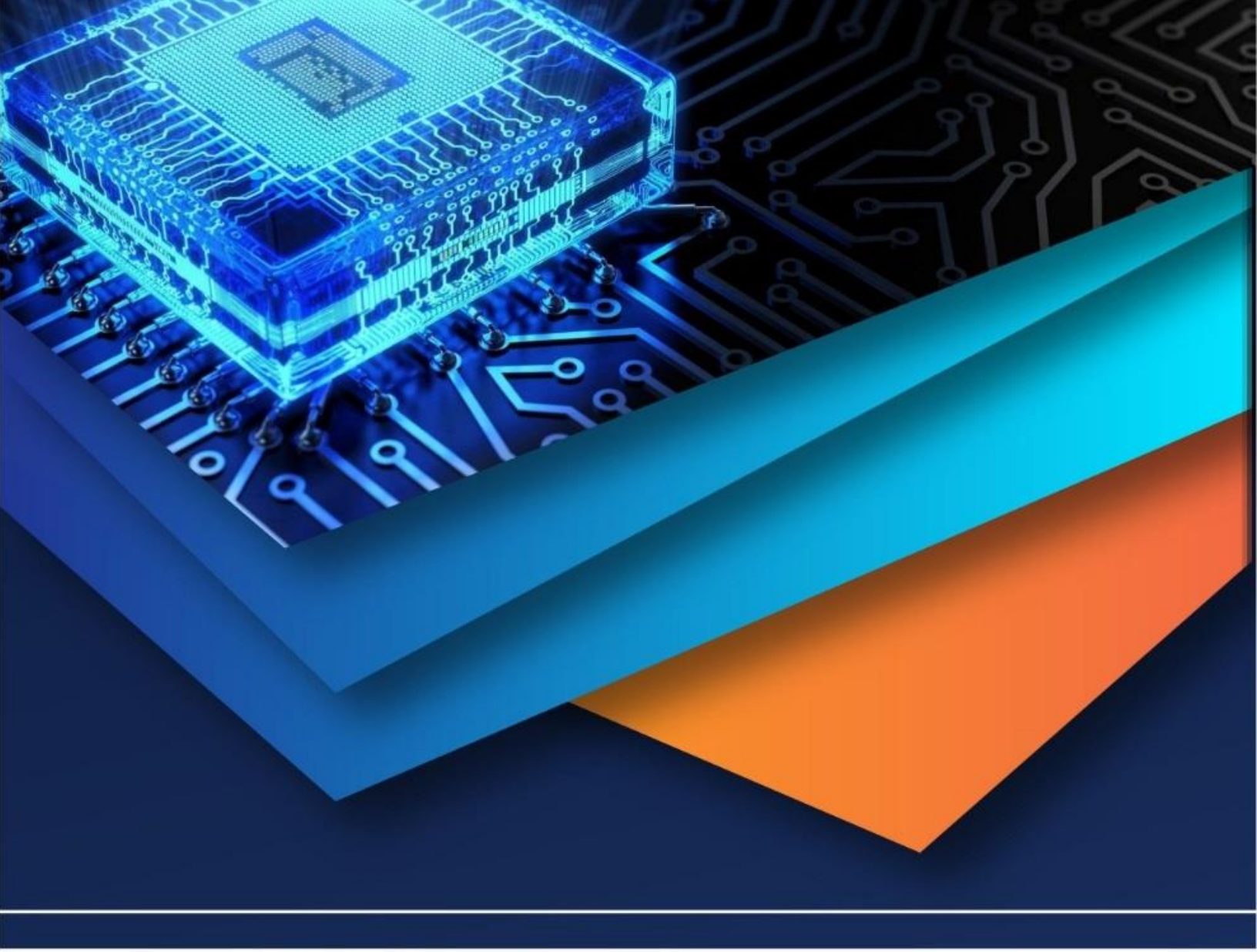

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