Proceeding International Conference on Religion, Science and Education (2023) **2**, 679-685

Review for Understanding Dark Matter in The Universe as Negative Energy

Ruben Cornelius Siagian[1], Lulut Alfaris[2], Goldberd Harmuda Duva Sinaga[3]
[1]Physics Departement, Faculty of Mathematics Science and Natural Science, Universitas Negeri Medan, Indonesian,
[2]Marine Technology Department, Politeknik Kelautan dan Perikanan Pangandaran, Indonesian,
[3]Department of physics education, Faculty of Teacher Training and Natural Sciences, Universitas HKBP Nommensen Medan, Indonesian.
[1] Jl. William Iskandar Ps. V, Kenangan Baru, Kec. Percut Sei Tuan, Kabupaten Deli Serdang, Sumatera Utara 20221,
[2] Babakan, Kec. Pangandaran, Kab. Pangandaran, Jawa Barat 46396,
[3] Sutomo No.4A, Perintis, Kec. Medan Timur, Kota Medan, Sumatera Utara 20235

Corresponding author
[1]Rubensiagian775@gmail.com

Abstract: Some scholars dispute the old claim of negative mass in physics. Most experts now agree that negative mass cannot exist in the universe because it contradicts the known laws of physics. However, research is still being carried out looking for evidence of negative masses, and new theories are being developed to explain how negative masses could exist. This paper also discusses the problems of vacuum instability, uncontrolled motion, and the difference between negative and positive mass wheels. The law of the conservation of energy states that negative mass is required. Negative mass can explain important characteristics of dark matter, such as the effects of centripetal forces, its interactions with other matter, and its role in the accelerating expansion of the universe. Therefore, we need to seriously study the negative mass model to find answers to unanswered questions about the universe.

Keywords: Dark matter, Negative Energy, Gravity.

Introduction

Dark matter is a hypothetical form of matter that is thought to make up about 85% of the total matter in the universe (1). Despite its name, dark matter does not emit, absorb, or reflect any electromagnetic radiation, making it invisible to telescopes. Its existence is inferred through its gravitational effects on visible matter, radiation, and the large-scale structure of the universe. The paper in question aims to give a comprehensive overview of the current state of research on dark matter. This likely includes a summary of the current leading theories on the nature and behavior of dark matter, as well as an overview of the experimental methods used to detect it. It may also discuss recent discoveries and advancements in the field, as well as any unresolved questions or controversies. The goal of the paper is to provide a broad understanding of the current state of knowledge in the field of dark matter research for those who are not experts in the area. The background section of the paper is likely to provide an overview of the history of the discovery and observation of dark matter. This would likely include a brief history of how scientists first came to realize that there must be a form of matter that is not visible, but can be inferred through its gravitational effects. It would also likely include a summary of the key discoveries and observations that have led to the current understanding of dark matter, such as the observation of galactic rotation curves and the discovery of the cosmic microwave background radiation. Additionally, the section could also mention some of the current leading theories on the nature and behavior of dark matter, such as the theory that dark matter is made up of Weakly Interacting Massive Particles (WIMPs) or the theory that dark matter is made up of axions. Furthermore, the section could also provide an overview of the current evidence for the existence

ISSN 2829-3355 | EISSN 2828-8467

of dark matter. This could include a summary of the observational and experimental evidence, such as gravitational lensing, the Bullet Cluster, and the cosmic microwave background radiation. It would also likely discuss the current status of the search for dark matter, such as the ongoing efforts to detect dark matter particles through direct detection experiments and the search for dark matter through indirect detection methods. Overall the background section is intended to provide the reader with a general understanding of the history, current understanding and evidence of dark matter, which will serve as a foundation for the rest of the paper. This paper will likely focus on the concept of negative energy and its potential role in dark matter. Negative energy is a type of energy that has a lower value than the zero point energy, the lowest possible energy that a quantum mechanical physical system may have. In physics, negative energy is known to be related to the idea of the Casimir effect, where two parallel uncharged metal plates in a vacuum will experience a force due to the fluctuation of virtual particles. Negative energy can also be generated by a gravitational field, for example in the form of a black hole. The paper will probably discuss a specific model known as the negative energy dark matter model, which posits that dark matter is composed of negative energy. This model suggests that the dark matter particles are made up of negative energy fields, which would result in a repulsive force instead of the attractive force that we see in normal matter. The paper will likely discuss the strengths and limitations of this model, such as its ability to explain the observed properties of dark matter and its compatibility with current observational data and other theories. The paper may also explore the implications of this model for our understanding of the universe, such as its potential to explain the observed large scale structure of the universe or its ability to account for the observed acceleration of the expansion of the universe. Additionally, the paper may also discuss the current experimental efforts to test this model and the current status of the field.

Materials and Methods

The method used in this research appears to be a combination of theoretical and observational studies. The scholars in this study are examining the old claim of negative mass in physics and discussing the problems associated with its existence. They also mention that most experts now agree that negative mass cannot exist in the universe because it contradicts the known laws of physics. However, research is still being carried out looking for evidence of negative masses and new theories are being developed to explain how negative masses could exist. The paper also mentions the law of the conservation of energy and states that negative mass is required. It also discusses the implications of negative mass for important characteristics of dark matter such as the effects of centripetal forces, its interactions with other matter, and its role in the accelerating expansion of the universe. It can be inferred that the research is mainly theoretical, but they are also looking for any observational evidence that could support the existence of negative mass.

Results and Discussion

Background of Dark Matter

Dark matter is a hypothetical form of matter that is thought to make up about 85% of the total mass of the universe (2). The concept of dark matter was first proposed in the 1930s by Swiss astronomer Fritz Zwicky, who observed that the total mass of a galaxy cluster was insufficient to account for the gravitational forces holding the clusters together (3). This led him to suggest the existence of "dark matter" which is invisible, but present in large quantities to provide an extra gravitational pull. The idea of dark matter can be represented mathematically by the following equation (4):

$$\frac{V^2}{R} = \frac{GM}{R^2} \quad (1)$$

Where V is the velocity of the galaxy R is the distance from the center of the galaxy G is the gravitational constant M is the mass of the galaxy.

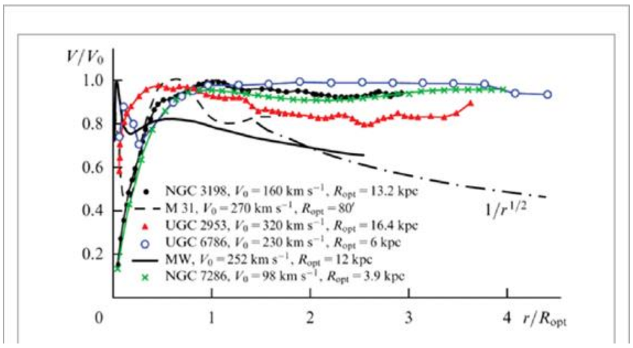

Figure 1. Rotation curves of spiral galaxies normalized to the rotation velocity maximum
Source Khoverskov (2017)

This equation is known as the "rotation curve" and it is used to calculate the velocity of a galaxy at a given distance from its center. The rotation curve is observed to be flat or nearly flat at large distances from the center of a galaxy, indicating that the mass of the galaxy is distributed differently than what is expected from visible matter alone (5). The discrepancy between observed rotation curves and the predictions of Newtonian gravity can be mathematically represented by the following equation:

$$V_{obs}^2 = G\frac{M_{tot}}{r} \qquad 2$$

where V_{obs}^2 is the observed rotation velocity, G is the gravitational constant, M_{tot} is the total mass (including dark matter) within a given radius r, and r is the distance from the center of the galaxy. However, the Newtonian gravity equation can be represented as:

$$V_{pred}^2 = G\frac{M_{lum}}{r} \qquad 3$$

where V_{pred}^2 is the predicted rotation velocity, G is the gravitational constant, M_{lum} is the luminous mass (not including dark matter) within a given radius r, and r is the distance from the center of the galaxy. As we can see in the fig 1, the observed rotation velocity is much higher than the predicted rotation velocity (6). The difference between the two is thought to be due to the presence of dark matter, which is not visible but is thought to be present in large quantities in galaxies (7). So, the discrepancy between observed and predicted rotation curves can be mathematically represented by (8):

$$-V_{\text{Pred}}^2 = G\frac{M_{tot} - M_{lum}}{r} \qquad 4$$

This equation suggests that the observed rotation velocity is higher than the predicted rotation velocity due to the presence of dark matter, which is not visible but is thought to be present in large quantities in galaxies.

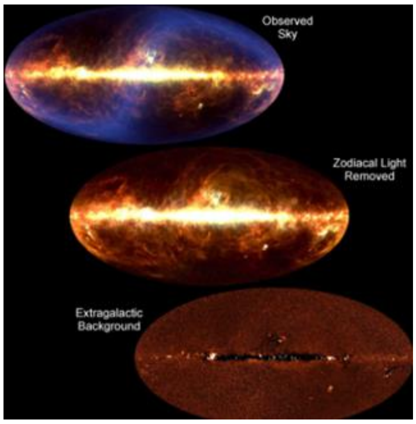

Figure 2. Three views of the infrared universe by the Cosmic Background Explorer (COBE) satellite
Source Britanica

COBE a satellite mission launched in 1989 that aimed to study the cosmic microwave background radiation, which is the afterglow of the Big Bang (9). The mission produced several important results, including precise measurements of the temperature of the cosmic microwave background and the detection of small temperature fluctuations that are thought to be the seeds of structure in the universe (10). These results were important for our understanding of the early universe and the origin of structure Since then, several pieces of evidence have been found to support the existence of dark matter (11). One of the most significant pieces of evidence for the Big Bang theory is the observation of the Cosmic Microwave Background radiation (CMB), which is the afterglow of the Big Bang (12). The CMB is a faint glow of light that fills the universe and has been observed in all directions. The CMB radiation can be described mathematically using the Planck's law of black body radiation, which is given by the following equation (13):

$$B_\lambda(T) = \frac{2hc^2}{\lambda^5}\frac{1}{e^{\frac{hc}{\lambda k_B T}}-1} \quad 5$$

Where $B_\lambda(T)$ is the spectral radiance of the CMB radiation (the energy emitted per unit area per unit time per unit solid angle per unit wavelength) h is the Planck constant c is the speed of light λ is the wavelength of the radiation k_B is the Boltzmann constant T is the temperature of the CMB radiation. This equation describes how the intensity of the radiation depends on the temperature and wavelength. The temperature of the CMB radiation is found to be 2.725 K, which is very close to absolute zero (14).The observation of the CMB radiation is considered as one of the most significant evidence for the Big Bang theory because it provides strong support for the idea that the universe began as a hot, dense state, and has been expanding and cooling ever since. Since then, several pieces of evidence have been found to support the existence of dark matter. One of the most significant pieces of evidence for the Big Bang theory is the observation of the Cosmic Microwave Background radiation (CMB), which is the afterglow of the Big Bang (12). The CMB is a faint glow of light that fills the universe and has been observed in all directions. The CMB radiation can be described mathematically using the Planck's law of black body radiation, which is given by the following equation (13):

$$\boldsymbol{G}_{\mu\nu} = 8\pi T_{\mu\nu} \quad 6$$

where $\boldsymbol{G}_{\mu\nu}$ is the Einstein tensor, which describes the curvature of spacetime, and $T_{\mu\nu}$ is the stress-energy tensor, which describes the distribution of matter and energy in the universe. In order to account for the observed rotation curves of galaxies and the large scale structure of the universe, it is necessary to postulate the existence of a form of matter that does not emit or interact with electromagnetic radiation, known as dark matter (2). The presence of dark matter can be represented mathematically by adding a term to the stress-energy tensor, $\boldsymbol{T'}_{\mu\nu} = T\mu\nu + T^{DM}\mu\nu$, where $T^{DM}\mu\nu$ represents the stress-energy tensor of dark matter. This modification to the stress-energy tensor allows for a solution of the field equation that can account for the observed rotation curves of galaxies and large scale structure of the universe without violating the laws of physics (11).

The modification to the stress-energy tensor that allows for a solution of the field equation that can account for the observed rotation curves of galaxies and large scale structure of the universe without violating the laws of physics is known as Modified Newtonian Dynamics (MOND) (15). The MOND equation is given by:

$$\frac{\mu\left(\frac{|\boldsymbol{g}|}{a_0}\right)\boldsymbol{g}}{|\boldsymbol{g}|} = \boldsymbol{g}_N \quad 7$$

Where: $\mu(x)$ is an interpolating function that smoothly connects the Newtonian regime $x >> 1$ to the deep-MOND regime $(x << 1)$ a_0 is a fundamental acceleration scale $\boldsymbol{g}$ is the gravitational acceleration g_N is the Newtonian gravitational acceleration. This equation helps to explain the discrepancy between the observed rotation curves of galaxies and the predictions of Newtonian gravity.

The Concept of Negative Energy

Negative energy is a concept in physics that refers to any form of energy that has a negative value (16). This means it has the opposite effect of positive energy, which is the more common form of energy we are familiar with. One of the most famous examples of negative energy is the Casimir effect, which is the force that occurs between two parallel uncharged metal plates brought close to each other (17). The effect is caused by the quantization of the electromagnetic field, which means that only certain energy levels are allowed for the field. Consequently, there is less energy in the space between the plates than in the space outside the plates, and this energy difference creates a force that pushes the plates together (18).

This force is thought to be caused by the negative energy that exists between the plates. The theory predicts that the energy density of a gravitational field can be negative, meaning that the energy is pulling matter into the field rather than pushing it away. This negative energy can cause the gravitational field to become unstable and collapse, forming a black hole. The cosmological constant, denoted by the Greek letter lambda (λ), is a term in Einstein's equations of General Relativity that represents the energy density of empty space. It is usually represented in the following form:

$$G_{\mu\nu} = 8\pi T_{\mu\nu} + \Lambda G_{\mu\nu} \quad 8$$

The cosmological constant represents the energy density of the vacuum of space and it can be positive, negative or zero. A positive value of the cosmological constant would represent a repulsive force, a negative value of the cosmological constant would represent an attractive force and a zero value of the cosmological constant would represent a space without any energy density. The cosmological constant is thought to be responsible for the observed acceleration of the universe's expansion, and its value is related to the amount of negative energy present in the universe. Negative energy is a concept in physics that refers to any form of energy that has a negative value, and is related to phenomena such as the Casimir effect, black holes, and the cosmological constant.

The concept of negative energy can be explained mathematically through the use of the energy-momentum tensor, which is a mathematical representation of the distribution of energy and momentum in a physical system. The energy-momentum tensor, also known as the stress-energy tensor, is a mathematical object that describes the distribution of matter and energy in a given region of spacetime. It is a symmetric rank-2 tensor, which means that it has two indices and it is symmetric when its indices are interchanged. In a given coordinate system, its components can be represented by a matrix, where each element of the matrix corresponds to a component of the tensor. In special and general relativity, the energy-momentum tensor is used to describe the energy-tension of physical systems. In general, the energy-momentum tensor consists of two parts: energy density and pressure. Energy density is energy per unit volume, and is the time-time component of the energy-momentum tensor. Pressure is the force per unit area, and is the spatial-spatial component of the energy-momentum tensor. Negative energy is a concept that refers to the existence of a negative energy density, which can be represented mathematically by negative values for the time-time component of the energy-momentum tensor, $T^{00} < 0$. This can occur in certain physical systems, such as in the Casimir effect, where the energy density of the vacuum state is negative. This can also be represented mathematically by the concept of exotic matter, that is, matter that has a negative energy density and negative pressure. This type of matter can lead to the formation of wormholes and other exotic phenomena in general relativity. In summary, the concept of negative energy can be represented mathematically by negative values for the time-time component of the energy-momentum tensor, $T^{00} < 0$, which describes the energy density of a physics system.

Models of Negative Energy Dark Matter

The negative energy dark matter model refers to theoretical models that propose that dark matter may be composed of negative energy, rather than the more traditional idea of dark matter being composed of some form of invisible matter. One example is the Casimir effect, a phenomenon that occurs when two parallel metal plates are brought close together. The effect is caused by the quantization of the electromagnetic field, which means that only certain energy levels are allowed for the field. Consequently, there is less energy in the space between the plates than in the space outside the plates, and this energy difference creates a force that pushes the plates together. This force is thought to be caused by the negative energy that exists between the plates. MOND was proposed by Mordehai Milgrom in 1983, which modifies Newton's laws of motion in the low acceleration regime, the mathematical relationship is given as :

$$F = \mu\left(\frac{a}{a_0}\right)F_N \quad 9$$

Where F is the observed gravitational force, F_N is the Newtonian gravitational force, a is the acceleration, a_0 is a fundamental acceleration constant, and $\mu(x)$ is a function that interpolates between the Newtonian and MOND regimes.

Instead, it shows that the gravitational force becomes stronger at very low accelerations, and this stronger force can explain the rotational curve of the shot. In addition, the cosmological constant, which is a term in Einstein's equations of general relativity that represents the energy density of empty space, is also related to negative energy. The cosmological constant is thought to be responsible for the observed acceleration of the universe's expansion, and its property is related to the amount of negative energy present in the universe. All of these models are still under research, and there is currently no conclusive evidence that dark matter is composed of negative energy, but these models are alternative ways of observing that have led to the idea of dark matter. One mathematical model for negative energy dark matter is the Casimir effect, which can be described by the equation:

$$\Delta E = \left(\frac{\pi \hbar c}{240 a^4}\right) \sum_{n=1}^{\propto} \frac{1}{n^4} \qquad 10$$

where ΔE is the change in energy (or "negative energy") caused by the effect, $\hbar$ is the reduced Planck constant, c is the speed of light, a is the distance between two parallel uncharged conducting plates, and the summation symbol represents the infinite series of energy levels between the plates. Another mathematical model of negative energy dark matter is the vacuum energy density, which can be described by the equation:

$$\Lambda = \left(\frac{8\pi G}{c^4}\right) \rho_{vacuum} \qquad 11$$

where Λ is the cosmological constant, G is the gravitational constant, c is the speed of light and ρ_{vacuum} is the vacuum energy density.

Future Directions and Challenges

Future directions in dark matter research include continuing to search for direct detection of dark matter particles, as well as studying the properties and behavior of these particles through indirect detection methods such as observing their effects on the cosmic microwave background and large scale structure formation (19). Another area of research is to explore the possibility of dark matter being made up of new particles or fields beyond the Standard Model of particle physics (20). One of the major challenges in dark matter research is the lack of a definitive detection of dark matter particles. Despite many searches and experiments, a direct detection of dark matter has yet to be made. Another challenge is the lack of understanding of the properties and behavior of dark matter, such as its mass and interaction with other particles (21). Another challenge is the large number of theoretical models that have been proposed to explain dark matter, making it difficult to determine which model is correct. There are also ongoing challenges in developing new experimental techniques and technologies to detect and study dark matter, as well as in interpreting and analyzing the data from current experiments.

Conclusions

The conclusion of this paper is that it aims to provide an overview of the current state of research in the dark matter field. It provides a brief history of dark matter discovery and observation and current understanding and evidence for its existence. The paper also studies the concept of negative energy and its potential role in dark matter. The negative energy dark matter model is discussed, including its strengths and limitations. Finally, the paper discusses future directions and challenges in the field, including ongoing and proposed experiments and the need for new theoretical models. The paper aims to provide a comprehensive understanding of the current state of dark matter research and the potential implications of negative energy in this area.

References

Zumalacarregui M, Seljak U. Limits on stellar-mass compact objects as dark matter from gravitational lensing of type Ia supernovae. Phys Rev Lett. 2018;121(14):141101.

Rowland D. Dark matter revealed. J Phys Astron. 2020;8(3):196.

Haraux A. About dark matter and gravitation. 2020;

Bahamonde S, Böhmer CG, Carloni S, Copeland EJ, Fang W, Tamanini N. Dynamical systems applied to cosmology: dark energy and modified gravity. Phys Rep. 2018;775:1–122.

Llanes-Estrada FJ. Elongated Gravity Sources as an Analytical Limit for Flat Galaxy Rotation Curves. Universe. 2021;7(9):346.

El-Badry K, Quataert E, Wetzel A, Hopkins PF, Weisz DR, Chan T, et al. Gas kinematics, morphology and angular momentum in the FIRE simulations. Mon Not R Astron Soc. 2018;473(2):1930–55.

Albert A, André M, Anghinolfi M, Anton G, Ardid M, Aubert JJ, et al. Search for dark matter towards the Galactic Centre with 11 years of ANTARES data. Phys Lett B. 2020;805:135439.

Vikram V, Sakstein J, Davis C, Neil A. Astrophysical tests of modified gravity: stellar and gaseous rotation curves in dwarf galaxies. Phys Rev D. 2018;97(10):104055.

Teoh HC. The Cosmic Microwave Background. In: Analyzing the Physics of Radio Telescopes and Radio Astronomy. IGI Global; 2020. p. 272–89.

Chluba J, Abitbol M, Aghanim N, Ali-Haimoud Y, Alvarez M, Basu K, et al. New horizons in cosmology with spectral distortions of the cosmic microwave background. Exp Astron. 2021;51(3):1515–54.

Farnes JS. A unifying theory of dark energy and dark matter: Negative masses and matter creation within a modified ΛCDM framework. Astron Astrophys. 2018;620:A92.

HEBERT J. Astronomy Magazine: Big Bang in Crisis? Creat Sci Update. 2020;

Livadiotis G, McComas DJ. Black-body radiation in space plasmas. EPL Europhys Lett. 2021;135(4):49001.

Kalhor B, Mehrparvar F, Kalhor B. How does quantum redshift describe quantum cosmic microwave background. Available SSRN 3730665. 2020;

Oria PA, Famaey B, Thomas G, Ibata R, Freundlich J, Posti L, et al. The phantom dark matter halos of the Local Volume in the context of modified Newtonian dynamics. Astrophys J. 2021;923(1):68.

Feynman RP. The principle of least action in quantum mechanics. In: Feynman's Thesis—A New Approach To Quantum Theory. World Scientific; 2005. p. 1–69.

Stange A, Campbell DK, Bishop DJ. Science and technology of the Casimir effect. Phys Today. 2021;74(1).

Huang WJ, Creath CJ. The midline diastema: a review of its etiology and treatment. Pediatr Dent. 1995;17:171–171.

Tulin S, Yu HB. Dark matter self-interactions and small scale structure. Phys Rep. 2018;730:1–57.

Arbey A, Mahmoudi F. Dark matter and the early Universe: a review. Prog Part Nucl Phys. 2021;119:103865.

Bertone G, Tait TM. A new era in the search for dark matter. Nature. 2018;562(7725):51–6.