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Dark Matter as Antimatter Galaxies in the Composite Photon Theory

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Abstract

In the composite photon theory, the photon is a bound state of an electron neutrino and an electron antineutrino with spin one. The theory also predicts an antiphoton that is distinct from the photon. Since this antiphoton does not interact with ordinary matter, antimatter galaxies would appear to us as dark matter, neither emitting light (that we can detect) nor reflecting ordinary light. The possibility of a patchwork universe with matter and antimatter galaxies in different regions, once thought to be excluded, has recently been shown to be viable. This interpretation accounts for many phenomena attributed to dark matter, although it cannot explain the galactic rotation curves. However, these curves are well explained by Modified Newtonian Dynamics (MOND). The mass spectrometer at the International Space Station has reported antihelium events in cosmic rays, providing unexpected evidence of antimatter in the universe.

Keywords

Dark Matter, Antimatter, Antiphoton, Composite Photon Theory

1. Antimatter Behaves as Dark Matter in a Composite Photon Theory

The predictions of the composite photon theory are very similar to those of the elementary photon theory [1]. However, in the Standard Model, the photon is its own antiparticle, while in the composite photon theory, the antiphoton is different. In the composite photon theory [1], the photon is a bound state of a left-handed electron neutrino and a right-handed electron antineutrino. It is assumed that the electron neutrino is massless. The internal structure of the photon is taken to be,

$$\gamma = \nu_{eL}\bar{\nu}_{eR}, \tag{1}$$

yielding a particle with helicity +1 or −1.

Under the charge conjugation operation,

$$C\nu_{eL} = \bar{\nu}_{eL},\ C\bar{\nu}_{eR} = \nu_{eR}. \tag{2}$$

Thus the antiparticle of the photon is,

$$\bar{\gamma} = \bar{\nu}_{eL}\nu_{eR}. \tag{3}$$

Not only is $\bar{\gamma}$ different from γ, but its neutrinos types are not considered to exist. It was shown [1] that antiphotons do not interact with electrons in a matter world, because ν_{eR} and $\bar{\nu}_{eL}$ have the wrong helicity. This is because the electron-neutrino interaction is V-A; thus, it selects left-handed neutrinos and right-handed antineutrinos. In a symmetric manner photons do not interact with positrons in an antimatter world.

Therefore, antimatter galaxies should appear to us as dark matter, neither emitting light that we can detect or reflecting ordinary light. Because antimatter galaxies would be difficult to detect, it has been suggested [2] that the universe might be symmetric with equal amounts of matter and antimatter.

The feasibility of dark radiation ("dark photons") mediating interactions between dark matter particles, and not Standard Model particles, has been discussed [3]. In the context of the present theory, the dark photons are antiphotons and dark matter is antimatter.

There are photon eigenstates of charge conjugation, that are a superposition of the photon and antiphoton,

$$|\gamma_1\rangle = \frac{1}{\sqrt{2}}\left(|\gamma\rangle + |\bar{\gamma}\rangle\right)\ \ |\gamma_2\rangle = \frac{1}{\sqrt{2}}\left(|\gamma\rangle - |\bar{\gamma}\rangle\right), \tag{4}$$

Under charge conjugation,

$$C|\gamma_1\rangle = |\gamma_1\rangle,\quad C|\gamma_2\rangle = -|\gamma_2\rangle, \tag{5}$$

showing that $|\gamma_1\rangle$ is an eigenstate of C with value +1, while $|\gamma_2\rangle$ is an eigenstate of C with value −1. Under the combined operation of charge conjugation and parity,

$$CP\gamma = \bar{\nu}_{eR}\nu_{eL} = \gamma,\quad CP\bar{\gamma} = \nu_{eR}\bar{\nu}_{eL} = \bar{\gamma}. \tag{6}$$

The electromagnetic field transforms in the usual manner only under the combined operation of *CP*. The search for invisible decays of positronium [4] showed that all photons in positronium annihilation are detected. Therefore, the photons involved must be $|\gamma_1\rangle$ and $|\gamma_2\rangle$, the superposition of $|\gamma\rangle$ and $|\bar{\gamma}\rangle$. Since positrons interact with the electromagnetic field in a manner similar to that of electrons, the composite photon theory requires that the effect of virtual photons must be the same in matter and antimatter worlds.

2. Evidence Requiring Dark Matter

Some of the phenomena that demand a dark matter explanation include: (1) The residual mass discrepancy in galaxy clusters ("cluster conundrum") [5] [6]. Examples include the Bullet Cluster and the Coma Cluster. In the Bullet Cluster, as analyzed using Lambda-CDM, when the galaxies collided X-ray gas interacted and slowed down, remaining in the center, while the galaxies passed one another. The gravitational potential shows two large concentrations centered on the galaxies and not on the X-ray gas, where most of the normal matter is located. A dark matter halo in the galaxies is proposed to explain the offset between the gravitational potential and the X-ray gas [6]. (2) Some galaxy clusters exhibit gravitational lensing signals that magnify and distort the light from the background objects behind them [7]. Analysis of lensing data for the galaxy cluster Abell 1689 [7] shows that this residual missing mass problem becomes more severe towards the cores of galaxy clusters. (3) The observed anisotropies and acoustic peaks in the cosmic microwave background (CMB) [8] require the existence of dark matter.

Lambda-CDM has been successful in explaining these astronomical observations. In contrast, the presence of antimatter galaxies, although conceptually appealing, faces more constraints. Unlike Lambda-CDM, which allows adjustable dark matter distributions, the antimatter model requires equal quantities of matter and antimatter, structured similarly into galaxies, clusters, and gas.

Thus, showing that antimatter, which appears as dark matter, can explain these three problems is beyond the scope of this study. However, we offer some speculative remarks: (1) Explaining the Bullet Cluster would require analysis of antimatter galaxy cluster collisions alongside matter ones, (2) Dark matter clumps observed with weak gravitational lensing [9] could be antimatter galaxy clusters, and (3) The CMB anisotropies might have been influenced by matter-antimatter interactions in the early universe.

3. Galactic Rotation Curves

In the 1970s, Vera Rubin mapped the rotation curves of many spiral galaxies [10], and showed that they did not decrease with distance as predicted by Newton's laws. Instead, they remained nearly flat. Rubin’s results have been verified over several decades [11].

The presence of antimatter galaxies CANNOT explain the observed galactic rotation curves of visible galaxies. Antimatter galaxies must be well separated in distance from matter galaxies, and therefore they would have no effect on what happens internally in matter galaxies.

There are two competing explanations for the observed rotational curves: the Lambda-CDM and MOND models. In the Lambda-CDM model the shape of the curves are explained by the presence of a dark matter halo [12]. Milgrom [13] in the early 1980s proposed a theory (modified Newtonian dynamics or MOND) in which Newton’s laws of gravity are modified to fit the galactic rotation curves. Milgrom noted that the inner part of the galactic rotational curve agrees with that expected for the visible matter in the galaxy. Because Newton’s laws have already been modified three times (for special relativity, quantum mechanics, and general relativity), a fourth for long distances is not unreasonable.

On the experimental side, McGaugh *et al.* [14] studied 153 galaxies using a method involving near infrared photometry that provides a direct link between starlight and stellar mass. They found that the rotation curves are completely determined by the visible matter that they contain even if the galaxy must have 100 times more dark matter in the Lambda-CDM model. The baryonic mass of a galaxy correlates exactly with the amplitude of the rotational velocity curve at large radii as shown in Figure 3 of McGaugh *et al.* [14]. To create the curve shown in their Figure 3, for each radius in a given disk, they computed two quantities: the centripetal acceleration expected from the gravitational pull of the visible matter and the actual centripetal acceleration determined from the measured rotational velocity. Thus, their Figure 3 shows a universal law, relating baryon centripetal acceleration and observed centripetal acceleration, that they discovered:

$$g_{obs} = \frac{g_{bar}}{1 - \mathrm{e}^{-\sqrt{g_{bar}/g_{\dagger}}}}. \tag{7}$$

This curve and its experimental law is strong evidence that modifying Newtonian gravitational force for long distances is the solution to the galactic-rotation-curve problem. Since the results span orders of magnitude in mass and density, it would require unrealistic dark matter variations and halo formations in the Lambda-CDM model. To explain these results with the Lambda-CDM model would require dark matter to baryonic matter ratios of 3 for some galaxies to hundreds of times for other galaxies, and the distribution of the dark matter must be just right for each galaxy. There is no simple relationship between the dark matter mass in a galaxy and its baryonic mass.

In a 2022 published survey of dwarf galaxies from the Fornax Deep Survey (FDS) catalogue [15], a group of astronomers and physicists concluded that "observed deformations of dwarf galaxies in the Fornax Cluster and the lack of low surface brightness dwarfs towards its centre are incompatible with Lambda-CDM expectations but well consistent with MOND." Thus, MOND is by far the best explanation for galactic rotation curves.

4. Conclusions

We have shown that the antiphoton, predicted by the composite photon theory, causes antimatter to appear as dark matter. Consequently, antimatter galaxies could explain many dark matter observations, though not galactic rotation curves, which are best explained by MOND.

Lambda-CDM requires the universe to have approximately five times more dark matter than baryonic matter. In contrast, this theory—combined with MOND—requires only equal amounts of matter and antimatter.

Mass peaks, observed with weak gravitational lensing and lacking luminous counterparts, could be consistent with antimatter galactic clusters. However, detailed modeling is required [9].

In 1999, the AMS Collaboration [16] in searching for antihelium nuclei in cosmic rays reported a flux ratio of antihelium to helium of $<10^{-6}$. In 1998, Cohen *et al.* [17] and in 2002, Stecker [18] noted that the detection of just one antihelium nucleus would be strong evidence of extra galactic antimatter. More recently (2016) the Alpha Magnetic Spectrometer (AMS-02) on board the International Space Station has reported antihelium nuclei events [19]. If confirmed, such detections would point to large antimatter reservoirs [16]-[20] in the universe.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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