# **Title**: The Absence of the Implications of Negative Mass and the Resultant Problems in Physics

**Abstract**: In the Standard Model, there is a lack of discourse on the effects of particles with negative masses to be taken into consideration to attempt solutions of outstanding problems such as Dark Matter, Dark Energy and other experimentally observed phenomena for which no exhaustive data and therefore no suitable explanations exist. Also, it was while deriving the equation, $R = GM/c^2$, in which the restrictive condition for creation of a Black Hole at the end of a stellar collapse is totally removed, similar to the Schwarzschild's Radius $R_\odot$ for a Black Hole resulting from a stellar collapse, $R_\odot = 2GM_\odot/c^2$, very uncomfortable questions arose that are yet to be addressed. Moreover, the asymmetry between the ubiquitous presence of particles and the relative scarcity of antiparticles in the observable universe also isn't explainable. The present article continues to probe the untouched areas of inferable possibilities, not yet arrived at by peers in peer-reviewed materials, and touch upon some of the yet unsolved questions by probing aspects of matter-energy relationship.

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## Main Article

The hypothesis of the **Residual Potential Energy and the Infinite Upper and Lower Continuum of Particles and Fields** was reached at, by studying the Dirac's Relativistic Field Equation and its prediction of the Positron, in 2002-03.

Unfortunately, in the middle of the bygone era when the observable four forces and fields were discovered, all

the gross details in physics appeared to be nearly complete. What was speculated to be remaining was the finer aspects that needed high energy collision experiments to be sorted out and a unification of the four forces to be arrived at in due time.

Let us return to the Dirac's Electromagnetic Field Equation:

$i\hbar\frac{\partial\Psi}{\partial t} = \left(c\boldsymbol{\alpha}\left(p-\frac{e}{c}\boldsymbol{A}\right)+\boldsymbol{\beta}mc^2+e\boldsymbol{\Phi}\right)\Psi$ where **α** are the familiar 2 X 2 Pauli Matrices and $\boldsymbol{\beta}$ stands for 2 x 2 unit matrices.

Considering the non-relativistic condition for a free electron, the equation would reduce to:

$i\hbar\frac{\partial\Psi}{\partial t} = \boldsymbol{\beta}mc^2\boldsymbol{\Psi}$ with $\boldsymbol{\beta} = \begin{pmatrix}1 & 0\\ 0 & -1\end{pmatrix}$

and the probability wave functions of the form:

$\boldsymbol{\psi}_1 = e^{\left(\frac{-imc^2}{\hbar}t\right)}\begin{pmatrix}1\\0\\0\\0\end{pmatrix}$, $\boldsymbol{\psi}_2 = e^{\left(\frac{-imc^2}{\hbar}t\right)}\begin{pmatrix}0\\1\\0\\0\end{pmatrix}$, $\boldsymbol{\psi}_3 = e^{\left(\frac{+imc^2}{\hbar}t\right)}\begin{pmatrix}0\\0\\1\\0\end{pmatrix}$ and $\boldsymbol{\psi}_4 = e^{\left(\frac{+imc^2}{\hbar}t\right)}\begin{pmatrix}0\\0\\0\\1\end{pmatrix}$, the first two matrices with the coefficient $e^{\left(\frac{-imc^2}{\hbar}t\right)}$ being positive energy solutions and the last two, with $e^{\left(\frac{+imc^2}{\hbar}t\right)}$ being the negative energy ones.

The implications of the solution gained prominence when the antiparticle to electron, i.e., positron, was discovered. Subsequently, over the years, other such antiparticles have been discovered and the table of particle-antiparticle groups was complete by the 1960s. But we are getting too far ahead from the present analysis.

After this Herculean effort of solving the equation, Dirac appears to have become limited by the absence of

experimental data currently available to the present generation physicists. Dirac probably associated the minus(–) with ***m*** and introduced the Hole theory, but negative masses weren't experimentally observed. Then there was the problem of vacuum polarisation. He might have imagined the vacuum being filled up by the sea of Holes. I am unsure on what he might have speculated. It is impossible to probe his mind with whatever little he wrote on the matter. His interpretation isn't clear to me. So I am just assuming. Feynman and Stuckelberg bypassed the lack of experimental observations with Dirac's interpretation, including the absence of evidence for vacuum polarisation, and made an interpretation of their own: antiparticles are particles moving backwards in time, probably associating the minus with ***t***.

But if the solution to the Dirac equation is looked from up close and scrutinised, it will be observed that the minus (–) could accompany the either **c** through the term $(ic)^2$, or ***t*** or ***m***. The minus accompanying ***m*** could not be correctly interpreted during that era. The minus accompanying time ***t*** didn't make much sense. The only association scientists didn't make was having an ***ic***, with ***i***= $\sqrt{-1}$ , i.e., an imaginary constant associated with the speed of light. This would have opened up the domain of Faster Than Light speeds. Evidently for scientists at the time, since the minus couldn't accompany ***m*** it had to accompany ***t***. So without the experimental evidence later observed for galaxies that was interpreted to be the effect of Dark Matter, and the universe expanding progressively faster because of Dark Energy, etc., still speculation or unknown, the scientists were limited by the lack of data to make their own interpretations.

When the hypothesis of **RePIULCoPaFil,** a creative acronym of **Residual Potential Energy and an Infinite Upper and Lower Continuum of Particles and Fields**, was being drawn up, the idea of an infinite upper and lower continuum of particles and fields being both above and below the *'construct that we know and identify as the Universe'* was already framed and self-accepted. Hence the restriction **that** the minus couldn't accompany ***m,*** a scenario that could bother physicists of the only Peer Ecosystem that we identify as Research Institutions and Universities, didn't bother me. Also, the question that why the

brightest couldn’t arrive at an apparently simple solution while I, a relatively naive individual in comparison to my illustrious peers, could so easily arrive at a solution that seemed reasonable, also didn’t arise within. But the unease remained at the back of the mind and continued to pester.

Then the derivation of the equation capturing the condition of Mass-Radius relationship for a non-stellar Black Hole (Ref: https://vixra.org/abs/2301.0140) right up to the dimensions of the Planck Length, quantified by the equation $R = \frac{GM}{c^2}$ that depends only on matter density, rather than the Schwarzschild’s Condition for a limiting Stellar Radius and Mass, quantified by the equation $R_\odot = 2GM_\odot/c^2$, by the end of 2018, again brought the earlier unease to the fore. The question, as to *“why the foremost among peers couldn’t visualise the seemingly easy inference”* began to bother: was it that the leading peers were not able to visualise the implications of their own equations? Was it why Einstein, Schwarzschild, Penrose, Bohm, Hawking and the rest couldn’t simply mentally simulate? Was it a psychological inability to really Visualise and Imagine?

Hence, the hypothesis of RePIULCoPaFil was again revisited, this time with a greater awareness of the psychological condition that appeared to afflict the human mind. A lot more issues clarified themselves immediately. For example, if the textbook, Introduction To Special Relativity, by Robert Resnick, is revisited, replacing the mass ***m*** with minus ***m*** (***-m***), from the relativistic equation for momentum onwards many outrageous equations and scenarios begin to emerge. Various variations could be tried with ***-e*** and ***-m*** to discover diverse scenarios with greater complexities. But I wouldn’t like to remain stuck there.

Let us briefly visit the phenomenon of Pair Production. For photons with high photon energy (MeV scale and higher), pair production is the dominant mode of photon interaction with matter. These interactions were first observed in Patrick Blackett's counter-controlled cloud chamber during 1933. If the photon is near an atomic nucleus, the energy of a photon can be converted into an

electron–positron pair:
$Z + \gamma \rightarrow e^- + e^+$
The only constraint being that the photon must have an energy higher than the sum of the rest mass energies of an electron and positron (i.e., 2 x 511 keV = 1.022 MeV, resulting in a photon-wavelength of 1.2132 picometer) for the pair-production to be feasible.

Let us now return back to our analysis. Though a high enough energy photon is required for producing a pair of particle-antiparticle, even empty space, i.e., absolute vacuum as per the present Standard Model, could spontaneously create an $m + (-m)$ pair, as the two, when arithmetically added up, results in zero mass and therefore, zero energy.

Also, it should immediately be clear that though a positive and a negative mass are created spontaneously in pairs such that those two masses would arithmetically be: $m + (-m) = 0$, they couldn't annihilate each other again.

At this point let us define $-m$ by a phrase, Prati-particle. Since the word "Anti" is already taken up to represent particles with identically opposite charges, the Sanskrit word "Prati", from "Pratikul (Devnagari प्रतिकूल), which is Vipareet ( Devnagari विपरीत), to represent Opposite or Inverted, had to be used to describe a negative with respect to Mass.

It is essential to recall that Gravitational force between particles, antiparticles or pratiparticles having mass isn't a force field in reality. The particles just distort the space-time fabric around them. The effect of this distortion causes the motion of the either particle, antiparticle or pratiparticle to be influenced by the other in such a way that they appear to be under the influence of an Inverse Square Law of Force Field created by the other interacting particle, historically called gravity. This aspect will be briefly touched upon later within this article.

Let us briefly revisit the Inverse Square Law of Gravitational Force of attraction, $\vec{F} = -G \frac{m_1.m_2}{(r_{12})^3} \vec{r}_{12}$, , where $m_1$ and $m_2$ are two different particles, G is the Universal Gravitational Constant and $r_{12}$ is the shortest

distance between those two particle pair.

For our particle-*Prati*particle pair, though ***m*** + (***-m***) = 0, they couldn't be made to come together, as the force between a particle and a *Prati*-particle would be repulsive and shoot up when the two are brought closer. If $m_1$ is a particle $m_p$, and $m_2$, a pratiparticle $-m_p$, then the equation $\vec{F} = -G \frac{m_1.m_2}{(r_{12})^3} \vec{r}_{12} = -G \frac{m_p.(-m_p)}{(r_{12})^3} \vec{r}_{12}$ reduces to: $\vec{F} = G \frac{m_p{}^2}{(r_{12})^3} \vec{r}_{12}$ and is thus repulsive. The two massive particles can't simply come together close enough to mutually annihilate under any circumstance.

In other words, the Energy-Mass interconversion Symmetry in the Universe breaks down with the spontaneous creation of particle-pratiparticle pairs. Unlike the two particle-antiparticle pair, say a proton-antiproton pair, each of mass $m_p$ created from high energy photons having energies greater than $2m_pc^2$, as briefly discussed above, a particle-pratiparticle, each of mass $m_p$ and $-m_p$ respectively, could be created even under a zero energy condition, i.e., absolute vacuum. But once a matter-pratimatter is created, they can't be annihilated back to vanish with a zero energy outcome.

Also, the material Universe created from the Big Bang after the initial energy ball could become transformed into innumerable matter-pratimatter pairs that continue to exist in near-equal proportion unlike that of the matter-antimatter pairs, in which matter is several orders more than antimatter, that exist.

Unfortunately, Newton's Law of Gravitation and the gravitational force visualised only the condition for massive particles, i.e., positive massive particles, not the negative massive particles, i.e., the (***-m***)s, given the empirical data available at the time.

Theoretically, there *isn't* a restriction in the said equation for gravitational force equation being satisfied for pratiparticles, or for a cluster of particles-pratiparticles, as there isn't for a particle-antiparticle pair or an antiparticle pair. Only that from the Newtonian era to the time until the discovery of antiparticles, physicists didn't envisage such kinds of

pratiparticles or antiparticles to exist.

In the scenario among particles of all varieties, only a prati-antiparticle could annihilate a charged particle. That is for example, a prati-antiproton could annihilate a proton, but the experimental data should show a tiny bit greater time period from the time for the said imaginary pair getting into an orbit to the time of their annihilation than that for the proton-antiproton annihilation. The proton, pratiantiproton pair would approach closer and closer, but the mass, pratimass of the two particles would resist coming closer. The gravitational force field being of the order of 40 times weaker than the electromagnetic force field in case of the pair of particle and prati-antiparticle, the increase of the time period from capture to annihilation should be minuscule, nearing ~$10^{-39}$ seconds, but not observable presently with the current day detectors capable of observing only upto atto-second transitions.

With the idea of pratiparticles in place, the idea of virtual photons serving as intermediaries, becomes easier to accept and visualise for the above scenario of repulsion and attraction. The complexities of visualisation are greatly reduced. If a positive energy virtual photon is visualised as a crest pulse or a bump, the negative energy virtual photon could be visualised as a trough pulse or a dent. The bump would push out, while the dent would pull in.

## The interactions of particles and pratiparticles with each other:

It is clear that a pratiparticle repels a particle and force of the repulsion is governed by Newton’s inverse square law of gravitation. However, two pratiparticles should attract each other, the force of attraction quantified by the same inverse square law of gravitation. Hence, there isn’t an impediment in pratiparticles coming up together and forming a cluster or a rigid body of pratiparticles, and those rigid bodies interacting with each other in the same predictable manner determined by the existing laws of kinematics and follow the same laws of motion as do the particles. It is quite natural to speculate that exotic stars of pratiparticles could exist, as could galaxies of pratiparticles.

## Galaxies with varying orders of Dark Matter:

Dark matter doesn’t interact with electromagnetic radiation in the same way as do normal matter. Dark matter interacts with normal matter in the same way as constituents of matter do with each other.

However, pratimatter is different.

Pratimatter should be able to coexist in an unstable equilibrium with ordinary matter within the intragalactic space. As they repel matter, pratimatter would be favoured to have stable, bigger structures outside of galaxies, forming galaxies of their own or disperse within the intergalactic space between galaxies of ordinary matter.

For Dark Matter, their presence is observed within Galaxies by the latter turning out to be more massive, and turning, rotating and moving differently than they are predicted to be by their appearance alone on imaging devices or photographic plates, in either the narrow visible band, or in the other bands of the electromagnetic spectrum, from outside, but the presence of pratimatter also explains why:

(1) different galaxies have different proportions of Dark Matter with respect to normal matter, and

(2) why the expansion of the Universe is accelerating because of the unknown Dark Energy. This dark energy could be because of pratimatter.

Regarding the point (1) above, the conditions in the universe could just be a case of evolving random distribution of matter, dark matter, pratimatter and other exotic matters not yet envisaged. Only experimental evidences in the future could clarify if these constituents are fundamentally different.

Regarding the point (2) above, because of the pratimatter being repulsive to matter by the very nature of their being pratimatter, a pair of matter-pratimatter particles can’t collide to annihilate each other. Instead, they remain in the Universe unaffected by matter, even if the

net mass-charge content of the Universe is zero. On the contrary, charged particles can annihilate their corresponding charged antiparticles.

At another level, a particle is simply energy waves bundled together. Let us for example look at the following Python3 script, when copied-pasted into a plain text file with a “.py” extension, and executed from a terminal in GNU/Linux with the command mentioned below:

```
--------BEGIN SCRIPT---------
# run as python3 OneConstantPacket.py"

import numpy as np
import matplotlib.pyplot as plt
from matplotlib.animation import FuncAnimation

# Define the parameters
k = 0.5  # Wavenumber for the bell packet
omega = 1.5  # Angular frequency for the bell packet
A_bell = 1  # Amplitude for the bell packet
A_wavelet = 0.05  # Reduced amplitude for individual
wavelets
num_wavelets = 5  # Number of individual wavelets

# Define the wave function for the bell packet
def bell_packet(x, t):
    return np.abs(A_bell * np.exp(-((x - 5)**2) / 4) *
np.cos(k * x - omega * t)) + 1  # Shifted down by 1

# Define the wave function for individual wavelets
def wavelet(x, t, n):
    offset = 0.2 * (n - (num_wavelets + 1) / 2)  #
Adjusted offset based on the wavelet index
    return A_wavelet * np.sin(2 * np.pi * n * (x - t)) +
offset  # Shifted up with adjusted offset

# Create a meshgrid for x and t
x_values = np.linspace(0, 10, 1000)
t_values = np.linspace(0, 6, 200)

# Create a figure and axis for plotting
fig, ax = plt.subplots()

# Initialize empty lists to store line objects for each
```

```
wavelet
wavelet_lines = []

# Initialize the bell packet line with a dummy line
bell_line, = ax.plot([], [], lw=2, label='Bell Packet')

# Function to update the plot for each time step
def animate(t):
    # Plot the bell packet
    bell_wave = bell_packet(x_values, 0)
    bell_line.set_data(x_values, bell_wave)

    # Update or create wavelets lines
    while len(wavelet_lines) < num_wavelets:
        line, = ax.plot([], [], lw=1)
        wavelet_lines.append(line)

    # Plot the individual wavelets and set their colors
    for i, line in enumerate(wavelet_lines):
        wave = wavelet(x_values, t, i + 1)
        line.set_data(x_values, wave)
        line.set_color(plt.cm.jet(i / num_wavelets))

    return [bell_line] + wavelet_lines

# Set plot labels and title
ax.set_xlabel('x')
ax.set_ylabel('Wave Amplitude')
ax.set_title('Bell Wave Packet with Individual Wavelets
(Maximum Envelope)')
ax.legend()

# Set axis limits
ax.set_xlim(0, 10)
ax.set_ylim(-1, 2.5)  # Adjusted y-axis limit to
accommodate individual wavelets

# Create the animation
ani = FuncAnimation(fig, animate, frames=t_values,
interval=50, blit=True)

# Display the animation
plt.show()
--------ENDOF SCRIPT---------
```

As can be seen, the resultant wave packet, a crest, results from multiple waves if a specific quantifiable condition is satisfied. Given the underlying field condition and the constituent simple harmonic energy waves, there isn’t any constraint for the wave packet not to be inverted, i.e., a trough.

Here, one should be better served by visualising ripples travelling across the surface of a large water body otherwise undisturbed by strong winds to cause large scale randomness on its surface. Then carry the visualisation forward for wave packets and then for photons traversing in an electromagnetic field sustained by charged particles distributed throughout the infinite space.

The resultant wave packet, which could be representative of a static particle, results from multiple waves under a specific condition of the frequency, phase and amplitude of each wavelet from a set of monochromatic wavelets. As said, there isn’t any constraint for the wave packet not to be inverted, i.e., a trough. If a positive wave packet, the crest, is representative of a particle, then the inverted, negative wave packet, a trough, should be representative of an antiparticle or pratiparticle, according to the specific set of condition of the underlying field-particle conglomerate within a local area.

**Concluding Words:**
Coming back to the main course of analyis, this independent existence of matter and pratimatter clusters is only possible if an underlying field-particle conglomerate exists as the creation base for the said clusters, like air molecules that form the underlying field-particle conglomerate creation base for sound waves and shock waves to exist and propagate.

Then, following the principle of continuity and symmetry, illustrated by the phrase, *As Above, So Below*, a never-ending cascade of Field-Particle Conglomerates forming an infinite upper and lower continuum is the logical and quantifiable outcome.

We recall that in pure vacuum, there is no sound or a

shock wave. Pure vacuum is practically unattainable. A data-set with different observation points for sound reaching a destination point with respect to varying conditions of partial vacua is generally suitable to be extrapolated, and the case for the condition in an absolute vacuum, inferred.

The idea of pratiparticles was made lucid in the paper, Inadequacies of the existing interpretation of the quantum phenomena, and the hypothesis of RePInULCoPaFil, that couldn't be published 20 years ago, but had to be copyrighted with the Copyrights Office, Bharat. The gross idea is easily visualised from the eye of a cyclone or a tornado, which is actually of much lesser density of gases than is the normal air. The core is initially created because of hot, and therefore lesser dense air and low pressure, which, with moisture, makes the core even lesser dense. One could even imagine a whirlpool in the ocean where floating objects are drawn in. The vortex for all practical reasons exists as a physical entity. Physically, the cyclonic core of low pressure exists, but it comes into being because of the heavier air surrounding, and rotating at high speeds around, it. Similarly, the particles and pratiparticles exist, but only because of the lower underlying order of field-particle conglomerate supporting them.

Scepticism continues as to whether the present paper would be illustrative to readers. The paper, Non-Stellar Black Holes, has not drawn attention yet, though it should have. Because someone looked into an aspect where widely acknowledged luminaries like Einstein, Schwarzschild, Hawking, Bohm, Penrose, et al, failed to, and derived an important equation not yet derived by anyone else.

However, positivity is sustained by the historical record of Huygens recording his principle in 1671 and a subsequent historical evidence being first provided by Thomas Young from the Double-Slit experiment in 1800. Unfortunately for Huygens, the presently ubiquitous digital Social Media didn't exist during his time.