

BARYON SYMMETRY AND THE LEAD OF ANTIMATTER OVER MATTER IN A STRESS-FREE UNIVERSE

Original Research Article

ABSTRACT

An analysis is presented, based on the exponential stress-free model of the universe [1], in which it is shown that the rate of production of particle matter is equal to the rate of production of antimatter, which is consistent with baryon symmetry. In addition, the observed ratio of particle matter mass to total mass in the universe under baryon symmetry is used to consider the timing of the increase of matter and antimatter in the expanding universe, and it is found that, the antimatter signal leads the ordinary matter signal by about 2/3 of the time constant for the antimatter annihilation. It is also shown that the annihilation process is responsible for the initial expansion rate of the universe, and the ratio of particle mass to total mass in the universe

Keywords: net-zero stress evolution of the universe, baryon symmetry, particle to total mass ratio of the universe

1. Introduction

The evolution of the universe under stress-free conditions has been investigated in [1] and [2] for the two forms of matter – dark matter and ordinary matter. In this paper, we extend the same investigation techniques to the third form of matter – antimatter, which has recently [3] been shown to respond to the force of gravity in the same manner as for ordinary matter.

2. Wave matter, particle matter and antimatter in the stress-free universe

In the stress-free model, the evolving universe expands at the homogeneous rate [1],

$$dR/dt_R = K(t_0) \quad 0 \leq t_0 \leq \infty \quad (1)$$

27 where $K(t_0)$ is the homogeneous expansion rate in which, t_0 is the absolute time, and t_R is the
 28 local time at the radius (R). The homogeneous expansion rate may be regarded as due to the
 29 two components of the ordinary mass field ($M(t_0)$), which are the wave mass ($M_W(t_0)$), which is
 30 the dark mass left over after the formation of the particle mass ($M_P(t_0)$), and the particle
 31 mass($M_P(t_0)$), which together comprise the mass,

$$32 \quad M(t_0) = M_W(t_0) + M_P(t_0) \quad (2)$$

33 . On the assumption that a growing exponential rate,

$$34 \quad K_W(t_0) = K_0 \exp(\lambda t_0) \quad , \lambda > 0 \quad (3)$$

35 exists for the wave mass (M_W), and a decaying exponential rate occurs for the particle mass,

$$36 \quad K_P(t_0) = K_0 \exp(-\lambda t_0) \quad , \lambda > 0 \quad (4)$$

37 in which,

$$38 \quad K_W(0) = K_P(0) \quad (5)$$

39 at the origin of the universe ($t_0/T \rightarrow 0$), where T is the age of the universe, it was shown in [1]
 40 that,

$$41 \quad M_P(0) = M_W(0) \quad (6)$$

42 which was stated to be an exact wave-particle duality, and expressions were obtained for
 43 $M_W(t_0)$ and $M_P(t_0)$ in [1] by substituting (3) and (4) in (1).

44 *2.1 The wave mass (M_W) and the particle mass (M_P) in the mature universe*

45 For the mature universe, which occurs at the time, $t_0 = T$, they are,

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$$47 \quad M_W = m_0 c T / \ln(1/\alpha) \quad (7)$$

48 and

$$49 \quad M_P = m_0 K_0 T / \ln(1/\alpha) \quad (8)$$

50 where $\alpha = K_0/c$, in which c is the velocity of light, and $m_0 = c^2 / G$ in which G is the universal
 51 constant of gravitation.

52 *2.2 The antimatter mass (M_A) in the mature universe*

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54 Antimatter may be included in the model by assuming that the antimatter decay rate,

55 $K_A(t_0) = A K_0 \exp(-\mu t_0)$, $\mu > 0$ (9)

56 is of the same form as the particle decay rate (4) for ordinary matter, except that the decaying
57 exponential rate (μ) is the annihilation rate for the antimatter due to interaction with the particle
58 matter, and $A > 1$ is a constant to be determined. On substituting (9) in (1), the solution for the
59 antimatter mass, for the mature universe, M_A , obtained as in [1], is,

60 $M_A = m_0 A K_0 T_A / (1 - \alpha)$ (10)

61 in which the annihilation time constant, $T_A = \mu^{-1}$, is much less than the age of the universe ($T_A /$
62 $T \ll 1$)

63 **3. Relations between the masses of wave matter and particle matter and antimatter in the**
64 **mature universe**

65 *3.1 Baryon symmetry*

66 Eqs. (8) and (10) predict that the ratio of antimatter to particle matter in the mature universe ,

67 $M_A / M_P = B T_A / T$ (11)

68 where,

69 $B = A \ln(1/\alpha) / (1 - \alpha)$ (12)

70 Eq. (11) is a highly significant relation, which states that for $B = 1$, the rate of production of
71 particle matter (M_P / T) is equal to the rate of production of antimatter (M_A / T_A),

72 $M_A / T_A = M_P / T$ (13)

73 Eq. (13) is the condition for Baryon symmetry. There is no mystery here. The reason why the
74 mature universe of which we are a part, is not eviscerated by antimatter in the twinkling of an
75 eye, is simply one of the time scale difference between matter and antimatter.

76 *3.2 Antimatter annihilation*

77 The short time scale of the antimatter compared with the matter ($T_A / T \ll 1$) due to their
78 mutual annihilation provides the Einsteinian energy source for the universe, and since from
79 (13), $M_A / M_P \ll 1$, it also has a negligible effect on the mass dynamics. Eq. (13) is a
80 prediction for the annihilation time constant (T_A) in a universe in which the ratio of antimatter
81 to matter is known. Recent observations [4] indicate the range, $M_A / M_P \approx 10^{-14} - 10^{-15}$.
82 Hence, from (13), $T_A \approx 4000 - 400$ s. In all events, (13) predicts that the greater the
83 proportion of antimatter, the greater is its lifetime, and for a cosmic mass symmetry in which
84 $M_A = M_P$, the time scale (T_A) for the annihilation of antimatter would be identical with the age
85 of the universe (T).

86 On the assumption that $B = 1$, (12) yields,

$$87 \quad A = (1 - \alpha) / \ln (1/\alpha) \quad (14)$$

88 in which α can be estimated from the observed values of the age of the universe, $T = 13.8$
89 10^9 yr and the mass of the universe, $M = 1.5 \cdot 10^{53}$ kg. Using (8), with $M_P = \alpha / (1 + \alpha) M$,
90 yielded $\alpha = 0.235$ [1], and hence on substituting for α in (14), $A = 0.53$. This result is also
91 highly significant, since A can be interpreted in terms of the lag (L) of the antimatter
92 exponential signal,

$$93 \quad L = \ln A / \mu \quad (15)$$

94 and since $\ln A = -0.64$, $L < 0$, which indicates that the antimatter signal leads the ordinary
95 matter signal, which is consistent with the annihilation process for antimatter and matter
96 outlined in Section 3.1. In this process, from (15), the lead time ($-L$) would be about two-thirds
97 of the annihilation time constant (T_A).

98 Eq. (15) indicates that the annihilation process, which determines (L/T_A) and hence A , also
99 determines α from (14), and therefore is directly responsible for, (i) the initial homogeneous
100 expansion rate of the universe ($K_o = \alpha c$), and (ii) the particle mass ratio of the universe (M_P/M
101 $= \alpha/(1 + \alpha)$), where M is the mass of the universe [1].

102 We suggest that the annihilation process is an inherent property of the universe, which in
103 ordinary matter dynamics is manifested as the key to instability on the infinitesimal time scale
104 which drives the macro-scale systems, as so famously characterized by Ed Lorenz through
105 a single flap of a butterfly's wings in Brazil, which transforms the climate in Texas [5]. Stress
106 is the compounding of such events [6]

107 **4. Interpretation**

108 The results of Section 3 are ultimately a response to an unresolved problem of physics, made
109 possible through the assumption that the universe is stress-free. In this model, the expansion of
110 the universe occurs from a mass-free origin under net stress-free conditions. The simplest
111 hypothesis is that the expansion is mediated by dark matter, which has a uniform density within
112 the universe [7]. It is proposed that the emergent structure of the dark matter, which was shown
113 in [7] and [8] to be the basis for wave and particle matter, is also the basis for antimatter (which
114 was not considered in the earlier analysis) as is shown by the similar form of the decay
115 relations (4) and (9). What distinguishes the evolution from dark matter, of ordinary matter
116 and antimatter, is the absence of a growing mode for antimatter.

117 **5. Conclusions**

118 The exponential – stress model, which was originally applied in [1] to consider the relation
119 between particle mass and wave mass, has been used here to consider also the relation between
120 particle mass and antimatter mass. The principal prediction is that baryon symmetry occurs in
121 which the rate of production of matter on the large scale is equal to the rate of production of
122 antimatter on the small scale. The vastly different time scales in the two cases has led to the
123 misconception of baryon asymmetry [9]. The good news is that this vast difference in time
124 scale provides a mass rich, large scale universe, supported by a mass poor small scale universe,
125 for our enjoyment.

126 The concept of stress, familiar to fluid dynamicists, appears to be largely absent in the myriad
127 of papers on cosmic evolution, for example [10 -12]

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129 **ACKNOWLEDGEMENTS**

130 The continuing support of Charles James is gratefully acknowledged, as also are the
131 suggestions by two reviewers for the presentation of the results of the study

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133 **COMPETING INTERESTS**

134 Author has declared that no competing interests exist.

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