Original Research Article

BARYONSYMMETRY AND THE LEAD OF ANTIMATTEROVER MATTERIN A STRESS-FREE UNIVERSE

ABSTRACT

An analysis is presented, based on the exponential stress-free model of the universe [1], in which it is shown that therate 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 mattermass to total mass in the universe under baryonic symmetry is used to consider the timing of the increase of matter and antimatter in thr early phase of the expanding universe, and it is found that, the antimatter signal leads the ordinary mattersignal 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 theuniverse,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 ofmatter – 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 andantimatter in the stress-free universe

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

$$dR/\, dt_R = K\,(t_o) \qquad 0 \le t_o \le \infty \qquad (1)$$

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

$$M(t_o) = M_W(t_o) + M_P(t_o) \quad (2)$$

. On the assumption that a growing exponential rate,

$$K_W\,(t_o) = K_o \exp\,(\lambda\, t_o) \qquad , \lambda > 0 \qquad (3)$$

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

$$K_P\,(t_o) = K_o \exp\,(-\,\lambda\, t_o) \qquad , \lambda > 0 \quad (4)$$

in which,

$$K_W\,(0) = K_P\,(0) \qquad (5)$$

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

$$M_P\,(0) = M_W\,(0) \qquad (6)$$

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

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

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

$$M_W = m_o\, c\, T / \ln\,(1 / \alpha\,)(7)$$

and

$$M_P = m_o K_o\, T / \ln\,(1 / \alpha\,)\ (8)$$

where $\alpha = K_o/c$, in which c is the velocity of light, and $m_o = c^2 / G$ in which G is the universal constant of gravitation.

2.2 The antimatter mass (M_A) in the mature universe

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

$$K_A (t_o) = A K_o \exp(- \mu t_o) \quad , \quad \mu > 0 \qquad (9)$$

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

$$M_A = m_o A K_o T_A / (1 - \alpha) \qquad (10)$$

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

3.Relations between the masses ofwave matter and particle matter and antimatter in the mature universe

3.1Baryon symmetry

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

$$M_A/M_P = B\, T_A/T \qquad (11)$$

where,

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

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

$$M_A / T_A = M_P / T \qquad (13)$$

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

3.2 Antimatter annihilation

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

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

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

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

$$L = \ln A/\mu \qquad (15)$$

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

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

3. Interpretation

The results of Section 3 are ultimately a response to an unresolved problem of physics, made possible through the assumption that the universe is stress-free. In this model, the expansion of the universe occurs from a mass-free originunder net stress-free conditions. The simplest hypothesis is that the expansion is mediated by dark matter, which has a uniform density within the universe [6]. It is proposed that the emergent structure of the dark matter, which was shown in [6] and [7] to be the basis for wave and particle matter, is also the basis for antimatter (which was not considered in the earlier analysis) as is shown by the similar form of the decay relations (4) and (9). What distinguishes the evolution from dark matter,of ordinary matter andantimatter,is the absence of a growing mode for antimatter.

4.Conclusions

The exponential – stress model ,which was originally applied in [1] to consider the relation between particle mass and wave mass, has been used here to consider also the relation between particle mass and antimatter mass. The principal prediction isthat baryon symmetry occurs in which the rate of production of matter on the large scale is equal to the rate of production of antimatter on the small scale. The vastly different time scales in the two cases has led to the misconception of baryon asymmetry [5]. The good news is that this vast difference in time scale provides a mass rich,large scale universe, supported by a mass poor small scale universe, for our enjoyment,

REFERENCES

1. Bye JAT The origin of wave-particle duality. Intl. Astron and Astrophys. Res. J. 2023; 5(1): 71-74

2. Bye JAT The anti-gravitational force (F): The previously ignored gravitational partner.. Intl. Astron and Astrophys. Res. J. 2023; 6(1): 184-188

3. Anderson GK et al 2023Observations of the effect of gravity on the motion of antimatter. Nature 621 2023; 716 -722 https://dir.org/10.1038/s -41586-023-065 27-1

4. Steigman G. and R. Scherrer 2018Is the universal matter-antimatter asymmetry fine tuned ? Consolidation of Fine Tuning 1 -38 Cornell University.https://arxiv.org/pdf/1801.10059.pdf

5. Canetti L et al 2012 Matter and antimatter in the universe. New J. Phys. 14(2012) https://doi.org/10.48550/arXiv.1204.4186

6. Dark matter in the Planetary System Intl. Astron and Astrophys. Res. J. 20213(4): 31 – 38

7. One-dimensional Mass and the Sisterhood of Habitable PlanetsIntl. Astron and Astrophys. Res. J. 2022 4(2): 19 - 25