A Universe Comprised of 50% Matter Mass-Energy and 50% Dark Energy

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Abstract

The new C.G.S.I.S.A.H. theory of dark matter is used to appropriately classify and quantitate the previously-overlooked cold ground state neutral atomic hydrogen within the intergalactic vacuum. A surprising discovery is demonstrated in the Results section that approximately one-fifth of the cosmic critical density can be attributable to intergalactic cold ground state neutral atomic hydrogen. By subtracting this quantity of the critical density from the dark energy ledger column and adding it to the total matter mass-energy ledger column, our current universe appears to be equally proportioned between total matter mass-energy and dark energy. This has been a longstanding prediction of the Flat Space Cosmology model.

Keywords

Dark Matter, Dark Energy, CGSISAH Theory, Flat Space Cosmology, Dirac Sea, Intergalactic Medium, Interstellar Medium, ΛCDM Concordance Model

1. Introduction and Background

Before 1998, the energy density of the universe was believed to be wholly comprised of approximately 5% visible matter (*i.e.* the visible stars, warm molecular gas clouds and cosmic dust), an unknown quantity of dark matter within and haloed around the visible galaxies, and a comparatively negligible amount of radiation energy. Observations prior to 1998 consistent with current spatial flatness provided support for the idea that our universe is at, or nearly at, critical density. And yet there didn't seem, at the time, to be sufficient galactic and peri-galactic (*i.e.* virial) dark matter to account for this. However, since the 1998 discovery of dark energy, the balance of the previously missing critical density has been wholly ascribed to a mysterious energy within the intergalactic vacuum. As such, cosmological general relativity equations now incorporate a "cosmo-

logical constant" to represent this non-matter dark vacuum energy.

Furthermore, observations of galactic rotation [1], the Milky Way [2], and the cosmic microwave background (CMB) anisotropy appear to confirm that the galactic and peri-galactic dark matter mass is approximately 5 to $5\frac{1}{2}$ times the visible galactic matter mass. For instance, the Gaia-Hubble Collaboration reported in March 2019 that the Milky Way has a total virial mass of approximately 1.5 trillion MƟ and a visible matter mass of 250 billion MƟ, in support of a 5:1 dark matter to visible matter ratio. A recent consensus [3] is that the visible baryonic matter of the universe comprises 4.95%, the galactic and peri-galactic dark matter comprises 26.55%, and the dark vacuum energy comprises 68.5% of the critical density (ρ_c), now estimated to be 8.533×10^{-27} kg·m^{-3} (using the 2018 Planck Collaboration H_0 consensus value, 67.4 ± 0.5 km·s^{-1}·Mpc^{-1}).

One of the puzzling things about the current cosmological energy density partition of approximately one-third total matter mass-energy and approximately two-thirds dark vacuum energy is the fact that, at present, these energy densities are of the same order of magnitude! This appears to be an extraordinary coincidence, because the ΛCDM concordance model stipulates that the total matter mass-energy density must have been many orders of magnitude greater than the vacuum energy density in the early universe and will be many orders of magnitude smaller than the vacuum energy density in the future of the universal expansion. How then is it that we happen to be living at just the right time in the history of the universe that these energy densities are nearly equal? Or, are we wrong in assuming radically different energy density partitions in the remote past and the distant future? These and other questions arise concerning this unexpected coincidence, which is known among cosmologists as the "coincidence problem". As an aside, there is an interesting link between the coincidence problem and the cosmological constant problem, but that is beyond the scope of the current paper. In the history of progress in our understanding of the universe, unexplained coincidences have often been signposts leading to a deeper understanding.

One of the questions one might ask concerning the coincidence problem is whether there could be some systematic error in our quantitation of dark matter that, once corrected, could point to a 50%/50% energy density partition (*i.e.* 50% total matter mass-energy and 50% dark energy). This could be achieved, for instance, if approximately one-fifth of the critical energy density currently being classified as a component of the vacuum energy is actually hidden dark matter within the deep intergalactic vacuum. This has long been one of the predictions of the Flat Space Cosmology (FSC) $R_h = ct$ model [4] [5]. In fact, this model stipulates a perpetual 50%/50% energy density partition as a falsifiable prediction. This is in stark contrast to the approximately 31.5%/68.5% energy density partition now widely accepted, within tight constraints, and claimed by proponents of the ΛCDM concordance model (see [3]). Over the last 40 years, standard inflationary cosmology has been repeatedly subject to *ad hoc* adjustments from

new observations, and has made relatively few falsifiable predictions in comparison to the new FSC model [6].

Once-tight constraints, however, can sometimes be broken when new discoveries and/or theories arise. Prior to the discovery of dark energy, for instance, the very idea of a cosmological constant was thought to be highly improbable. A new case in point, as emphasized in this paper, has been the assumption that the dark matter within and haloed around the galaxies is all, or nearly all, of the discoverable dark matter within the universe.

There is now a new and very plausible theory of dark matter which should loosen the ΛCDM density partition constraints considerably. It is the purpose of this paper to show how the C.G.S.I.S.A.H. (Cold Ground State Inter Stellar Atomic Hydrogen) theory of dark matter [7] can be used to identify dark matter within the deep intergalactic vacuum which should be removed from the dark energy ledger column and placed under the total matter mass-energy ledger column.

2. Results

It has long been known that the intergalactic vacuum is exceedingly sparse with respect to matter. However, it is not entirely empty! Observational 21-cm studies of the cold ground state neutral atomic hydrogen within the intergalactic vacuum, of a similar nature to those made of the interstellar vacuum of the Milky Way, have determined an average density of approximately one atom per cubic meter [8]. Thus, the average cold ground state neutral atomic hydrogen density of the intergalactic vacuum is approximately 1.67×10^{-27} kg·m^{-3}. This is one million times less dense than that within the Milky Way galactic disc (1.67×10^{-21} kg·m^{-3}). Nevertheless, one can readily see that the following ratio equation is relevant to the purpose of this paper:

$$\left[\text{intergalactic } H \text{ density}\right]/\left[\rho_c\right] = \left[1.67 \times 10^{-27} \text{ kg} \cdot \text{m}^{-3}\right]/\left[8.533 \times 10^{-27} \text{ kg} \cdot \text{m}^{-3}\right] \quad (1)$$

which equals 0.195.

This is approximately one-fifth of the observed critical density!

3. Discussion

The ratio equation given in the Results section shows that the currently-observed average density of intergalactic cold ground state neutral atomic hydrogen is 19.5% of the critical density determined from the 2018 Planck Collaboration report (see [3]). This is a component of the cosmic total matter mass-energy and should not be considered as a component of the vacuum dark energy. By this calculation, one can readily see that 19.5% of the current critical density has been misappropriated by the ΛCDM concordance model as dark energy. In fact, in accordance with the new C.G.S.I.S.A.H. dark matter theory, it should be credited as intergalactic dark matter. Thus, by extending the C.G.S.I.S.A.H. dark matter concept to the intergalactic vacuum, a previously-ignored reservoir of additional dark

matter is discovered.

With correct re-apportionment of this additional dark matter to the total matter mass-energy, the cosmic critical energy density partition now becomes approximately 51% total matter mass-energy and 49% dark energy. The current negligible radiation energy contribution to the critical density does not affect the above approximations. Thus, the results of this new C.G.S.I.S.A.H. calculation may be considered to be well within the acceptable margin of observational error, and in support of the FSC prediction of 50%/50%. It should be remembered that there is no cosmological coincidence problem in the FSC model, which stipulates perpetual equality of the cosmological matter mass-energy and non-matter vacuum energy.

4. Summary and Conclusions

The new C.G.S.I.S.A.H. (Cold Ground State Inter Stellar Atomic Hydrogen) theory of dark matter is applied to the incredibly sparse cold ground state neutral atomic hydrogen within the intergalactic vacuum. Despite an average density of about one atom per cubic meter, this amounts to approximately one-fifth of the cosmic critical density! Thus, according to the new dark matter theory, the intergalactic vacuum contains an additional dark matter contribution to the total matter mass-energy ledger column which must be subtracted from the dark energy ledger column. Within the range of observational error, the resulting 51%/49% matter/dark energy partition of the critical density appears to strongly support the longstanding FSC prediction of 50%/50%. There is no cosmological coincidence problem in the FSC model.

Furthermore, this discovery of a universe comprised of 50% matter mass-energy and 50% dark energy suggests that the recent resurrection of the Dirac sea idea [9], as it may pertain to positive and negative energy eigenstates (rather than positive and negative mass eigenstates) within the FSC model, may be a guide to understanding matter and dark energy as the perpetual yin and yang of universal expansion. This is to be expected in a finite perpetual matter-generating cosmological model which begins from a zero-energy state and follows conservation of energy [10].

Dedications and Acknowledgements

This paper is dedicated to Dr. Stephen Hawking and Dr. Roger Penrose for their groundbreaking work on black holes and their possible application to cosmology. Dr. Tatum also thanks U.V.S. Seshavatharam for his co-authorship of the seminal papers of FSC, and Dr. Rudolph Schild of the Harvard-Smithsonian Center for Astrophysics for his past support and encouragement.

Conflicts of Interest

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

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