Review of: "Dark Energy as an intrinsic property of Matter"

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I do not recommend this paper, as the results presented do not appear to be of physical significance. It is well known that any spacetime geometry can be taken to be a solution of the Einstein Field Equations by choosing the appropriate source, but the choice here involves several arbitrary assumptions, and several erroneous or misleading assertions diminish the credibility of the proposed model.

The model here is based on an hypothetical form of matter/energy with equation of state p=-epsilon/3, where p is pressure, epsilon is energy density, and the speed of light is taken as c=1. (Strictly speaking, this would be a form of ``dark energy,'' given an equation of state unlike those of ordinary matter or radiation.) This is constructed from a combination of ``stiff matter,'' with equation of state p_m=epsilon_m, and ``space energy,'' with equation of state p_e=-epsilon_e. Evolving independently, the former would vary with the expansion of the scale factor a of a Friedmann-Robertson-Walker spacetime as epsilon_m~1/a^6, while the latter epsilon_e would stay constant (like a vacuum energy density). But these are held in strict proportion epsilon_m=epsilon_e/2 by an unspecified coupling which must continuously convert space energy to matter energy. The result is a combination with p=-epsilon/3. This varies as epsilon~1/a^2, corresponding to a flat ``potential'' in the Friedmann equation and an evolution a~t for a spatially flat (k=0) or hyperbolic (k=-1) FRW spacetime---the same as that of the empty Milne universe. This evolution does not correspond to that of the observed universe; it is obtained from the arbitrary choices made to specify the source matter/energy.

The ``Space Production Model (SPM)'' mass-energy source described here is based on several arbitrary assumptions. The coupling which enforces the condition epsilon_m=epsilon_e/2 is never described. The process of ``space emission'' which supposedly gives rise to the epsilon_e

component is based on no known physics. The "stiff matter" component is associated with the kinetic-energy term of a scalar field theory (although that would ordinarily be expected to behave like radiation, with energy density varying as 1/a^4 in FRW spacetime). The ``space energy'' component is associated with the scalar-field potential, and the theory is taken to yield the desired mass/energy properties. The SPM does not yield evolution of an FRW spacetime even remotely in accord with observation. It is suggested that the model might be successful in an inhomogeneous cosmology, though no example to support this is shown. Given enough arbitrary assumptions, any results can be obtained, but their significance is not clear.

This paper contains enough false or misleading assertions to confuse matters further. In the Introduction, it is stated that the contribution of dark matter in standard models could also be the effect of spatial curvature, moved to the source side of the Einstein Field Equations. But the contribution of spatial curvature would vary as 1/a^2, that of (cold) dark matter as 1/a^3, potentially yielding different expansion behavior. The basic notion of space emission or production here is at odds with Einsteinian understanding of space and spacetime. Cosmological expansion is not understood as a production or flow of space, as explained in detail, e.g., in Misner, Thorne, and Wheeler, ``Gravitation'' (Freeman 1973, reprinted by Princeton 2016), p.739. Maintaining the condition epsilon_m=epsilon_e/2 requires the conversion of otherwise constant space-energy density to otherwise decreasing matter density, not the other way around as stated following Eq. (22) here. And the assertion ``in an inhomogeneous setting there is acceleration…'' following Eq. (36) appears to contradict the assertion from which that equation is derived.

The ultimate result here, the derivation of a source with equation of state p=-epsilon/3 relies on various unclear or dubious assumptions and does not yield a realistic alternative cosmological model. It is the judgement of this reviewer that considerably more work needs to go into this to produce a reasonable contribution to the literature in the field of physical cosmology.