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A conventional form of dark energy

K Kleidis[1,2] **and N K Spyrou**[1]

[1]Department of Astronomy, Aristoteleion University of Thessaloniki, 541.24 Thessaloniki, Greece

[2]Department of Mechanical Engineering, Technological Education Institute of Serres, 621.24 Serres, Greece

E-mail: kleidis@astro.auth.gr & spyrou@astro.auth.gr

Abstract. Motivated by recent results, indicating that the dark matter (DM) constituents can be *collisional*, we assume that the DM itself possesses also some sort of *thermodynamical properties*. In this case, the Universe matter-content can be treated as a gravitating fluid of positive pressure, and, therefore, together with all the other physical characteristics, *the energy of this fluid's internal motions* should be taken into account as a source of the universal gravitational field. In principle, this form of energy can compensate, also, the *extra (dark) energy*, needed to compromise spatial flatness, while, the post-recombination Universe remains ever-decelerating. What is more interesting, is that, at the same time (i.e., in the context of the collisional-DM approach), the theoretical curve, representing the distance modulus as a function of the cosmological redshift, fits the *Hubble diagram* of an extended sample of SN Ia events quite accurately. However, as we demonstrate, this is not the case for someone who, although living in a Universe filled with collisional DM, insists in adopting the traditional, *collisionless-DM* approach. From the point of view of such an observer, the distant light-emitting sources seem to lie farther (i.e., they appear to be dimmer) than expected, while, the Universe appears to be either accelerating or decelerating, depending on the value of the cosmological redshift.

1. Introduction

The current cosmological picture includes two major unresolved issues: (i) According to the observational data on the temperature-variations of the cosmic microwave background, the Universe can be described, adequately, by a spatially-flat Robertson-Walker (RW) model (see, e.g., [1]) and, therefore, it must contain a considerably-larger amount of energy, than the equivalent to the total rest-mass density of its matter content does (see, e.g., [2]). (ii) The various cosmologically-distant indicators appear to be dimmer than expected [3], [4], something that has been accommodated in the context of a recent phase of accelerated expansion [5], [6].

In order to compromise the above-mentioned observational results within a unified theoretical framework, an extra, dark energy (DE) component, of negative pressure, has been introduced [7], [8]. Other physically-motivated models have also appeared in the literature, including alternative-gravity theories [9], [10], braneworld scenarios [11], [12], Chaplygin gas [13], Cardassian Cosmology [14], theories of compactified internal dimensions [15], mass-varying neutrinos [16], [17], etc. However, each and everyone of these attempts suffers from the so-called *coincidence problem*, i.e., why is the Universe transitioning from deceleration to acceleration so recently; the *inflection point* is being (observationally) set at the cosmological redshift $z_t = 0.46 \pm 0.13$ (see, e.g., [18] and references therein).