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ORIGINAL ARTICLE

Interacting new agegraphic dark energy in a cyclic universe

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Abstract The main goal of this work is investigation of NADE in the cyclic universe scenario. Since, cyclic universe is explained by a phantom phase ($\omega < -1$), it is shown when there is no interaction between matter and dark energy, ADE and NADE do not produce a phantom phase, then can not describe cyclic universe. Therefore, we study interacting models of ADE and NADE in the modified Friedmann equation. We find out that, in the high energy regime, which it is a necessary part of cyclic universe evolution, only NADE can describe this phantom phase era for cyclic universe. Considering deceleration parameter tells us that the universe has a deceleration phase after an acceleration phase, and NADE is able to produce a cyclic universe. Also it is found valuable to study generalized second law of thermodynamics. Since the loop quantum correction is taken account in high energy regime, it may not be suitable to use standard treatment of thermodynamics, so we turn our attention to the result of Li et al. (Adv. High Energy Phys. 2009: 905705, 2009), which the authors have studied thermodynamics in loop quantum gravity, and we show that which condition can satisfy generalized second law of thermodynamics.

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1 Introduction

Cosmological and astronomical observations such as supernovae type Ia observational data (Perlmutter et al. 1997; Reiss et al. 1998; de Bernardis et al. 2000) and Wilkonson Microwave Anisotropic Probe (WMAP) (Astier et al. 2006; Perlmutter et al. 1999; Peiris et al. 2003; Riess et al. 2007) imply that the universe is undergoing a period of accelerated expansion. Since normal matter can not give rise to accelerated expansion of the universe, Scientists came up with a solution which expresses that this expansion is a result of an ambiguous fluid named Dark Energy (Bridle et al. 2003; Koght et al. 2003).

The theoretical and experimental analysis suggest that the universe consist of 73% dark energy, 23% cold dark matter (CDM), and remnant matter is baryons (Fujii and Maeda 2003; Spergel et al. 2003). Unfortunately the nature and origin of dark energy are ambiguous up to now, but people have proposed some candidates to describe dark energy. Amongst the various candidates of dark energy to describe accelerated expansion of the universe, cosmological constant (vacuum energy), Λ, with equation of state (EoS) $\omega = -1$ is located in central position. However, as it is well known, the cosmological constant proposal has two famous problems, fine-tuning problem and the cosmic coincidence problem (Weinberg 1989; Steinhardt 1997; Carroll 2001; Peebles and Ratra 2003). Some other of dark energy models suggest that dark energy component can treat as scalar field with dynamical EoS. In this scenario the evolution of the field is very slow, so that kinetic energy density is less than the potential energy density, and this give us a negative pressure, responsible to the cosmic ac-