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ORIGINAL ARTICLE

Two-fluid scenario for dark energy models in an FRW universe-revisited

Bijan Saha · Hassan Amirhashchi · Anirudh Pradhan

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Abstract In this paper we study the evolution of the dark energy parameter within the scope of a spatially homogeneous and isotropic Friedmann-Robertson-Walker (FRW) model filled with barotropic fluid and dark energy by revisiting the recent results (Amirhashchi et al. in Chin. Phys. Lett. 28:039801, 2011a). To prevail the deterministic solution we select the scale factor $a(t) = \sqrt{t^n e^t}$ which generates a time-dependent deceleration parameter (DP), representing a model which generates a transition of the universe from the early decelerating phase to the recent accelerating phase. We consider the two cases of an interacting and non-interacting two-fluid (barotropic and dark energy) scenario and obtained general results. The cosmic jerk parameter in our derived model is also found to be in good agreement with the recent data of astrophysical observations under the suitable condition. The physical aspects of the models and the stability of the corresponding solutions are also discussed.

Keywords FRW universe · Dark energy · Two-fluid scenario

B. Saha
Laboratory of Information Technologies, Joint Institute for Nuclear Research, 141980 Dubna, Russia
e-mail: bijan@jinr.ru

H. Amirhashchi
Young Researchers Club, Mahshahr Branch, Islamic Azad University, Mahshahr, Iran
e-mail: h.amirhashchi@mahshahriau.ac.ir

A. Pradhan (✉)
Department of Mathematics, Hindu Post-graduate College, Zamania 232 331, Ghazipur, India
e-mail: pradhan.anirudh@gmail.com

1 Introduction

The use of Type Ia supernovae as standardized light sources—calibrated candles—led to the observational discovery of dark energy by two groups in 1998 (Riess et al. 1998; Perlmutter et al. 1999). Before the accelerated expansion of the universe was revealed by high red-shift supernovae Ia (SNe Ia) observations (Riess et al. 1998; Perlmutter et al. 1999), it could hardly be presumed that the main ingredients of the universe are dark sectors. The concept of dark energy was proposed for understanding this currently accelerating expansion of the universe, and then its existence was confirmed by several high precision observational experiments (Bennett et al. 2003; Spergel et al. 2003; Tegmark et al. 2004; Abazajian et al. 2004; Hawkins et al. 2003; Verde et al. 2002), especially the Wilkinson Microwave Anisotropy Probe (WMAP) satellite experiment. The WMAP shows that dark energy occupies about 73 % of the energy of the universe, and dark matter about 23 %. The usual baryon matter, which can be described by our known particle theory, occupies only about 4 % of the total energy of the universe. Measurements as of 2008, with the greatest weight coming from the combination of supernovae with either cosmic microwave background or baryon acoustic oscillation data, show that dark energy makes up 72 ± 3 % of the total energy density of the universe, and its equation of state averaged over the last 7 billion years is $\omega = 1.00 \pm 0.1$ (Kowalski et al. 2008). This is consistent with the simplest picture, the cosmological constant, but also with a great many scenarios of time varying dark energy or extended gravity theories. In order to explain why the cosmic acceleration happens, many theories have been proposed. Although theories of trying to modify Einstein equations constitute a big part of these attempt, the mainstream explanation for this problem, however, is known as