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ORIGINAL ARTICLE

Rip brane cosmology from 4d inhomogeneous dark fluid universe

I. Brevik · V.V. Obukhov · A.V. Timoshkin · Y. Rabochaya

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Abstract Specific dark energy models with linear inhomogeneous time-dependent equation of state, within the framework of 4d Friedman-Robertson-Walker (FRW) cosmology, are investigated. It is demonstrated that the choice of such 4d inhomogeneous fluid models may lead to a *brane* FRW cosmology without any explicit account of higher dimensions at all. Effectively, we thus obtain a brane dark energy universe without introducing the brane concept explicitly. Several examples of brane Rip cosmology arising from 4d inhomogeneous dark fluid models are given.

Keywords Rip brane cosmology · Cosmological singularities · Cosmological equation of state

1 Introduction

The discovery of the accelerating universe has led to the appearance of new ideas/solutions in cosmology (Riess et al. 1998; Perlmutter et al. 1999). This mysterious cosmic acceleration can be explained via the introduction of dark fluid (see Bamba et al. 2012a for recent review) or via modification of gravity itself (for review, see Nojiri and Odintsov 2006, 2011). According to astronomical observations dark energy currently accounts for some 73 % of the total mass/energy of the universe and only 27 % of a combination of dark matter and baryonic matter. Dark energy proposed to explain the cosmic acceleration should have the strong negative pressure and/or negative entropy.

The equation of state dark energy parameter is known to be negative:

$$w = \frac{p_D}{\rho_D} < 0, \tag{1}$$

where ρ_D is the dark energy and p_D is the dark pressure.

According the present observational data value being $w = -1.04^{+0.09}_{-0.10}$ (Nakamura et al. 2010). For a universe filled with phantom energy ($w < -1$ case) there are many possible new scenarios for the end of such universe. Phantom dark energy can lead to a Big Rip future singularity (Caldwell 2002; Caldwell et al. 2003; Nojiri et al. 2005; Nojiri and Odintsov 2003a, 2005; Capozziello et al. 2006; Faraoni 2002; Gonzalez-Diaz 2004; Elizalde et al. 2004; Singh et al. 2003; Csaki et al. 2005; Wu and Yu 2005; Nesseris and Perivolaropoulos 2004; Stefancic 2004; Chimento and Lazkoz 2003; Hao and Li 2005; Dabrowski and Stachowiak 2006; Godlowski and Szydlowski 2005; Sola and Stefancic 2005), where the scale factor becomes infinite at a finite time in the future. Another possible scenario is a sudden (Type II) singularity (Shtanov and Sahni 2002; Barrow 2004; Nojiri and Odintsov 2004; Cotsakis and Klaoudatou 2005; Dabrowski 2005); Fernandez-Jambrina and Lazkoz 2004, 2009; Cattoen and Visser 2005; Barrow and Tsagas 2005; Stefancic 2005; Tretyakov et al. 2006; Balcerzak and Dabrowski 2006; Sami et al. 2006; Yurov et al. 2008; Koivisto 2008), where the scale factor is finite at the Rip time (for general classification of finite-time future singularities see, Nojiri et al. 2005). However, a final evolution without singularities is also possible. It occurs in

I. Brevik (✉)
Department of Energy and Process Engineering, Norwegian University of Science and Technology, 7491 Trondheim, Norway
e-mail: iver.h.brevik@ntnu.no

V.V. Obukhov · A.V. Timoshkin
Tomsk State Pedagogical University, 634061 Tomsk, Russia

Y. Rabochaya
Eurasian National University, Astana, Kazakhstan