Astrophys Space Sci (2012) 338:333–336
DOI 10.1007/s10509-011-0935-z

ORIGINAL ARTICLE

LRS Bianchi type-II dark energy model in a scalar–tensor theory of gravitation

R.L. Naidu · B. Satyanarayana · D.R.K. Reddy

Received: 30 October 2011 / Accepted: 15 November 2011 / Published online: 3 December 2011

Abstract A locally rotationally symmetric Bianchi type-II (LRS B-II) space-time with variable equation of state (EoS) parameter and constant deceleration parameter have been investigated in the scalar-tensor theory proposed by Saez and Ballester (Phys. Lett. A 113:467, 1986). The scalar-tensor field equations have been solved by applying variation law for generalized Hubble's parameter given by Bermann (Nuovo Cimento 74:182, 1983). The physical and kinematical properties of the model are also discussed.

Keywords Scalar–tensor theory · LRS Bianchi type-II universe · Dark energy · Variable EoS parameter

1 Introduction

In recent years there has been a lot of interest in scalar-tensor theories of gravitation. Brans and Dicke (1961) formulated a scalar-tensor theory of gravitation which introduces an additional scalar field $\emptyset$ besides the metric tensor g_{ij} and a dimensionless coupling constant ω. This theory goes to general relativity for large values of the coupling constant $\omega > 500$. Saez and Ballester (1986) proposed a scalar-tensor theory of gravitation in which the metric is coupled with a dimensionless scalar-field in a simple manner. This coupling gives a satisfactory description of the weak fields. Inspite of the dimensionless character of the scalar field an antigravity regime appears in this theory. Also, this theory, suggests a possible way to solve missing matter problems in non-flat FRW cosmologies.

Supernova 1a data (Perlmutter et al. 1998; Riess et al. 1998) and the observations of anisotropies in the cosmic microwave background radiation and the large scale structure have confirmed the accelerated expansion of the universe (Bennett et al. 2003; Verde et al. 2002; Hawkins et al. 2003; Abazajian et al. 2004). Astrophysical observations indicate that this expansion of the universe is driven by an exotic energy with large negative pressure which is known as dark energy. Inspite of all the observational evidence dark energy is still a challenging problem in theoretical physics. The data indicates that the universe is spatially flat and is dominated by 76% dark energy 24% by other matter (20% dark matter and 4% other cosmic matter). Several models have been proposed such as quintessence (Sahni and Starobinsky 2000; Padmanabhan 2008), phantom field (Caldwell 2002; Nojiri and Odintsov 2003), tachyon field (Sen 2002; Padmanabhan 2002), interacting dark energy models, Chaplygin gas (Kamenshchik et al. 2001; Bento et al. 2002), holographic models (Wang 2005; Setare 2006) etc. However, none of these models can be regarded as being entirely convincing so far.

Dark energy has conventionally been characterized by the EoS parameter given by $\omega(t) = \frac{p}{\rho}$ which is not necessarily constant, where p is the fluid pressure ρ is energy density (Carroll and Hoffman 2003; Ray et al. 2010; Akarsu and Kilinc 2010a, 2010b; Yadav et al. 2011; Yadav and Yadav 2011; Pradhan and Amirhashchi 2011; Amirhashchi et al. 2011; Pradhan et al. 2010) are some of the authors who have investigated dark energy models with variable EoS parameter.

R.L. Naidu (✉) · B. Satyanarayana
Department of Basic Sciences and Humanities, GMR Institute of Technology, Rajam 532127, Andhra Pradesh, India
e-mail: lakshunnaidu.reddi@gmail.com

B. Satyanarayana
e-mail: satyam22us@gmail.com

D.R.K. Reddy
Department of Science and Humanities, M. V. G. R. College of Engineering, Vizainagaram, Andhra Pradesh, India
e-mail: reddy_einstein@yahoo.com