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LETTER

Does accelerating Universe permit varying speed of light?

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Abstract We investigate the possible variation of c in the context of the present accelerating Universe as discovered through SN Ia observations and show that variability of c is not permitted under the variable Λ models.

Keywords General relativity · Dark energy · Varying velocity of light

1 Introduction

Historically, the prominent inception of the idea of changing speed of light is due to Thomson and Tait (1874). Earlier Michell (1784) showed that a particular mass to radius ratio of a star implies that the escape velocity of the star would be equal to the speed of light. Contrary to Eddington (1946) a changing speed of light was also not unpleasant to Einstein (1911). However, in the 1930s, variation of c came in the picture through the alternative explanation of cosmological redshift (Stewart 1931; Buc 1932; Wold 1935).

Recently proposed varying speed of light (VSL) theories (Moffat 1993; Barrow and Magueijo 1998; Albrecht and Magueijo 1999; Magueijo 2000; Moffat 2002) consider the idea of phase transition to solve the horizon problem and other associated aspects of the Big Bang model. On the other hand, via the relation $\alpha = e^2/hc$ (where e is the charge of a proton and h is Planck's constant), variability of α implies variability of c provided constancy of e and h is assumed (Webb et al. 1999; Murphy et al. 2001). In dilaton theories also variation of c have been assumed by several investigators (Bekenstein 1982; Olive and Pospelov 2002; Sandvik et al. 2002).

Under this background, in this small note we have presented our analytical investigation of the possible variation of c in the context of the accelerating Universe (Perlmutter et al. 1998; Riess et al. 1998).

2 The field equations and their solutions

A major problem with the variation of light speed is the violation of energy-conservation law of special theory of relativity, viz. $E = mc^2$, where c being the velocity of light quanta photon in vacua is a constant. To avoid this problem the Einstein field equation

$$G_{ij} = \frac{8\pi G}{c^4} T_{ij} \tag{1}$$

can be written as (Farrell and Dunning-Davies 2007)

$$G_{ij} = \frac{8\pi G m}{c^2}, \tag{2}$$

by assuming the energy component of T_{ij} as mc^2. Therefore, for any departure from $\Omega \neq 1$, the speed of light and the curvature term will adjust themselves so as to make the Universe flat.

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