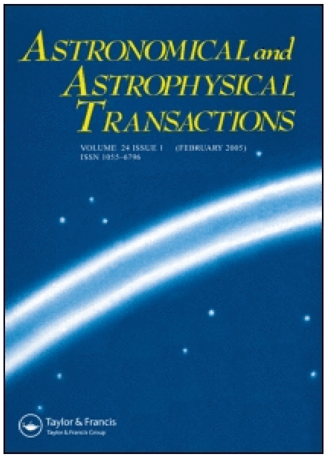

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ON DE SITTER DEFLATIONARY COSMOLOGY FROM THE SPIN-TORSION PRIMORDIAL FLUCTUATIONS AND COBE DATA

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Fluctuations on de Sitter metric solution of Einstein-Cartan field equations are obtained in terms of the matter and spin-torsion density fluctuations. A proof for the gravitational instability of the de Sitter metric in spaces with torsion from COBE data is obtained. In fact Einstein-de Sitter solution is shown to be unstable even in the absence of torsion.

KEY WORDS **Primordial density fluctuations, torsion, de Sitter cosmology**

Recently D. Palle (1999) computed the primordial matter density fluctuations from COBE satellite data. More recently I have extended Palle's work to include the dilaton fields (L. C. Garcia de Andrade (in press)). Also more recently I have considered a mixed inflation model with spin-driven inflation and inflaton fields (L. C. Garcia de Andrade (Los Alamos archives)) where the spin-torsion density has been obtained from the COBE data on temperature fluctuations. However in these last attempts no consideration was given to the spinning fluid and torsion was considered as just coming from the density of inflaton fields which of course could be considered as massless neutrinos. Earlier Maroto and Shapiro (1997) have discussed the de Sitter metric fluctuations and showed that in the case with dilatons and torsion the higher-order gravity the stability of de Sitter solutions depends on the parametrization and dimension, but that for the given dimension one can always choose parametrization in such a way that the solutions are unstable. In this letter we show that starting from the Einstein–Cartan equations as given in Gasperini for a four-dimension space-time with spin-torsion density, the de Sitter solutions are also unstable for large values of time. Of course one should recall that Maroto–Shapiro solutions do not possess spin but are based on a string type higher order gravity where torsion enters as in Ramond action. Let us start from the Gasperini

(1998) form of the Einstein–Cartan equations for the spin-torsion density

$$H^2 = \frac{8\pi G}{3}(\rho - 2\pi G\sigma^2) \tag{1}$$

and

$$\dot{H} + H^2 = -\frac{4\pi G}{3}(\rho + 3p - 8\pi G\sigma^2), \tag{2}$$

where $\dot{a}/a = H(t)$, where $H(t)$ is the Hubble parameter. Following the linear perturbation method in cosmological models as described in Peebles (1993) we have

$$H(t,r) = H(t)[1 + \alpha(r,t)], \tag{3}$$

where $\alpha = \delta H/H$ is the de Sitter metric density fluctuations where the Friedmann metric reads

$$ds^2 = dt^2 - a^2(dx^2 + dy^2 + dz^2). \tag{4}$$

Also the matter density is given by

$$\rho(r,t) = \rho(t)[1 + \beta(r,t)] \tag{5}$$

and

$$\sigma(r,t) = \sigma(t)[1 + \gamma(r,t)], \tag{6}$$

where $\beta = \delta\rho/\rho$ is the matter density fluctuation which is approximately 10^{-5} as given by COBE data and $\gamma(r,t) = \delta\sigma/\sigma$, where σ is the spin-torsion density. Substitution of these equations into the Gasperini–Einstein–Cartan equations above in the simple case where the pressure p vanishes (dust) we obtain

$$\dot{\alpha} = \frac{\dot{H}}{H} + \frac{8\pi G}{3H}[\rho\beta - 16\pi G\sigma\gamma]. \tag{7}$$

This last equation can be integrated to

$$\alpha = 1 + \ln H + 8\pi G\left[\int \frac{\rho\beta\, dt}{H} - 16\pi G \int \frac{\sigma\gamma\, dt}{H}\right]. \tag{8}$$

When the variation of mass density and spin density are small with respect to time they can be taken as approximately constant and we are able to perform the integration for de Sitter metric ($H = H_0 = \text{constant}$) as

$$\alpha = 1 + \ln H_0 + \frac{8\pi G}{3H_0}t[\rho_0\beta - 16\pi G\sigma_0\gamma] \tag{9}$$

which shows clearly that the de Sitter solution to Einstein–Cartan equations is unstable and can be computed in terms of the matter and spin-torsion densities. Let us now compute the spin-torsion fluctuation from expressions (1) and (2). In the case of a pressureless de Sitter phase of the universe ($p = 0$) one may equate equations (1) and (2) to obtain

$$\rho = \frac{5\pi G}{3}(\sigma^2). \tag{10}$$

By considering now a radius where the spin and matter density are distinct from one another and since the model is homogeneous and isotropic we may write

$$\rho' = \frac{5\pi G}{3}(\sigma'^2) \tag{11}$$

and performing the matter density fluctuations with these equations one obtains

$$\frac{\delta\rho}{\rho} = \frac{\sigma'^2 - \sigma^2}{\sigma^2} = \frac{(\sigma' - \sigma)(\sigma' + \sigma)}{\sigma^2} \tag{12}$$

For spin densities closer to one another a simple expression for the spin-torsion density fluctuations may be obtained as

$$\frac{\delta\rho}{\rho} = 2\frac{\delta\sigma}{\sigma}. \tag{13}$$

Thus from the COBE data it is possible to obtain a numerical estimate for the spin-torsion fluctuation as

$$\frac{\delta\sigma}{\sigma} = 10^{-5}. \tag{14}$$

Indeed the general result for $\sigma' \gg \sigma$ is given by

$$\frac{\delta\sigma}{\sigma} = 10^{-5}\frac{\sigma}{\sigma'} \tag{15}$$

and since $\sigma/\sigma' \ll 1$ one may infer that the spin-torsion density fluctuation is much weaker than the matter density fluctuation. The results presented here may motivate some experimental cosmologists to imagine experiments to measure spin-torsion densities in the Universe such as done for COBE. One may also note that rewritting expression (2) as

$$\left(\frac{\ddot{a}}{a} < 0\right) = \frac{\dot{a}^2}{a} - \frac{4\pi G}{3}(\rho - 8\pi G\sigma^2). \tag{16}$$

Therefore in the deflationary case one notes that $\rho > 8\pi G\sigma^2$ and therefore spin-torsion density fluctuations allows a deflationary phase. Oscillatory Bianchi IX type Einstein–Cartan cosmological models are also possible and have been recently put forward in the literature (Garsia de Andrade, 2000).

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