

**A new cosmological model including inflation, deceleration,  
acceleration and deceleration again**

**P. V. N. M. C. Perera\* and K. D. W. J. Katugampala**

*Department of Mathematics, Faculty of Science,  
University of Kelaniya, Sri Lanka  
Email: niroshmperera@gmail.com*

Since Perlmutter and Riess (1997; 1998) observed that the Universe expands with an acceleration, many models involving dark energy have been proposed to explain this phenomenon. A family of cosmological models with both acceleration and deceleration are presented in this research.

Einstein's Field Equations in General Relativity is written in the form,

$$R^{\mu\nu} - \frac{1}{2}\bar{R}g^{\mu\nu} = kT^{\mu\nu} - \Lambda g^{\mu\nu}$$

Here  $\Lambda$  is cosmological constant. The Einstein's Field Equations are modified.  $\Lambda$  is considered as a variable of cosmic time. The assumptions of a homogeneous and isotropic universe based on the Mach's principal are made. The Robertson-Walker metric in spherical polar coordinates are started. The Christoffel symbols were found to define the Ricci tensor, the curvature scalar and the energy-momentum tensor using the Robertson-Walker metric. Using the Robertson-Walker metric and Energy momentum tensor are solved modified Einstein's Field Equations for scalar factor  $R(t)$  which is called "radius of the universe".

The solution is introduced in the following form, so that it shows the inflation at the beginning.

$$R = b\sqrt{(1 - \cos^3 \omega t)}$$

A solution is assumed for the universe which results in inflation, deceleration, acceleration and deceleration again. The age of the universe is estimated to be 13.7 billion years. Taking the present value of the cosmic time  $t$  as 13.7 billion years the density of the inflationary Universe is found as  $2.0211 \times 10^{-31} gcm^{-3}$  and deceleration of the Universe as  $9.1822 \times 10^5 cms^{-2}$  which are in agreement with the observations.

The redshift of light from extragalactic sources, which arise from the Robertson-Walker metric was discussed. This redshift is a measure of the expansion of the universe in a given period of time. The redshift is the ratio of the value of the scalar factor of the universe at present epoch to that at the epoch of emission of light from the extragalactic sources which is observed at present. The scalar factor is increasing with time  $t$  at present. However there could be epochs where the scalar factor is decreasing.

**Keywords:** Acceleration, Deceleration, Inflation