Cosmological Models with EoS Parameter and Particle Creation

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In 1998 studying the distant Type Ia Supernovae (SNe Ia) it was found that our Universe is expanding with acceleration. Further observations of distant Supernovae (SNe Ia), fluctuation of cosmic microwave background radiation (CMBR), large scale structure (LSS), Sloan Digital Sky Survey (SDSS), WMAP and Chandra X-ray observatory by means of ground and altitudinal experiments confirmed that 1998 findings. Theoretical study shows that such an accelerative mode of expansion can take place only if the Universe contains repulsive force. The measurement of photometric distances to the cosmological Supernova, supported by a number of independent arguments, in particular by the observational data on the angular temporal fluctuations of CMBR shows that the lion share of the energy density of matter belongs to non-baryonic matter. This form of matter cannot be detected in laboratory and does not interact with electromagnetic radiation. This form of matter is known as dark energy which has a positive enegy density and strong negative pressure. Given the fact that almost three fourth of energy density of the Universe originated from dark energy and plays crucial role in the accelerated mode of expansion of the Universe. There appears a large number of models capable of describing this dark energy.

In a series of works we study the evolution of the dark energy parameter within the framework of a FRW and Bianchi cosmological model filled with dark energy or two fluids [1, 2, 3, 4, 5, 6, 7]. In doing so we consider both interacting and non-interacting cases.

In [1] we study the evolution of the dark energy parameter within the scope of a spatially flat and isotropic FRW model filled with barotropic fluid and dark energy. To get the deterministic solution we choose the scale factor $a(t) = \sqrt{t^n e^t}$ which yields a time dependent deceleration parameter (DP). Here we consider the case minimally coupled with dark energy to the perfect fluid as well as direct interaction with it.

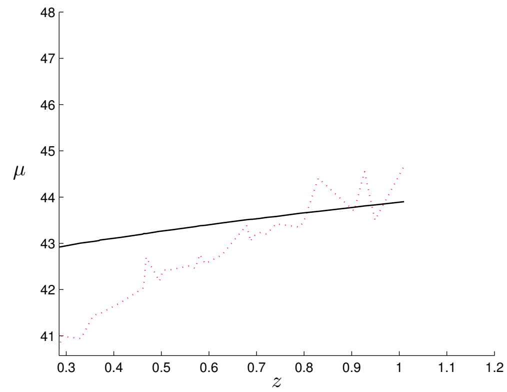
In [2] we study the spatially homogeneous and anisotropic locally rotationally symmetric (LRS) Bianchi type I cosmological model with dominance of dark energy. Assuming that the shear scalar in the model is proportional to expansion scalar we found that the anisotropic distribution of dark energy leads to the present accelerated expansion of Universe. The physical behavior of the Universe has been discussed in detail.

The comparison between the derived model and SNLS type Ia supernovae data can be seen in Fig. 1. The dotted line represents the observed distance modulus by SNLS type Ia supernovae data where as solid line represents the analyzed distance modulus μ of the derived model. It is observed that the derived model is best fit with high redshift values.

In [3] within the scope of spatially homogeneous and anisotropic locally rotationally symmetric (LRS) Bianchi type II cosmological model we study the dark energy model with variable deceleration parameter (DP) q and EoS parameter ω representing a model which generates a transition of universe from early decelerating phase to present accelerating phase. The Einstein's field equations have been solved exactly by taking into account the proportionality relation between one of the components of shear scalar and expansion scalar. The Hubble's parameter (H) and distance modulus (μ) in our descended model are found to be good concordance with recent data of astrophysical observations under appropriate condition [Fig. 2]. The physical and geometrical behavior of universe have been discussed in detail.

In [4, 5] we have studied the evolution of the Universe within the scope of Bianchi type V and VI models. Using the proportionality relation between the shear scalar with the expansion scalar exact solutions to the corresponding Einstein equations were found. In both cases the DP and EoS parameter are time varying. It is shown that if the energy momentum tensor is considered to have only diagonal components, the non-diagonal components of the Einstein tensor that occur in both BV and BVI cases, impose some restrictions on the components of energy momentum tensor.

In [6, 7] Bianchi type-I cosmological model with time dependent gravitational and cosmological constants is studied using two alternative approaches. It is found that for empty universe, the derived model is accelerating whereas for radiation domi-



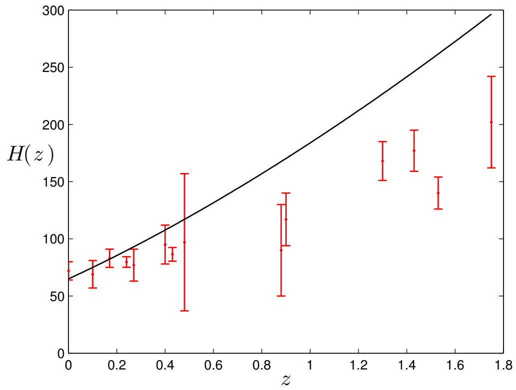


Figure 1: Distance modulus as a function of the redshift to the derived model compared with SNLS type Ia supernovae data from Astier et al. (2006)

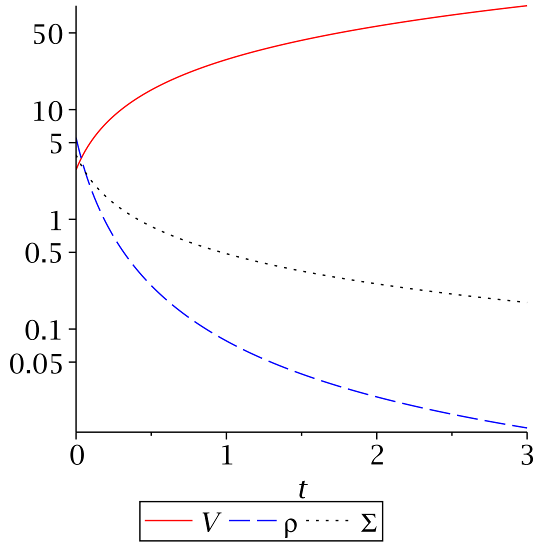
Figure 2: Hubble's parameter ($H(z)$) as function of redshift (z) to the derived model compared with observational $H(z)$ data from Coa et al. The observational 14 $H(z)$ data points are shown with error bars (red line) and the solid line (black colour) corresponds to Hubble's parameter of derived model.

nated and stiff fluid universes, we obtain models that depict a transition of the universe from the early decelerated phase to the recent accelerating phase.

In [8] we have studied the Bianchi type-VI model within the scope of a scale covariant theory of gravitation. Exact solutions to the corresponding field equations are found under some specific assumptions.

In [9] a spatially homogeneous and anisotropic Bianchi type V model filled with an imperfect fluid with bulk viscosity and particle creation, is investigated within the framework of General Relativity. Particle creation and bulk viscosity have been considered as separate irreversible processes. Exact solutions of the field equations are obtained by applying a special law of variation of Hubble parameter. Using this assumption, we obtain two types of cosmological models.

In [10] Bianchi type-I string cosmological model is studied in presence of a magnetic flux. Exact solutions to the Einstein field equations are obtained. Further quantum effects of this model is studied within the scope of loop quantum cosmology. The corresponding results are compared.



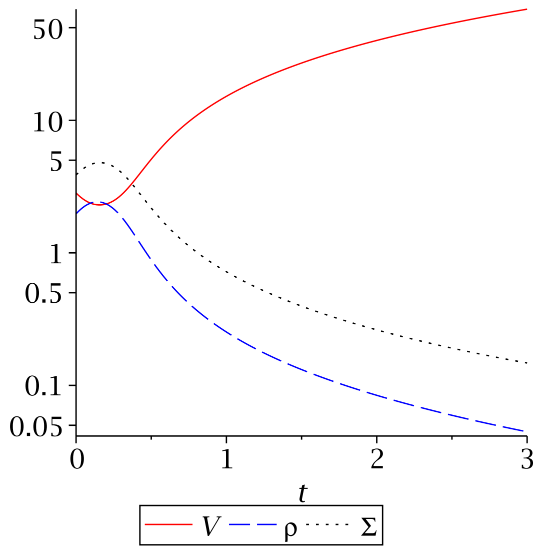


Figure 3: Classical evolution of volume scale V, energy density ρ and shear Σ

Figure 4: Evolution of volume scale V, energy density ρ and shear Σ withon LQC frame

In [11] within the scope of anisotropic non-diagonal Bianchi type-II, VIII and IX spacetime it is shown that the off-diagonal components of the corresponding metric impose severe restrictions on the components of the energy momentum tensor in general. It is shown that if the energy momentum tensor is considered to be the diagonal, and $f = f(z)$, all the cosmological models in question are locally rotationally symmetric and matter distribution is isotropic.

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