URSI AP-RASC 2019, New Delhi, India, 09 - 15 March 2019

Reconstruction of Extended Holographic Ricci Dark Energy in Presence of Bulk Viscosity and to View the Thermodynamic Consequences

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The two independent studies by Riess et al.[1] and Perlmutter et al [2] of high-redshift supernovae search team and supernovae cosmology project team reported the current universe is expanding with acceleration. Subsequent observational studies that include large-scale structure (LSS) and the cosmic microwave background (CMB) have further supported the accelerated expansion. In order to have thids expansion, one requires an exotic matter characterized by negative pressure and hence negative equation of state (EoS) parameter. The exotic matter with negative EoS parameter w is termed as dark energy (DE). For accelerated expansion, we need w<-1/3. Although the cosmological constant is the simplest candidate for DE with w=-1, different time varying models of DE have been proposed in the literature till date. In the present work, a variation of holographic dark energy has been considered in the presence of bulk viscosity and results have been compared with the observational data from SNLS3, BAO and Planck + WMAP9 + WiggleZ measurements.

The present work reports a study of the extended holographic Ricci dark energy (EHRDE) under the influence of bulk viscosity. Considering a coexistence of viscous EHRDE and viscous barotropic fluid with EoS, we have reconstructed Hubble parameter H. It is observed that the reconstructed Hubble exhibits a decreasing pattern with evolution of the universe for the early phases. However, an increasing pattern is apparent in a later stage. Moreover, values of the reconstructed H are found to be consistent with observational results. Also, it has been observed that under this reconstruction scheme, the EoS parameter exhibits a transition from quintessence to phantom and hence the reconstructed viscous EHRDE can be classified as "quintom". It may be noted that the viscous EHRDE has been considered in the framework of standard Eckart theory. It has been observed from the study that the current value of the EoS parameter for viscous EHRDE is found to favor the ΛCDM model and the EoS parameter for the current model is consistent with results obtained through observational data sets from SNLS3, BAO and Planck + WMAP9 + WiggleZ measurements. We have also studied the statefinder trajectories and the trajectories have been found they pass through today's point (z=0) and subsequently, in a later stage, they converge to the ΛCDM point. From this observation, it may be interpreted that although ΛCDM is favoured by the EoS parameter, the current model can be discriminated from ΛCDM point through statefinder parameters. It has also been interpreted that the non-equilibrium bulk viscous pressure is significantly smaller than the local equilibrium pressure.

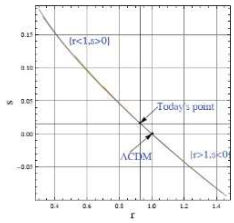

Fig.1. Statefinder trajectory

We have also studied the matter density perturbation δ and the growth function f for the current model. It has been observed that the growth function is consistent with the existing literature. Finally, we have considered the GSL of thermodynamics with the event horizon as the enveloping horizon of the universe. Under the assumption thermal equilibrium the time derivative of total entropy is found to be non-negative throughout the evolution of the universe and hence the GSL is found valid for EHRDE under the influence of bulk viscosity.

1. A. G. Riess et al., Astron. J. 116, 1009 (1998).
2. S. Perlmutter et al., Astrophys. J. 517, 565 (1999)..

Financial support from CSIR under EMR II Scheme with Grant Number 03(1420)/18/EMR-II is thankfully acknowledged.