CHRIST
(DEEMED TO BE UNIVERSITY)
BANGALORE · INDIA

Notice for the PhD Viva Voce Examination

Mr Kenath Arun (Reg. No. 1540076), PhD scholar at CHRIST (Deemed to be University), will defend his PhD thesis at the public viva voce examination on Wednesday, 15 July 2020 at 4.00 pm. The defense will be conducted online on the Webex Meeting platform.

Title of the Thesis	:	**Studies on Dark Matter, Dark Energy and Possible Alternate Models**
Discipline	:	**Physics**
External Examiner (Outside Karnataka)	:	**Dr Patrick Das Gupta** Professor Department of Physics and Astrophysics University of Delhi Delhi - 110007
External Examiner (Within Karnataka)	:	**Dr Rajeev Kumar Jain** Associate Professor Department of Astronomy and Astrophysics Indian Institute of Science Bengaluru - 560012
Supervisor	:	**Dr Shivappa B Gudennavar** Professor Department of Physics and Electronics CHRIST (Deemed to be University) Bengaluru – 560029
Co Supervisor	:	**Dr C Sivaram** Senior Professor Indian Institute of Astrophysics Bengaluru – 560034

Since it is an open viva, faculty members and research scholars from all the disciplines of research are cordially invited to attend.

Registrar

Place: Bengaluru
Date: 10 July 2020

ABSTRACT

The nature of dark matter (DM) and dark energy (DE) which is supposed to constitute about 95% of the energy density of the universe is still a mystery. There is no shortage of ideas regarding the nature of both. While some candidates for DM are clearly ruled out, there is still a plethora of viable particles that fit the bill. In the context of DE, while current observations favour a cosmological constant picture, there are other competing models which may be equally likely.

The standard model for the formation of structure assumes that there existed small fluctuations in the early universe that grew due to gravitational instability. The origin of these fluctuations are still unclear. In this study, we proposed the role of dark matter in providing the seed for star formation in the early universe, which is supported by very recent observations. With this we set observable constraints on luminosities, temperatures, and lifetimes of the early stars with an admixture of dark matter.

We also studied the effects of the background repulsive dark energy density for large scale cosmic structures. The relation, $M/R^2 \approx 1 g/cm^2$, seems to hold true for primeval galaxies as well as those at present epoch. From this, we set constraints on the nature and evolution of dark energy. Besides, we also set constraints on the size of galaxy clusters and superclusters due to the repulsive cosmological dark energy. This could indicate as to why large scale cosmic structures much larger than ~200 Mpc are not seen.

This study also looked at the evolution of the concept of the cosmological constant from its inception – a little over a hundred years ago when Einstein introduced the 'cosmological constant' in his General Theory of Relativity in order to obtain a static universe to conform to the philosophical view of the universe at that time – to it possibly making up close to about 70% of the energy density of the universe.

The present work also explored the possibility that a change of behaviour of missing energy density (from DM to DE) as determined by the change in equation of state (EoS) of a background fluid rather than a form of potential (for example a quintessence potential) could avoid fine-tuning problems (inherent in shallow potentials, almost massless fields, radiative corrections, etc.), while at the same time also account for both DM and DE.

In the view of negative results from all the ongoing experiments to detect DM, we have considered alternate theories to account for the indirect observations that support DM. We studied the possible alternatives to both DM and DE (such as MOND and modifications of general relativity) and possible means of observationally distinguishing between the alternatives.

Keywords: *Cosmology; dark matter; dark energy; alternate models to DM and DE; modified gravity; early Universe.*