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Notice for the PhD Viva Voce Examination

Mr Kiren O V (Registration Number: 2071211), PhD scholar at the Department of Physics and Electronics, School of Sciences, CHRIST (Deemed to be University), Bangalore will defend his PhD thesis at the public viva-voce examination on Friday, 27 June 2025 at 10.00 am in Room No. 044, Ground Floor, R & D Block, CHRIST (Deemed to be University), Bengaluru – 560029, Karnataka, India

Title of the Thesis	:	**Studies on Dark Matter Planets**
Discipline	:	**Physics**
External Examiner - I	:	**Dr P K Sahoo** Professor Department of Mathematics BITS - Pilani, Hyderabad Campus Secunderabad Telangana - 500078
External Examiner - II	:	**Titus K Mathew** Professor Department of Physics Cochin University of Science and Technology Cochin University Post Kochi - 682022 Kerala
Supervisor	:	**Dr Kenath Arun** Associate Professor Department of Physics and Electronics School of Sciences CHRIST (Deemed to be University) Bengaluru - 560029 Karnataka
Co-Supervisor	:	**Dr C Sivaram** Senior Professor (Former) Indian Institute of Astrophysics Koramangala Bengaluru -560034 Karnataka

The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva-voce examination.

Registrar (Academics)

Place: Bengaluru
Date: 24 June 2025

ABSTRACT

One of the fundamental components of the universe is dark matter (DM), which is five times more prevalent than ordinary matter. DM particles originate from the very early universe; they may have decayed or annihilated, and we observe today the particles that have survived until now. Dark matter's presence is supported by several astronomical measurements, which has prompted global experiments (such as the XENON1T project, LUXZEPLIN (LZ) experiment, Axion Dark Matter Experiment (ADMX) to name a few) to examine DM particles directly. So far, DM's interaction with ordinary matter has been so minimal (dark matter does not engage with baryonic matter or radiation except via gravitational forces) that it has evaded direct detection. Growth in structures is a significant argument in favor of the existence of DM. The cosmos consists of an immense quantity of galaxies and an intricate web of DM, resulting in a remarkable array of structures that have evolved over billions of years. The universe exhibits two distinct ways of structure formation: the top-down and bottom-up approaches. The top-down approach to structure development proposes that immense, supermassive entities first define the universe. According to the bottom-up model, the universe originated from a mostly uniform arrangement of matter, with minor variations in density.

The emergence of all structures is attributed to these minute variations, referred to as density perturbations. Observations suggest the structure formation as a bottom-up scenario, i.e., the lightest objects would have formed first, with the minor structures collapsing, followed by galaxies and galaxy clusters. Thus, the earliest structures to form could have been primordial planets. Furthermore, arguments suggest that primordial free-floating planets made of solid hydrogen could explain the whole of the 'missing baryons' in the universe. This was prompted by the recent discovery of many planets around old and metal-poor stars, believed to have originated during the early stages of the star's existence. These planets may have originated during early epochs. Here, we propose forming such primordial planets at high redshifts composed predominantly of DM particles. The masses of these objects vary from that of an asteroid to that of Neptune. The flux of DM particles could be significantly reduced as many DM particles are now trapped in such objects, perhaps accounting for the negative results seen so far in the ongoing DM detection experiments. We are looking at the process of evolution of these planets as the universe expands and at the different ways we can detect these planets. Another possibility for the problem of missing baryons in the universe could be that these baryons are mixed with DM particles inside the primordial planets. There are other possibilities of DM particles admixed with baryonic matter to form such objects. As baryonic matter rises, DM and baryonic particles will increase the planet's mass. As the proportion of baryonic matter to DM particles increases, the mass of a planet has the potential to exceed that of Jupiter. Their evolution is also discussed in detail. We also discuss the origin of black holes and galaxies during the universe's early stages. This provides evidence that structure building occurs from smaller components to larger ones.

Keywords: Dark matter, planet nine, admixture, DM planets

Publications:

1. **Kiren, O.V.**, Arun, K., and Sivaram, C. (2021). Evolution of primordial dark matter planets in the early universe. Advances in Space Research, 68(4), 2050. https://doi.org/10.1016/j.asr.2021.04.016.
2. **Kiren, O.V.**, Arun, K., and Sivaram, C. (2023). Primordial Planets with an Admixture of Dark Matter Particles and Baryonic Matter. Universe, 9(9), 401. https://doi.org/10.3390/universe9090401.
3. **Kiren, O.V.**, Sivaram, C., and Arun, K. (2024). Is Asteroid 33 Polyhymnia a Dark Matter (DM) Degenerate Object? The European Physical Journal Plus, 139, 547. https://doi.org/10.1140/epjp/s13360-024-05174-3.