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Beyond Einstein: Unravelling cosmic phenomena in modified gravity

Dr Chevarra Hansraj (Stellenbosch University)

DATE: Monday, 11 August 2025 | 16h00–17h00 SAST

VENUES:

- **Stellenbosch University:** Neelsie Cinema
- **University of the Witwatersrand:** Room P215, 2nd Floor, Physics Building
- **North-West University:** Seminar room K310, Physics building G5
- **Online**

--- A recording of the talk will be published on the NITheCS YouTube channel afterwards ---

ABSTRACT

Einstein's theory of general relativity (GR) is the most widely accepted theory of gravity. While it has passed many tests, a critical shortcoming is its inability to explain the observationally confirmed accelerated expansion of the Universe without referencing dark matter or including the cosmological constant. This necessitates extensions to the theory, leading to modified gravity theories like the Einstein-Gauss-Bonnet (EGB) framework. In this talk, I will provide an overview and substantiation of the theory. Then I will explore two critical features of modified gravitational systems: curvature singularities and mass gaps. Investigations into these features are central to our understanding of the structure and stability of compact objects in higher-dimensional gravity settings and for comparisons to classical GR. We first look at N -dimensional cosmology within the perfect fluid EGB framework, investigating the nature of singularities and the evolution of the Universe under nonstandard conditions. Using a transformation, we show that no curvature singularity is possible. Further, we provide a geometrical explanation for the mass gap phenomenon in 5D EGB black holes via spacetime decomposition. We show in the case of self-similar radiation collapse, the central singularity is not a sink for timelike geodesics and is extendable. These studies clearly demonstrate how the Gauss-Bonnet invariant affects the nature of the final state of collapse in this modified theory.

BIOGRAPHY

Dr Chevarra Hansraj is a lecturer in the Applied Mathematics Division at Stellenbosch University. She obtained her PhD in Applied Mathematics in 2022 from the University of KwaZulu-Natal and joined Stellenbosch University in January 2025. She was the proud recipient of an Oppenheimer Memorial Trust fellowship and the S2A3 medal for her research efforts in relativistic astrophysics. She is passionate about teaching, research and sharing her love for mathematics.



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