CoE-MaSS weekly seminar series

THE DST-NRF CENTRE OF EXCELLENCE IN MATHEMATICAL AND STATISTICAL SCIENCES (CoE-MaSS) PRESENTS A SEMINAR BY

Dr Sudan Hansraj

(University of Kwa-Zulu Natal)

"Higher curvature extensions of Einstein's theory"

Friday, 20 Oct 2017

10h30-11h30

Broadcast live from:
Videoconferencing Facility, 1st Floor
T.W. Kambule Mathematical Sciences Building, Wits West Campus

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Title:

Higher curvature extensions of Einstein's theory

Presenter:
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Abstract:
Einstein's general theory of relativity has been referred to by some as the most profound achievement of human thought. Einstein's field equations express an equivalence between geometry and physics in such a way that gravity is understood as an effect of spacetime curvature. Currently the classical theory still ranks amongst the most accurate theories of the gravitational field, being corroborated by numerous tests. However, it does have drawbacks. One major shortcoming is the failure of general relativity to explain the observed accelerated expansion of the universe. To overcome this Einstein himself modified the field equations to include a cosmological constant. Another attempt to correct the anomaly is to conjecture the existence of exotic matter fields such as dark energy and dark matter. A different approach is to revisit the geometry. This is the direction we are pursuing. We examine the Lovelock polynomial Lagrangian and its second order special case the Gauss—Bonnet action which is quadratic in the Riemann tensor, Ricci tensor and Ricci scalar. Remarkably, the equations of motion governing the gravitational field turn out to involve derivatives of at most second order despite the complexity of the action. A complicated system of coupled nonlinear partial differential equations emerges. To first order the Lovelock polynomial corresponds to the Einstein-Hilbert action and to zeroth order the cosmological constant is regained. We endeavour to solve the field equations using methods that have been attempted for the Einstein equations. Once an exact solution is found the complete model may be realised. We then examine the effect of the higher curvature terms in relation to the standard Einstein results. Introducing electrodynamics involves the supplementing the field equations with the Maxwell's equations and the extra degree of freedom allows for large classes of solutions to be found. However, it is not sufficient to merely find a solution – the solution generates a model which must meet stringent constraints.