Abstract submitted for 64th Annual Meeting of the Australian Mathematical Society

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Title: Spherical Monofractal and Multifractal Random Fields with Cosmological Applications
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Session: Probability Theory and Stochastic Processes

In this talk, we discuss multifractal behaviour of spherical random fields and applications to Cosmic Microwave Background (CMB) radiation data.
The main stochastic model which is used to describe the CMB data is isotropic spherical Gaussian fields. The Rényi function is one of the main tools in the analysis of multifractal random fields. For random fields on the sphere, there are only three models in the literature where the Rényi function is known explicitly. They are log-normal model, log-gamma model, and log-negative-inverse-gamma model [1]. In this presentation, we discuss some new models and approaches where the Rényi function can be computed and analysed explicitly. We show how to check moment conditions on the mother random field to guarantee the convergence of stochastic measures and specific forms of Rényi functions. For all considered random fields explicit expressions of their multifractal spectrum were obtained, see [2].
The considered mathematical models were motivated by investigations of CMB which is the radiation from the universe since 380,000 years from the Big Bang. We use data from the space mission Planck by the European Space Agency. One of the aims of this mission was to verify the standard model of cosmology using a very detailed resolution of observations and to find out fluctuations from this model. We present numerical multifractality studies and methodology for computing the Rényi function and the multifractal spectrum of the CMB data.
The obtained results can also find numerous potential applications for stochastic modelling and analysis of other geoscience, environmental and directional data.
The talk is based on joint results [2] with Professors Nikolai Leonenko (Cardiff University, UK) and Andriy Olenko (La Trobe University, Australia).

Keywords: Rényi Function, Random Field, Multifractality, Monofractality, Cosmic Microwave Background Radiation

References

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2. Leonenko, N., Nanayakkara, R., & Olenko, A. (2020). Analysis of Spherical Monofractal and Multifractal Random Fields. Stochastic Environmental Research and Risk Assessment Journal. https://doi.org/10.1007/s00477-020-01911-z