

TITLE: Generative mechanisms for systems displaying discrete scale invariance

Supervisors and coaches: Corneel Casert, Tom Vieijra, Jan Ryckebusch

Research group: [Theoretical Nuclear Physics and Statistical Physics](#)

General Context



Scientific observations or systems displaying discrete scale invariance (DSI) obey a weaker form of scale invariance: the invariance of the studied property is valid for a certain scaling factor λ_0 and for powers of it. Matroesjka puppets are prototypical examples of DSI systems displaying geometrical invariance under the operation of a well-defined scaling factor. DSI is often reflected in the occurrence of distributions with a

power law decorated by log-periodic oscillations. DSI has been connected with complex dimensions, Tsallis statistics and a plethora of physical phenomena in hierarchical systems. Examples of phenomena that display DSI include:

- Topological Semimetals: <https://arxiv.org/abs/1807.02459>
- Growth processes: <https://arxiv.org/abs/cond-mat/9707012>
- Financial stock market prices: <https://arxiv.org/abs/cond-mat/9903321>.
- Proton-proton collisions at high energies: <https://www.mdpi.com/1099-4300/17/1/384>

Research goals of the MSc thesis

$$P(S) \sim S^{-n - \frac{n}{2}(n+1)\gamma + \theta(\gamma^2)} \left[w_0 + w_1 \cos \left(\frac{2\pi}{\ln(1+\gamma)} \ln S \right) \right] \quad (S \gg T_0).$$

Scientific goal of the MSc thesis is to find and thoroughly test generative mechanisms for DSI.

In a recent publication (Section 2.4 of [THIS LINK](#)) we have suggested that DSI can find its origin in the formalism of nonextensive statistical mechanics ([CLICK HERE FOR AN](#)

[INTRODUCTION](#)). One of the paths that can be explored in the context of the MSc work is implementing the proposed dynamics in a simulation code followed by a thorough investigation of the robustness of the proposed generative mechanism.

We are seeking a creative student with an outspoken interest in Theoretical Physics and Statistical Physics who wishes to work on a project that combines analytical with numerical work. This thesis will also require elaborate literature searches.

Mobility options for the MSc thesis

Options for mobility are for example: research stays in other groups and attending Summer Schools on topics related to simulations, complexity science, sampling techniques,