

ABSTRACTS CONTRIBUTED TALKS

A5-5

Statistical physics of piecewise deterministic processes: theory and application to the resilience of semi-arid ecosystemsTobias Galla¹, John Realpe-Gomez^{1,2}, Mara Baudena^{3,4}, Alan J. McKane¹ and Max Rietkerk³

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We will discuss the effects of intrinsic noise on hybrid piecewise deterministic systems of interacting individuals. Such systems are characterized by a large number of individuals inhabiting an environment whose state is described by a set of continuous variables. The individuals may for example be plants or animals, the continuous degrees of freedom describe quantities such as water or nutrients. The dynamics is stochastic due to birth-death events of individuals, these happen at discrete moments in time. The stochasticity in this dynamics is referred to as ‘demographic noise’. Between the discrete birth-death events the dynamics is smooth and governed by deterministic differential equations for the continuous variables.

We use analytical techniques from statistical physics, in particular the celebrated system-size expansion due to van Kampen, and numerical methods to study the influence intrinsic noise has on the behavior of such systems [1]. Effects of demographic stochasticity in spatial systems include noise-induced patterns and oscillations, not captured by deterministic approaches based on reaction-diffusion equations.

We discuss the application of these concepts to models of semiarid ecosystems, characterised by feedback mechanisms between water and vegetation. This can lead to spatial self-organisation of vegetation, similar to those seen in real-world ecosystems. By means of numerical simulations we show that demographic noise can have important effects on the extinction and recovery dynamics of such model systems [2]. We find that stochastic models can escape extinction under a wide range of conditions for which the corresponding deterministic approximation predicts absorption into desert states. We will discuss the consequences for the modelling of resilient semi-arid ecosystems.

[1] J. Realpe-Gomez, T. Galla and A. J. McKane, *Demographic noise and piecewise deterministic Markov processes*, Phys. Rev. E **86**, 011137 (2012).

[2] J. Realpe-Gomez, M. Baudena, T. Galla, A. J. McKane, M. Rietkerk, *Demographic noise and resilience in a semi-arid ecosystem model*, preprint arXiv:1209.2588, submitted to Ecological Complexity.