Engineering and Physical Sciences Research Council Doctoral Landscape Award

PROJECT TITLE: From bees to physics: insect nests as active matter systems

Lead Supervisor: Professor Natalie Hempel de Ibarra, N.Hempel@exeter.ac.uk

Co-Supervisors:
David Horsell (d.w.horsell@exeter.ac.uk)
Steven Hepplestone (s.p.hepplestone@exeter.ac.uk)
Matt Eames (m.e.eames@exeter.ac.uk)

Webpage: https://experts.exeter.ac.uk/1087-natalie-hempel-de-ibarra

Project details: Self-organised systems in animals, such as the nests of social insects, have evolved to offer adaptive advantages that support survival across diverse habitats. These nests represent ideal systems to study collective processes, information flow and other dynamic events that shape behavioural decision-making and influence the development and success of the nest. In social insect colonies, individual efforts are joined and balanced across a range of behavioural tasks resulting in elaborate shelters for the colony and its offspring, fine-tuned control of the nest's internal conditions, effective nest maintenance and defence. This is all achieved without centralised control. Individual insects make decisions based on information gathered through interactions with nest mates and from its surroundings, including nest structures, materials and climatic conditions.

The project focuses on understanding how thermoregulation is achieved within an active bumblebee nest. It is an open system in which matter and energy changes under different environmental and social conditions. Bumblebee nests can be studied using empirical and modelling approaches, and there is opportunity in this project to develop those and combine them where suitable.

The successful candidate will join a collaborative team of supervisors with complementary interdisciplinary and methodological expertise and address innovative research questions at the interface of physics, material engineering and behavioural science. This work will make a significant contribution to the nascent field of active matter, where emergent material properties are governed by movement and energy exchange between components. These new types of material form an exciting and promising branch of metamaterials (an area where the University of Exeter plays a major research and leadership role in the UK) with uses across a whole range of applications, including thermal management. Adaptability of nests to changes in environments and climate determine the resilience of bee population and pollination services. By exploring how structures and materials can meet the thermoregulatory demands of these pollinators, this project endeavours to make a meaningful contribution across materials science, ecology and environmental monitoring.

We look for a candidate with a background in the natural or life sciences, with an interest in the application of physics-based solutions to environmental and biological problems. The PhD candidate will in effect benefit from working within lively and interdisciplinary research environments and access to sophisticated experimental facilities and equipment.

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The postgraduate student will be based on the UoE's Streatham campus, in the Exeter Bee Lab of the Centre for Research in Animal Behaviour (CRAB, https://psychology.exeter.ac.uk/research/centres/crab/), supervised by Professor Natalie Hempel de Ibarra, and in the Centre for Metamaterial Research and Innovation spending time in the lab of the second supervisor Dr David Horsell (https://www.exeter.ac.uk/research/metamaterials), as well as interacting with other collaborators in the departments of Physics and Engineering.

Project specific entry requirements: Standard requirements for PhD study

Potential PhD programme of study: PhD in Psychology

Department: Psychology

Location: Washington Singer Laboratories building, Streatham campus

Please direct project specific enquiries to: Natalie Hempel de Ibarra (N.Hempel@exeter.ac.uk) or David Horsell (d.w.horsell@exeter.ac.uk)

Please ensure you read the entry requirements for the potential programme you are applying for.

To Apply for this project please click on the following link - **APPLY HERE**