LMS Seminar

Scaling up distributed quantities from the micro to the macro in mechanics and economics

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Date, time, and venue

April 16, 2026 (2 – 3 pm), Amphithéâtre Pole Mecanique

Abstract

Many systems have complex, distributed quantities on a small scale that affect their properties on a larger scale. In this talk, I will focus on two particular examples. In materials modelling, I will show how distributions of fibre lengths, orientations and spatial distributions can be averaged and scaled up to predict macroscale mechanical properties, such as nonlinear stress-strain curves and effective elastic moduli, for biological tissues such as tendons, and for fibre network-based materials, such as polypeptide hydrogels. Then, I will show that, using very similar techniques, we can predict how distributions of income and firm productive capacity can be averaged and scaled up to predict the macroeconomic effects of inequality. In both cases, we find emergent phenomena on the macroscale that are not present on the microscale, which can be predicted in a computationally efficient manner. To do so, we describe the microscale property with a simple constitutive assumption combined with a probability density function to describe the distribution of one or more of its features. The macroscale property then arises naturally by calculating the expectation of the function of the continuously distributed random variable of interest.

About the speaker

Tom Shearer is a Reader in Applied Mathematics at the University of Manchester. His research is multidisciplinary, straddling Mathematics, Materials Science, Engineering, Biology, and Economics. His research background is in solid mechanics, with a focus on deriving non-linear constitutive equations for complex materials such as biological soft tissues and engineering composites and, more broadly, understanding how structure affects mechanical function in such materials. More recently he has expanded the focus of his research to Economics, showing that similar mathematical techniques can be used to make progress in both fields.

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