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Dispersive transport dynamics in porous media emerge from local correlations

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Understanding and controlling transport through complex media is central for a plethora of processes ranging from technical to biological applications. Yet, the effect of micro-scale manipulations on macroscopic transport dynamics still poses conceptual conundrums. Here, we will demonstrate the predictive power of a conceptual shift in describing complex media by local micro-scale correlations instead of an assembly of uncorrelated minimal units. Specifically, we will show that the non-linear dependency between microscopic morphological properties and macroscopic transport characteristics in porous media is captured by transport statistics on the level of pore junctions instead of single pores. Probing experimentally and numerically transport through two-dimensional porous media while gradually increasing flow heterogeneity, we find a non-monotonic change in transport efficiency. Using analytic arguments, we built physical intuition on how this non-monotonic dependency emerges from junction statistics. This suggests the value of a shift in perspective towards larger-level structural elements that can broadly affets our understanding of transport within the diversity of complex media.

Participation

In-Person

References

Meigel et al., Nature Communications 13:5885 (2022). DOI:10.1038/s41467-022-33485-5

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