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Hallmarks of chaotic mixing in two dimensional unsteady porous media flow

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Solute mixing in steady porous media flows is easy in three dimensions. Flows elongate solute filaments exponentially fast, and this "chaotic" elongation enables molecular diffusion to rapidly produce uniformity. In two dimensional steady flows, filament elongation is much slower, meaning mixing can be far less efficient. However, many porous media such as biological tissues and geological fractures can have a two-dimensional character, leading us to question if these media can also support chaotic mixing. In this talk, we share experimental evidence that two dimensional porous media flows can exhibit chaotic mixing whenever the underlying flow is made unsteady, for example by introducing (1) a second fluid phase or (2) transverse flow oscillations. In the oscillating flow case, we further demonstrate that the mixing efficiency has resonances as the amplitude and frequency of oscillations varies. These results constitute the first experimental evidence for chaotic mixing in two dimensional systems, and they lend new understanding from which we might one day produce efficient geologically inspired mixers.

Participation

In-Person

References

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