Nature Reviews Physics | https://doi.org/10.1038/s42254-020-00277-z | Published online: 06 January 2021

SOFT MATTER

Making waves without inertia

When a shallow film of water flows down a slope it often spontaneously forms ripples, such as those seen on hilly streets during heavy rain (pictured). Such ripples have been studied since at least the 1940s, and it is well-understood that they form because of inertia in the fluid. Intuitively, highly viscous fluids, in which inertial effects are negligible, should not behave the same way. However, writing in *Communications Physics*, Baptiste Darbois Texier and colleagues report that water thickened with cornstarch forms ripples that look just like those in pure water — but via a completely different mechanism.

How important inertial effects are in a fluid can be characterized by its Reynolds number, which is the ratio of inertial forces to viscous forces. For water flowing down a slope, ripples form if the Reynolds number exceeds a certain threshold, that is, if inertial effects overcome viscous ones. Darbois Texier et al poured cornstarch suspensions with different densities down a slope, and found that if the suspension was dense enough, ripples formed at Reynolds numbers that decreased dramatically with increasing density. In other words, dense suspensions form ripples without the need for the inertial effects that underpin ripple formation in water.

Credit: Zoonar GmbH/Alamy Stock Photo

The clue to how this happens comes from the unusual non-Newtonian rheology of cornstarch suspensions. A dense cornstarch suspension behaves like a normal liquid at low flow rates but like a solid at high flow rates, with a sudden transition between the two behaviours as the flow rate is increased. The minimum density required to see this unusual behaviour coincides with the density at which the Reynolds number threshold for ripple formation dropped off. Darbois Texier et al developed a model that quantitatively predicted this drop-off and that invoked only the rheology of the cornstarch suspensions, without requiring inertia. They suggest that the possibility of ripples forming in a non-inertial fluid may provide new ways of describing waves in other complex systems such as 'fluids' made of active matter.

Zoe Budrikis

ORIGINAL ARTICLE Darbois Texier, B. et al. Surface-wave instability without inertia in shear-thickening suspensions. *Communications Physics* https://doi.org/10.1038/s42005-020-00500-4 (2020)