Complex viscoelastic fluid properties of a tiny worm

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Undulatory motion is utilised by crawlers and swimmers, such as snakes and spermatozoa, at length scales spanning more than seven orders of magnitude. The understanding of this highly efficient form of locomotion requires experimental characterisation of the material properties of the crawling or swimming organism, as well as of its active force output on the surrounding medium. Here we present a novel experimental technique used to study the properties of the millmeter-sized nematode and microswimmer *Caenorhabditis elegans*. By using the deflection of a very flexible, force-calibrated micropipette, the viscoelastic material properties of the model organism were directly probed and characterised. The worm was shown to have a self-similar elastic structure as well as a, surprising, shear-thinning viscous component. The complex fluid properties were directly determined through dynamic relaxation measurements and successfully described by a power-law fluid model. The excellent force (pN) and time (ms) resolution provided by the micropipette deflection technique also enabled measurements of the active forces experienced by *C. elegans* swimming through a liquid. Our experimental study of this tiny nematode has revealed fascinating aspects of the design of an ultimate, undulatory microswimmer.

Figure 1. The material properties and swimming dynamics of the *C. elegans* nematode was directly measured using the micropipette deflection technique.

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