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What exactly is measured by passive microbead rheology? JAY SCHIEBER, EKATERINA PILYUGINA — The dynamic modulus G^* of a viscoelastic medium is often measured by following the trajectory of a small bead subject to Brownian motion in a method called "passive microbead rheology". In the pioneering manuscript that introduced the idea [T. G. Mason and D. A. Weitz, Phys. Rev. Lett. 74, 1250 (1995)], this equivalence between the autocorrelation function and G^* was assumed via the generalized Stokes-Einstein relation (GSER). We show here that this expression does not satisfy the correct initial condition. Also, earlier derivations of the GSER use an initial condition that freezes the bead in space until measurements begin, which is not typical for experiments. We use here an analytic solution of the forces on a sphere undergoing arbitrary displacement in an arbitrary viscoelastic medium combined with the fluctuation-dissipation theorem to derive what is actually measured in the microbead rheology experiment. We find that a convolution of G^* is indeed measured in bead-displacement statistics, which is similar to GSER but obeys the correct initial conditions. The result includes inertial effects, and allows for the presence of an optical trap, allowing a more general technique to extract the dynamic modulus from microrheology.

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