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A note on the breathing mode of an elastic sphere in Newtonian and complex fluids VAHE GALSTYAN, Columbia University, ON SHUN PAK, Santa Clara University, HOWARD STONE, Princeton University — Experiments on the acoustic vibrations of elastic nanostructures in fluid media have been used to study the mechanical properties of materials. The medium surrounding the nanostructure is typically modeled as a Newtonian fluid. A recent experiment however suggested that high-frequency longitudinal vibration of bipyramidal nanoparticles could trigger a viscoelastic response in water-glycerol mixtures [Pelton et al., "Viscoelastic flows in simple liquids generated by vibrating nanostructures," Phys. Rev. Lett. 111, 244502 (2013)]. Motivated by these experimental studies, we first revisit a classical continuum mechanics problem of the purely radial vibration of an elastic sphere in a compressible viscous fluid and then extend our analysis to a viscoelastic medium using the Maxwell fluid model. Although in the case of longitudinal vibration of bipyramidal nanoparticles, the effects of fluid compressibility were shown to be negligible, we demonstrate that it plays a significant role in the breathing mode of an elastic sphere. On the other hand, despite the different vibration modes, the breathing mode of a sphere triggers a viscoelastic response in water-glycerol mixtures similar to that triggered by the longitudinal vibration of bipyramidal nanoparticles.

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