Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Mechanical characterization of an acoustically levitated liquid droplet by bending plate oscillation ZILONG FANG, MOHAMMAD TASLIM, KAI-TAK WAN, Northeastern University — Resonance oscillation of an acoustically levitated liquid droplet has been widely used to characterize viscosity and surface tension for non-/ Newtonian liquids and gels. The classical theoretical models by Rayleigh and Lamb are proved to be useful in describing the behavior of inviscid liquids. However, significant modification is necessary to adapt to highly viscous liquids such as glycerin and engine oil with high molecular weight. In fact, it is difficult to observe the classical peripheral oscillations in such liquids. We lately observed a new oscillation mode. These liquids possess long relaxation time thus can be flattened by acoustic pressure to behave like an elastic plate. Three characteristic resonance modes were experimentally observed, namely, see-saw, saddleback, and monkey saddle at an increasing resonance frequency. The waveform conforms to an elastic plate with an out-of-plane oscillation along the azimuthal direction. A well-defined flexural rigidity can be empirically measured and correlated to the surface tension, viscosity, droplet dimension, and "plate" thickness. A dimensionless number analysis related to the Ohnesorge and Capillary numbers is found to fit the measurement. The experimental technique and analysis methods can be used to characterize a wide spectrum of Newtonian liquids.

Zilong Fang
Northeastern University

Date submitted: 03 Aug 2020 Electronic form version 1.4