GRADUATE STUDENT RESEARCH SEMINAR SERIES (2019)

THE ELASTIC RAYLEIGH DROP

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More than a century ago, Lord Rayleigh showed a spherical drop of inviscid liquid held by surface tension will oscillate with characteristic frequency and mode shape. This dispersion relationship has seen widespread use in multiple industries and applications. Bioprinting technologies rely on the formation of soft gel drops for printing tissue scaffolds and the dynamics of these drops can affect the process. Here we develop a model to compute the natural frequencies of a spherical drop with finite shear modulus and solid surface tension. We solve the governing Navier equations of linear elasticity incorporating the solid surface tension. The motions are decomposed into i) shape oscillations and ii) rotational modes. Rotational modes are uncoupled and not affected by capillarity, whereas the frequency of shape oscillations depend upon the elastocapillary number and compressibility. For an incompressible gel, there exists an infinity of radial modes for a fixed polar wavenumber and we show how these are affected by surface tension. We show that with increasing capillary effect, gel drop frequncies approach the Rayleigh frequency. For the limiting case of zero shear modulus, our dispersion relation in fact reduces back to the equation for Rayleigh frequency.

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