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Liquid chords: Mechanical properties of free standing liquid crystal filament

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It is well known that smectic liquid crystals, similar to soap solutions can form free standing planar films or bubbles. Few phases of such mesogens, however, form stable freely suspended filaments, for example when the material is pulled with a needle from a bulk droplet [1]. The layered structure of these mesophases, presumably in combination with some polar order of the mesogens, stabilizes the filaments against the Rayleigh-Plateau instability. The layers are wrapped cylindrically around one or more axial cores. One can distinguish a couple of mesophases (of bent-shaped molecules) that allow to draw stable freely suspended filaments with particularly high slenderness ratios (length to diameter), larger than 1000.

This paper describes an investigation of mechanical properties of these unique fluid microstructures, with few micrometers thickness and lengths of several millimeters [2, 3]. In our experiment, initially straight filaments are electrically deflected and stimulated to mechanical vibrations either by plucking (relaxation after application of an electric pulse) [4] or periodical electric forcing with sinusoidal excitation fields. Resonance frequencies and damping rates of the free oscillations are recorded. We develop a model for an empirical description of the dynamics of such liquid chords, which is used to evaluate the forces involved. The dependence of the oscillation parameters upon the filament geometry and temperature is discussed and a comparison with solid elastic strings is performed.

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