Acoustically driven oscillations of liquid crystal filaments

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It is well known that free standing cylinders of common liquids are unstable when their slenderness (length to diameter) exceeds the factor π, they decompose into droplets. However, a few liquid crystalline phases of bent-core mesogens form stable filaments with slenderness ratios of 1000 and larger. Their internal structure stabilizes them against the Rayleigh-Plateau instability while in axial direction the molecules can flow liquid-like. These structures behave mechanically like thin liquid chords. Their diameters are in the range from a few micrometres to about 100 µm, their lengths can be several millimetres or even centimetres. The response of such filaments to electric plucking has been studied earlier [1,2], and the frequency and damping rates of free oscillations have been measured [2].

In this study, filament oscillations are excited with harmonic sound waves. We determine amplitude and phase shift of the filament's response to the excitation signal. From the results, we develop a model of their dynamics and draw conclusions on the filament tension.

The inverse dependence of the filament resonance frequency f upon its length L is well established in the experiments. The relation $c = fL$ = const reflects the velocity of capillary waves along the filament axis, the order of magnitude of c is 1 m/s. The resonance frequency of thin filaments is roughly proportional to the inverse square root of the filament radius, $f \approx r^{-1/2}$. The experimental data are consistent with the assumption that the tension of the filament is related to the surface tension by $2\pi r\sigma$. For thicker filaments with radii of $r > 25$ µm and above, we observe faster oscillations than expected within this model. Possible contributions of additional bulk terms to the filament tension are discussed. Their influence increases with decreasing surface to volume ratio of the filaments.

(1) A. Jákli, D. Krüerke, and G.G. Nair, *Phys. Rev. E* **2003** *67* 051702
(2) R. Stannarius, A. Nemes, and A. Eremin, *Phys. Rev. E* **2005** *72* 020702(R)