Supporting Information Figures

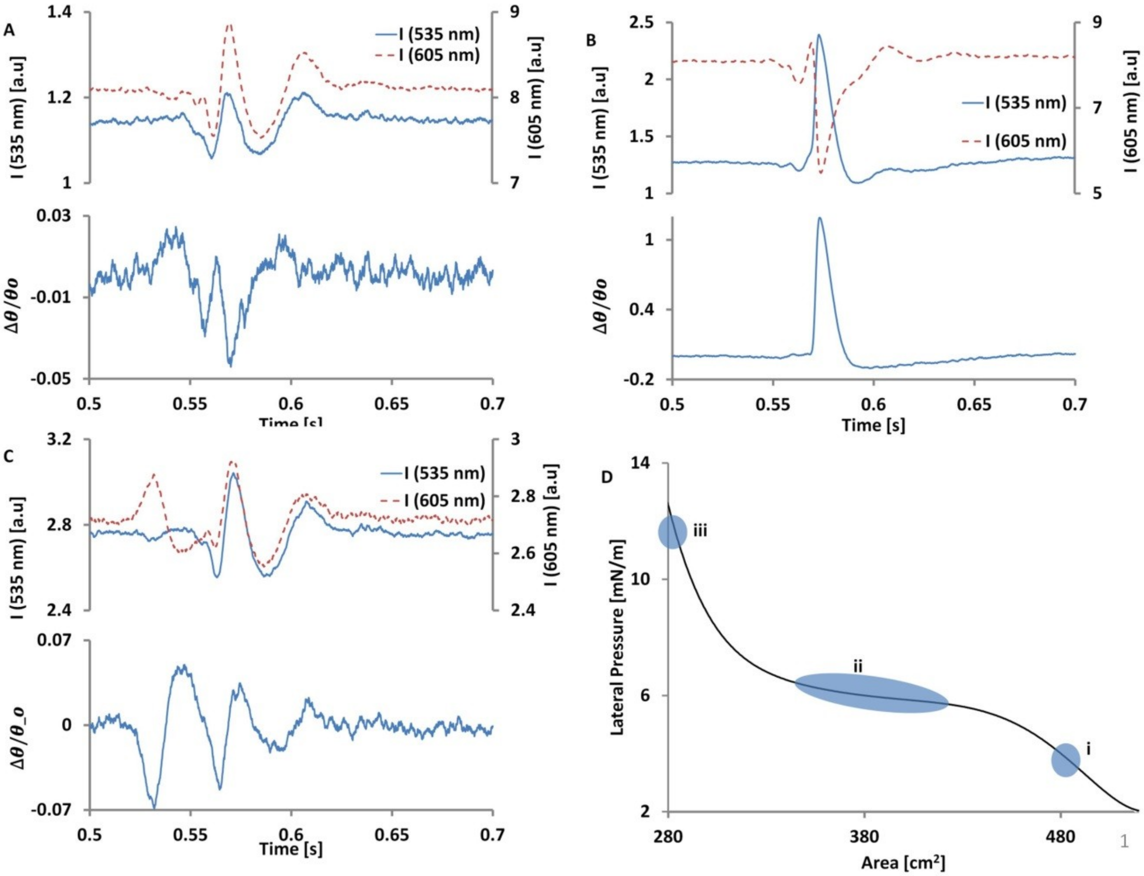

Figure S1. Optical trace of a propagating pressure pulse. *(top)* Temporal trace of absolute intensity in the 535 nm and 605 nm channels during a surface pulse at a mean lateral pressure of (A) 3.1mN/m , (B) 6mN/m and (C) 12.8mN/m marked by region (i), (ii) and (iii) in on the isothermal state diagram in (D) respectively obtained at 19 ^{o}C. The FRET variation (plots of $\Delta\theta/\theta_o$) was calculated according to Eq.2 of the main manuscript. The regions where the two signals are out of phase should represent the relative motion between acceptor and donor molecules (Fig. S1) [1,2], while the in-phase variations result from non-FRET processes, such as the vertical motion of the interface with respect to the focus of the microscope. A strong longitudinal mode is clearly visible in (A) even in the absolute intensities *(top)* with complementary rise and fall in the donor and acceptor signal respectively. The longitudinal mode is clearly weaker in (B) and (C). The data presented here is same as in figure 2 of the main manuscript; however note that the scale on y-axis for the pulses varies.

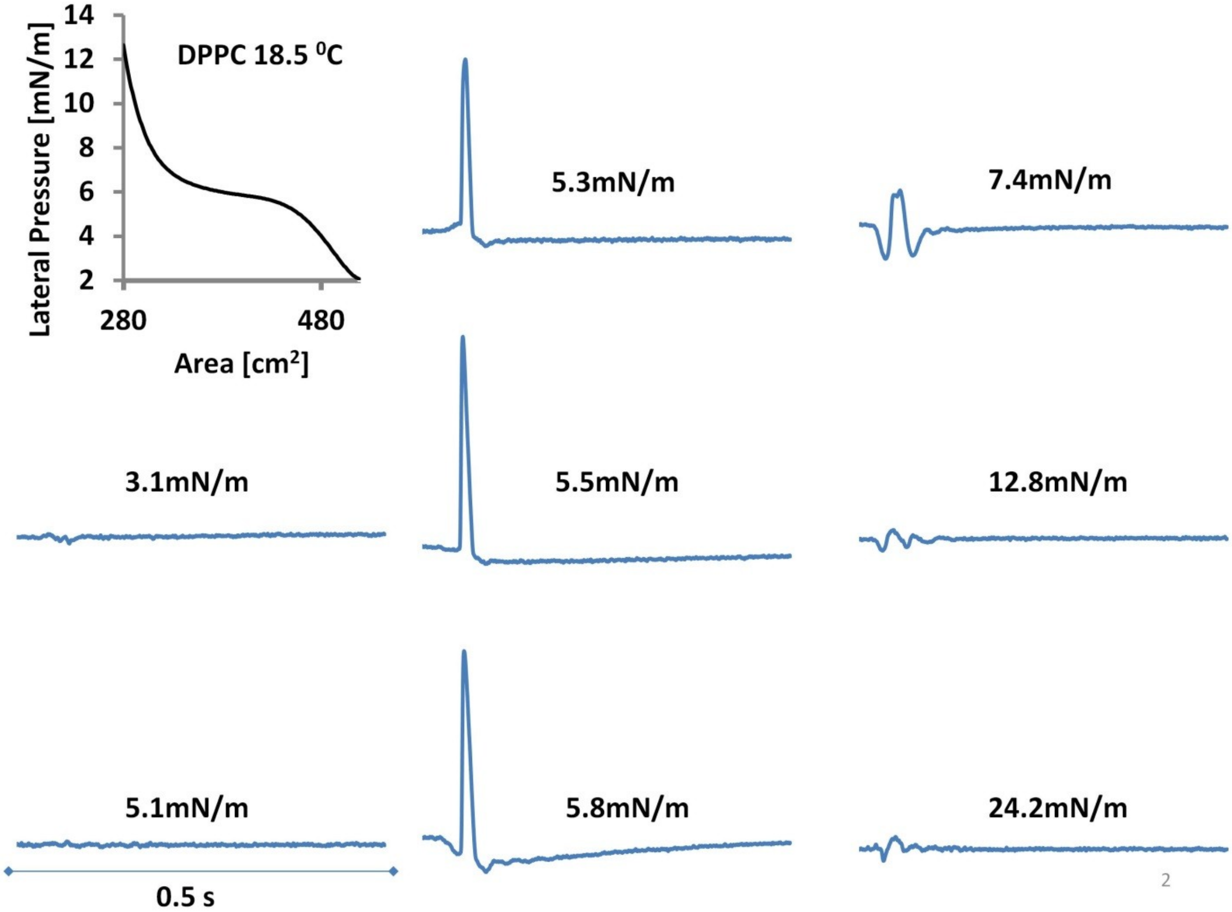

Figure S2. State dependence of pulse shape. The effect of mean lateral pressure on the pulse shape is illustrated. The sudden appearance of high amplitude solitary pulses occurs upon changing the pressure from 5.1 to 5.3mN/m. In general, when pulses are excited while proceeding on the state diagram from low to high pressures, it seems characteristic that the first pulses hardly have components below the base line. With increasing pressure, troughs on either side of the sharp crest gradually deepen while the crest splits, blunts and finally disappears completely at high pressures. The pulses were recorded at a distance of 0.7mm from the excitation source at 18.5 ^{0}C.

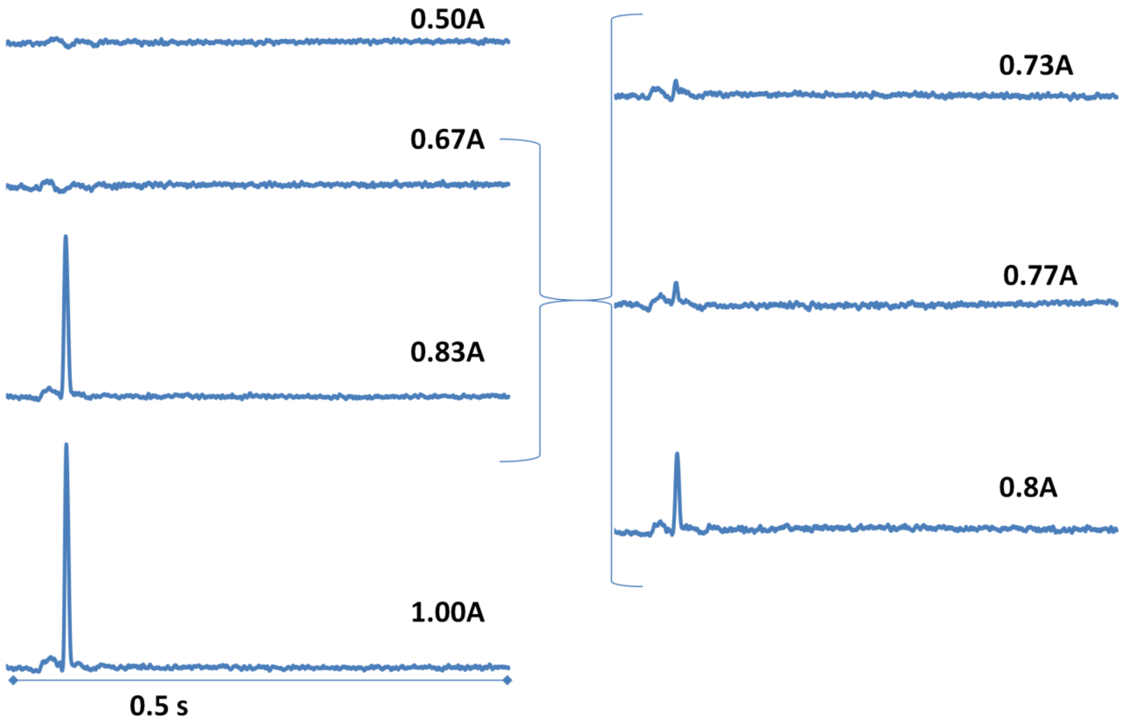

Figure S3. Resolving threshold excitation strength. The mechanical excitation strength was gradually increased to identify the exact threshold for the onset of solitary waves. As a result of nonlinear phenomena, one peak of the subthreshold components at 0.73A emerges upon superthreshold excitation. This behavior indicates that the energy is being focused temporally within the pulse. This whole process takes place within a very small range of amplitudes (0.73 to 0.8A) and finally saturates (0.83 to 1A) as explained in the text. The pulses were measured at a mean lateral pressure of 7.2mN/m and 21 ^{o}C.

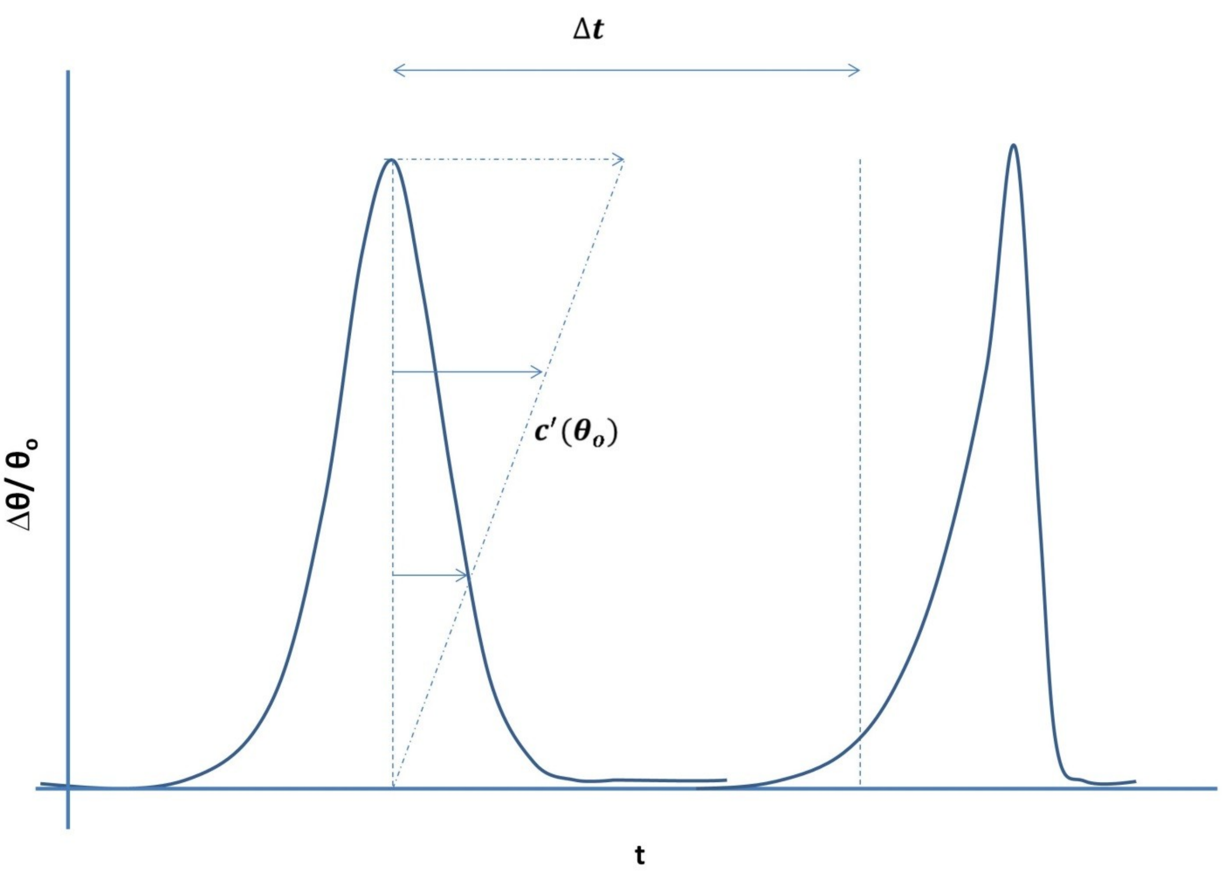

Figure S4. Nonlinear susceptibility and pulse evolution. The cartoon depicts the effect of nonlinearity on the pulse shape. In the nonlinear regime *c'* is significant and the velocity depends significantly on the amplitude resulting in different propagation velocities within a single pulse [3]. This causes the pulse shape to evolve, skewing it to a long tail and a steep front, or vice versa, depending on the state-velocity relationship. In terms of frequency spectrum, the steepening is represented by higher frequency components while the tail represents the lower frequencies that account for the resulting broadening of the spectrum. Under “right” conditions dispersion can counterbalance this effect and can thus cause new frequencies to fall back on the “mother” pulse.

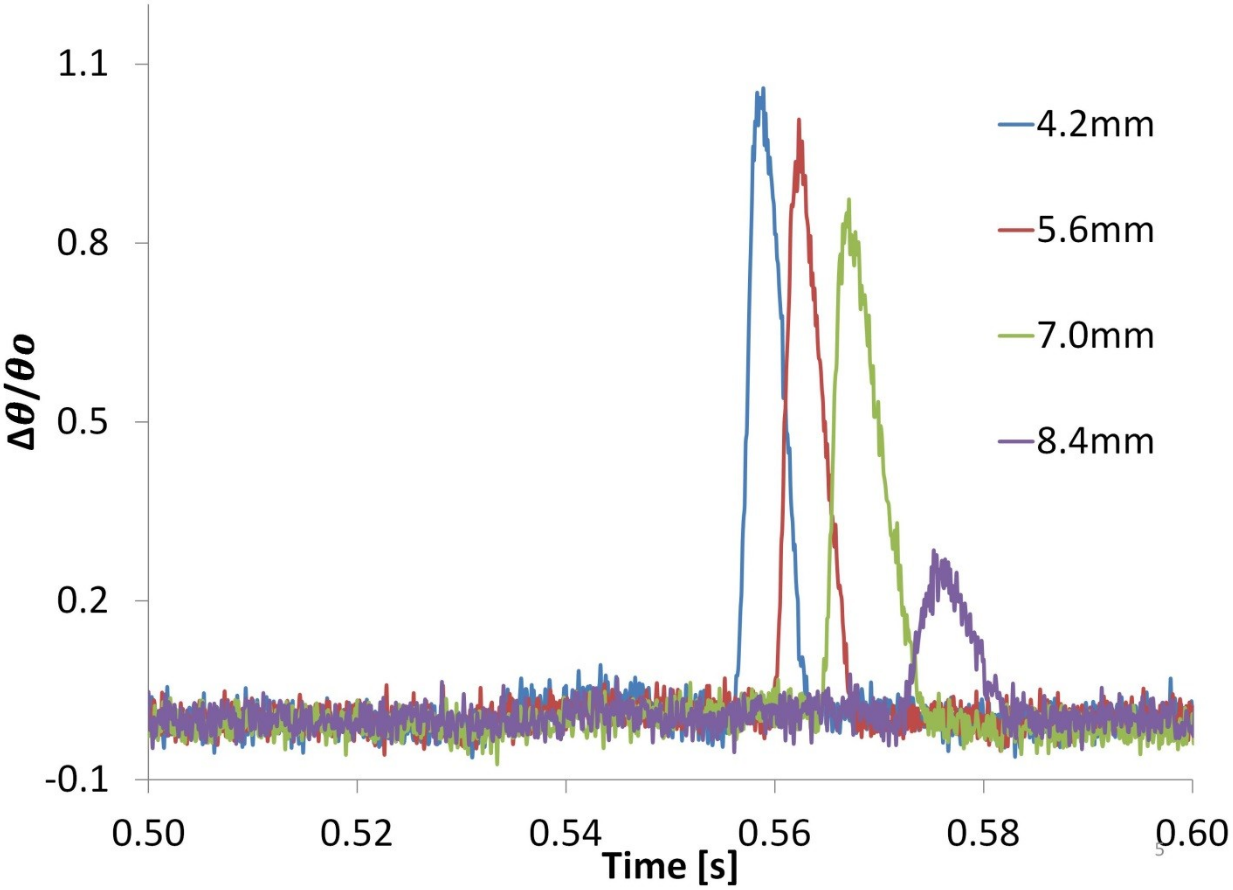

Figure S5. Decaying Solitary Pulses. Pulses were measured at different locations by varying the distance (point ‘c’ in Fig. 1) from the blade. All the experiments shown here were conducted for the same state (7mN/m and 21 ^{o}C). On increasing the distance up to 7 mm the amplitude decays moderately. Although at this point we do not know the source of this decay we believe it is driven either by (i) the in-plane spreading (perpendicular to the propagation), a behavior which should be sensitive to lateral confinement of the wave, or (ii) dissipation by viscous friction. Interestingly, further decay of the amplitude (from 7 mm to 8.4 mm) proceeds nonlinearly. The reason presumably for this behavior is the drop in amplitude to below thresholds level and the system cannot sustain the balance between the dispersive and nonlinear contributions. This once again underlines the solitary nature of these nonlinear pulses as opposed to shock waves that disperse strongly [4]. As evolution of a nonlinear pulse depends on amplitude, dispersion and dissipation, the distance dependence as reported in this figure depends nonlinearly on the exact state of the interface and further studies are underway to systematically analyze these effects.

References

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