Supplementary data

It is well known that the dynamic and static deflection of a cantilever are not the same [20]. However, due to the finite spot-size of the laser this effect is averaged out for small cantilevers. To test this we measured the static and dynamic deflection for cantilevers of various lengths.

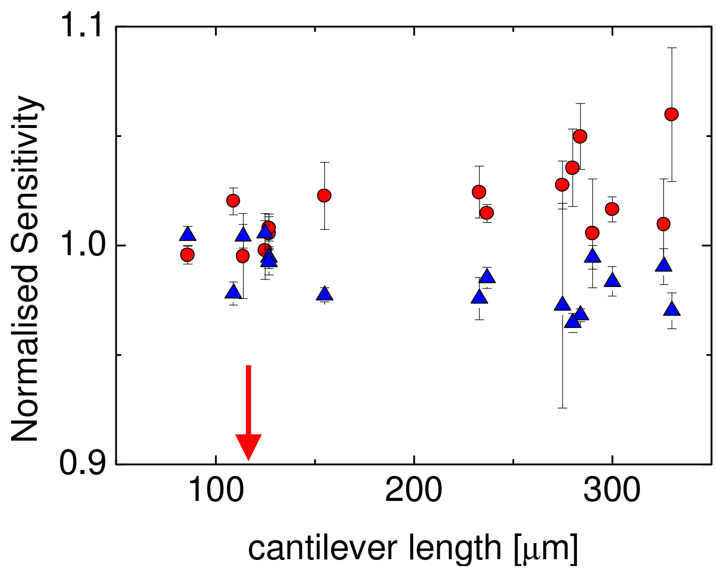

Figure 1 The normalized static (blue) and dynamic (red) deflection sensitivity for various cantilevers with a different length. The arrow denotes the length of the cantilevers typically used for the experiments described in this paper.

In order to compare our data we fitted the extracted interaction stiffness with a decaying cosine function (which is known to describe the oscillatory solvation forces for weakly interaction liquids like OMCTS very well).

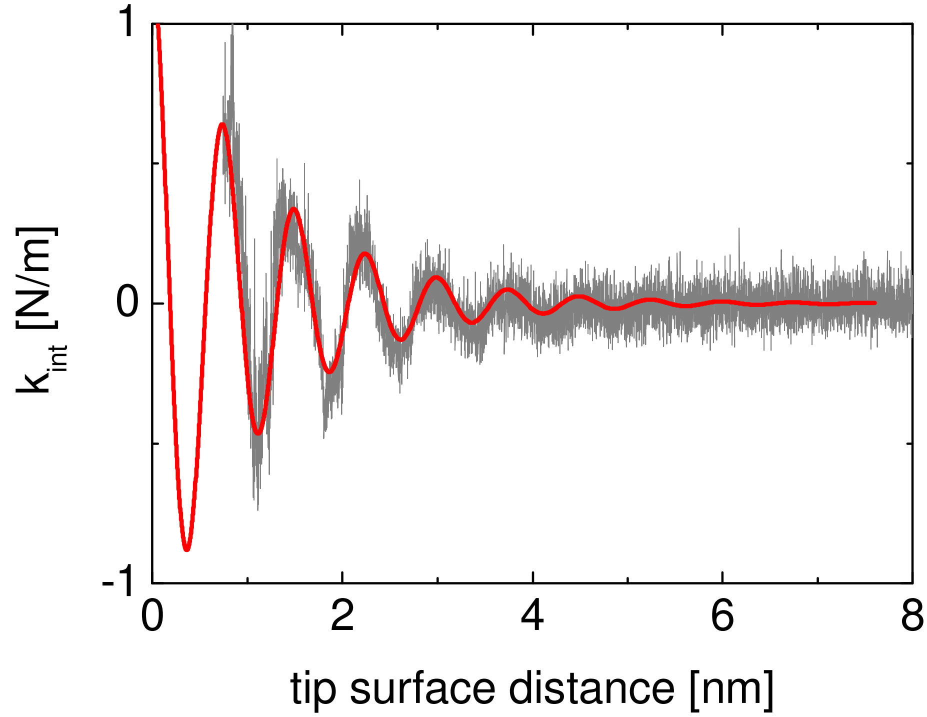

Fig. 2 The extracted interaction stiffness k_{int} fitted with a decaying cosine function to find the amplitude of the stiffness K_{int}.

To test whether the Reynolds squeeze-out damping under the cantilever changes as we approach the surface, we measure the APD curves over a larger distance. Since the amplitude and phase response of cantilever remain constant over this distance, we know that the Reynolds damping under the cantilever does not change (to a measurable extent).

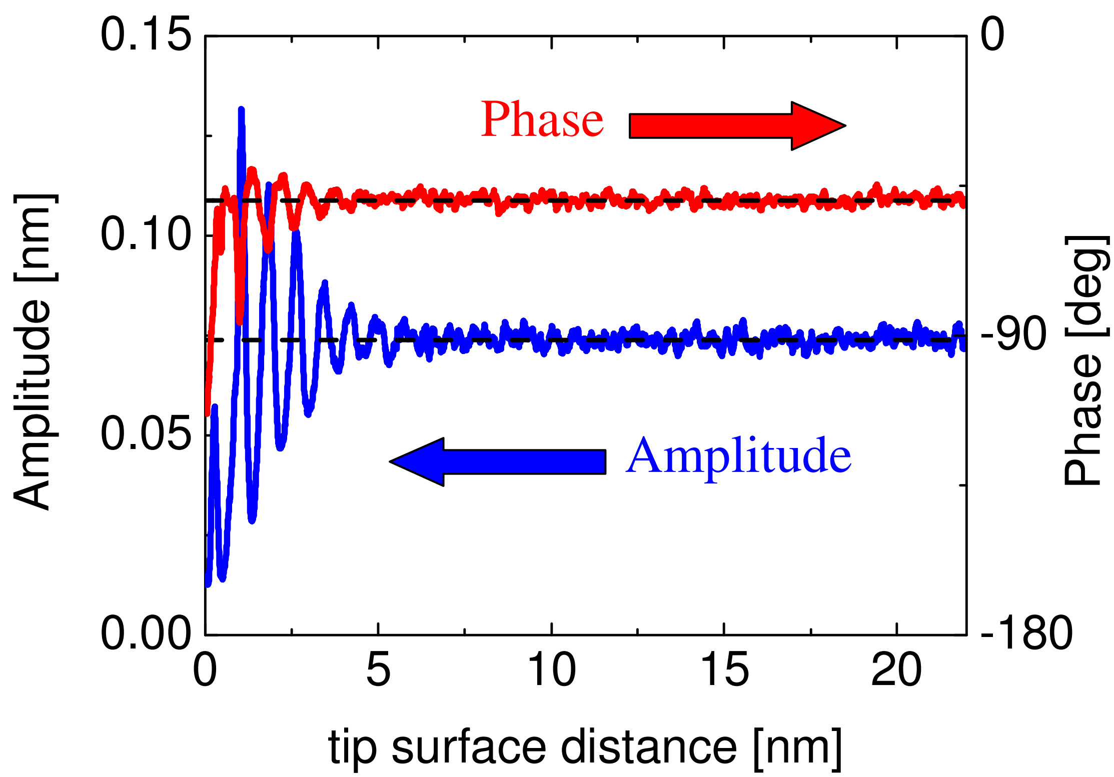

Fig.3 The Amplitude and Phase response of the cantilever over tens of nanometers ($\omega_{res}/2\pi$ = 42 kHz, Au-coated Si cantilever, ω/ω_0 = 0.75). Note that, apart from the oscillations close to the surface, the amplitude and phase response is constant.

In our experiments the biggest contribution to the total error comes from the uncertainty in the calibration constants. These uncertainties are mostly affecting the results on resonance. Note that on resonance the error in the phase is significant and can cause cross-coupling between the conservative and dissipative interaction forces.

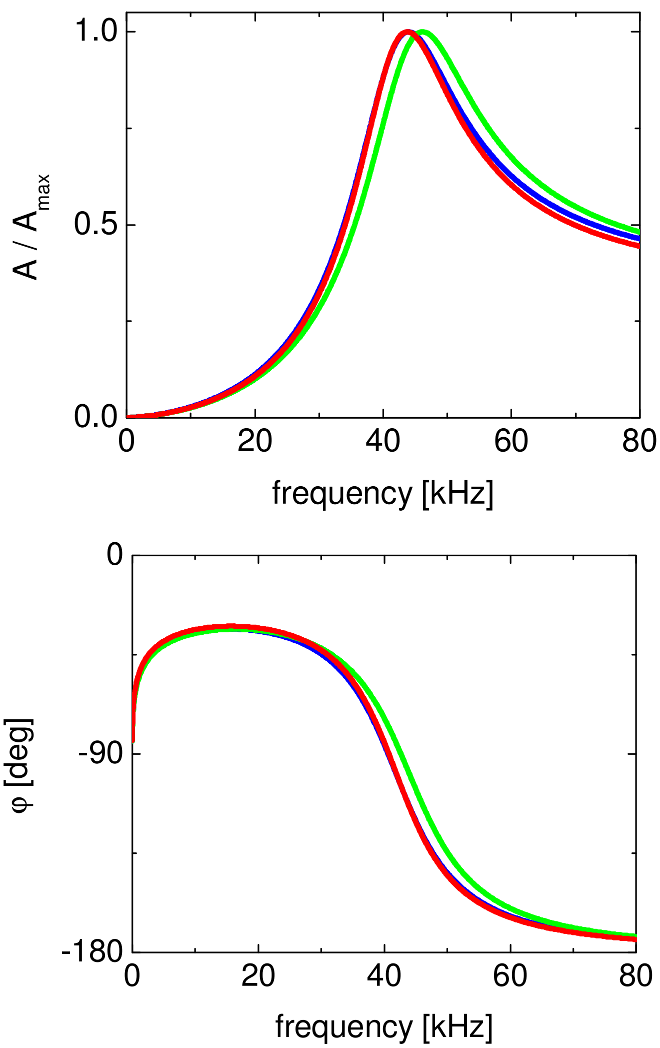

Fig. 4 The effect of an error of 5% in both Q (2.85+5%, red vs blue) and $\omega_{res}/2\pi$ (42 kHz+5%, green vs. blue) on the amplitude (a) and phase (b) response spectra of an acoustically driven cantilever using deflection detection.

Nevertheless, for acoustically driven cantilevers using deflection detection, the sensitivity to tip-sample interactions is approximately equal for low frequencies (15 kHz) and close to resonance (42 kHz). Fig. 5 shows the effect of an increasing interaction damping on the amplitude and phase response. Although the response in the amplitude is less for lower frequencies the response in the phase larger. For the effect of a change in interaction stiffness (an even more pronounced effect) we refer to ref. [15].

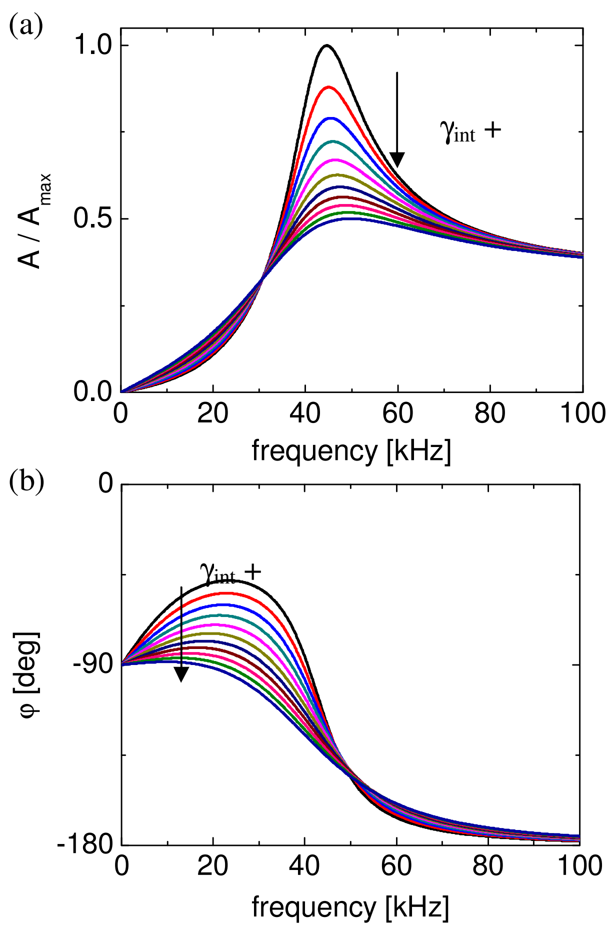

Fig. 5 The effect of a linearly increasing interaction damping (from 0 to 5 10^{-6} kg/s in steps of 0.5 10^{-6} kg/s) on the amplitude (a) and phase (b) response of an acoustically driven AFM cantilever using deflection detection ($\omega_{res}/2\pi$ = 42 kHz, Q = 2.85).