values of the separation on contact and of the lateral force calibration constant

$$\tilde{z}_0 = 131.4 \pm 3.8\,\text{nm}, \quad \tilde{k}_{\text{ben}} = 2.05 \pm 0.11\,\text{nN/unit}\ S. \tag{22}$$

Typically in our second set of measurements with the larger amplitude corrugations the calibration errors are a bit larger than in the first, where smaller amplitude corrugations were used.

IV. MEASUREMENT DATA FOR THE LATERAL CASIMIR FORCE AND ERROR ANALYSIS

Now we describe how the measurements of the lateral Casimir force were performed. In this case the residual voltage V_0, as determined in the electrostatic calibration using the normal electric force, was applied to the grating in order to make the electric force equal to zero. The x-piezo was used to move the grating along the x-axis and thus change φ. The z-piezo, which was independently controlled by an external voltage source, was used to change a. The piezo extensions with applied voltage in both directions were calibrated using optical interferometry [51].

Initially the corrugated sphere was positioned 3.79 nm from the separation on contact between the two surfaces z_0 determined by the corrugations and the highest roughness peaks. The thermomechanical drift of the separation distance was measured to be 0.14 nm/min from the difference in the z-piezo voltage to bring about contact of the two corrugated surfaces after a time interval around 30 minutes. A phase shift was introduced by moving the x-piezo continuously for a total distance of 3.3 μm at 0.103 Hz. The photodiode signal corresponding to the cantilever deflection was filtered with a low-pass filter with a 30 ms time constant and recorded at each of the 8192 points corresponding to x-changes of 0.4 nm. The effect of the scattered laser light which would lead to a linear modification of the signal with phase was found to be negligible in this experiment.

Then the separation from z_0 was increased by 3.6 nm from 3.79 nm to 7.39 nm and the deflection signal $S_{\text{lat}}^{\text{C}}$ was similarly measured as a function of φ and recorded. After this, the separation from z_0 was increased by 3.96 nm from 7.39 nm to 11.35 nm and the measurements repeated. Next $S_{\text{lat}}^{\text{C}}$ due to the lateral Casimir force as a function of φ was measured at separations of 20.05, 32.48, 45.30, 58.01 and 70.86 nm from z_0.