parameters of the first and second set of measurement. Every Matsubara term in Eq. (66) was evaluated with a precision of 1.5% which is also the computational precision of the obtained $F_{\rm lat}^{\rm C}$.

In Fig. 7(a-c) the exact computational results for the lateral Casimir force as a function of the phase shift between the sinusoidally corrugations on both surfaces are shown by the solid lines at separations $a = 124.7$, 128.6, and 149.8 nm, respectively (the the first set of measurements with corrugation amplitude on the sphere of 13.7 nm). No fitting parameters are used in the comparison As can be seen in Fig. 7(a-c), the solid lines are in a very good agreement with the experimental data shown as dots. These lines clearly demonstrate deviations from the sinusoidal behavior which decreases with the increase of separation. Thus, both the experimental data and the exact theory confirm the prediction of Ref. [38] made using the PFA approach that the lateral Casimir force is asymmetric.

In Fig. 8 the exact computational results for the $\max|F_{\rm lat}^{\rm C}|$ are plotted as a band between the solid lines versus the separation a between the mean levels of corrugations. The width of the band takes into account the computational errors equal to 1.5% and the correction to Eq. (66) due to surface roughness. The lower solid line is obtained as the computed $\max|F_{\rm lat}^{\rm C}|$ minus $0.015\max|F_{\rm lat}^{\rm C}|$. The upper solid line represents $(1+0.015+\eta_{\rm corr})\max|F_{\rm lat}^{\rm C}|$, where the correction factor $\eta_{\rm corr}$ for the first set of measurement was found in Sec. V. As can be seen in Fig. 8, the exact theory is in a very good agreement with the measurement data although it deviates significantly from the theoretical band between the two dashed lines computed using the PFA approach. Again no fitting parameters are used in the theory. This allows one to conclude that with the grating period of $\Lambda = 574.7$ nm the diffraction-type effects on the lateral Casimir force have been reliably demonstrated both experimentally and theoretically.

The results of similar computations using Eq. (66) are presented by the solid lines in Fig. 9(a-c) where the lateral Casimir force is plotted as a function of the phase shift for the second set of our mesurements at $a = 134$, 156.5, and 179 nm, respectively. As before no fitting parameters are used. In spite of the fact that the experimental data of this set of measurements with deeper corrugations on the sphere are more noisy, the exact theory is clearly consistent with data and confirms the asymmetric (nonsinusoidal) character of the lateral Casimir force. In Fig. 10 the exact computational results for the $\max|F_{\rm lat}^{\rm C}|$ in the second set of our measurements versus separation are presented as the band between the