Summary of the quantum analogon experiments

Particle in a periodic potential

1. Measure the resonances in tubes of different length and analyze the distance between the resonances Δf as function of tube length d. Vary length between 75mm and 600mm, using 75mm tubes and adjust the sweep bandwidth to clearly distinguish the resonances (~ 6-9kHz). Calculate the actual speed of sound by fitting the dependence $\Delta f \sim 1/d$.

2. Take an overview spectrum (0.4-12 kHz) of a tube made from 12 tube-pieces each 50 mm long. Plot the frequency as function of wave number *k*.

3. In the same frequency range (0.4-12 kHz) measure the spectra for 8 50mm tubes separated by irises of 16, 13 and 10mm diameter. Plot the dispersion curves for these results. From the dispersion curves define the width of the bands and gaps, summarize the results in a table. What can you conclude?

4. Measure a (0.4-12 kHz) spectra for 12 and 10 50mm tubes with Ø16mm irises. Compare these spectra with previously acquired spectrum for 8 tubes with Ø16mm irises. Describe the way the spectrum changes. Are there any mathematical patterns?

5. Take a (0.4-12 kHz) spectrum with 8 pieces 75mm long and Ø16mm irises. Compare this spectrum with the one of 8 50mm long pieces and Ø16mm irises. What difference in the spectra do you observe?

This summary is not intended to summarize all the analysis tasks of this experiment, please refer here to the original student manual. Just as an reminder - use the spectrum of 8 50mm tubes with 16mm irises to determine the density of states.

Atom-molecule-chain approach

6. Take an overview spectrum (0.4 - 22 kHz) in a single 50 mm long tube-piece. Identify the longitudinal and radial modes. Check the separation of the longitudinal modes Δf corresponds to the theoretically expected.

7. Measure a spectrum (0.4 - 22 kHz) in a longer tube-piece (75 mm). Check the separation of the longitudinal modes Δf corresponds to the theoretically expected.

8. Take a spectrum (0.4 -12 kHz) in a combination of two 50 mm long tube-pieces with an iris Ø10 mm between them. Repeat the experiment with Ø13 mm and Ø16 mm irises.

9. Take spectra (0.4 -12 kHz) with an increasing number of unit cells (3,4,6) and Ø16, Ø13, Ø10 irises. Observe how bands develop. In a table compare the

difference between bonding and antibonding states with the width of the corresponding band in a setup with large number of unit cells.

10. Make a setup of 12 tube-pieces 50 mm long and alternating Ø13 mm and Ø16 irises. Measure a (0.4-12 kHz) spectrum. Compare with the spectrum of 12 50mm tubes with Ø13 mm irises, taken in experiment 3.

11. Make a setup of 5 unit cells with each unit cell made of a 50 mm tube, a Ø16 mm iris, a 75 mm tube, and Ø16 mm iris. Measure a (0.4-12 kHz) spectrum and plot the band structure. Compare the “atomic” levels of the of 50mm tube and 75mm tube, taken in experiments 7 and 8, with this band structure.

12. Make a setup of 12 tube-pieces 50 mm long and Ø16 mm irises. Replace one tube-piece by a 75 mm long piece and measure the (0.4-6 kHz) spectrum. Put the defect at other positions within the one-dimensional lattice and measure the spectra produced. Does the frequency of the defect-resonance depend on the position? Use other tube lengths as a defect. You can try 25 mm, 37.5 mm and 62.5 mm for example.