Experimental Notes for the Underwater Acoustic Metamaterial Project

Jiaxin Zhong

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1 Introduction

Experiments were conducted to validate the enhanced transmission through an underwater acoustic metamaterial (AMM).

1.1 General settings

Table 1: Comparison of retrieved parameters.

Name	Symbol	Value	Comments
Emitter radius	–	1 inch	–
Metamaterial dimensions	–	$29\,\mathrm{mm} \times 29\,\mathrm{mm}$	–
Center frequency	f_c	445 kHz	–
Wavelength	λ_c	3.3 mm	–
Critical distance	$D_\mathrm{c} = a^2/\lambda_\mathrm{c}$	68.2 mm	–

2 Experimental logs

Equipment settings are:

- Oscilloscope

  - y division 1 V

  - x division 5 MHz

- Function generator

  - Vpp is 5 V

  - Burst mode, 1 ms period, 5 cycles

2.1 Exp230223B

- DDate: Feb 23, 2023

- Measurement of the transmitted sound field without AMM

2.2 Exp230227B

Specific settings

- Date: Feb 27, 2023

- Measurement of the transmitted sound field with AMM

2.3 Exp230228A

- AMM

- Transmistted sound field over the plane $y = 46\,\mathrm{mm}$.

2.4 Exp230228F

- AMM

- Transmistted sound field over the plane $y = 45.75\,\mathrm{mm}$.

2.5 Exp230301D

- AMM

- Transmistted sound field over the plane $y = 45.5\,\mathrm{mm}$.

2.6 Exp230302A

- Without AMM

- Transmistted sound field over the plane $y = 46\,\mathrm{mm}$.

2.7 Exp230302B

- Without AMM

- Transmistted sound field over the plane $y = 45.75\,\mathrm{mm}$.

2.8 Exp230302G

- Without AMM

- Transmistted sound field over the plane $y = 45.5\,\mathrm{mm}$.

2.9 Exp230303A

- With plate

- Horizontal plane

2.10 Exp230306A

- With plate

- Vertifcal plane at $y = 46\,\mathrm{mm}$

2.11 Exp230307A

- With plate

- Vertifcal plane at $y = 46\,\mathrm{mm}$

2.12 Exp230307B

- With plate

- Vertifcal plane at $y = 45.75\,\mathrm{mm}$

3 Results and discussions

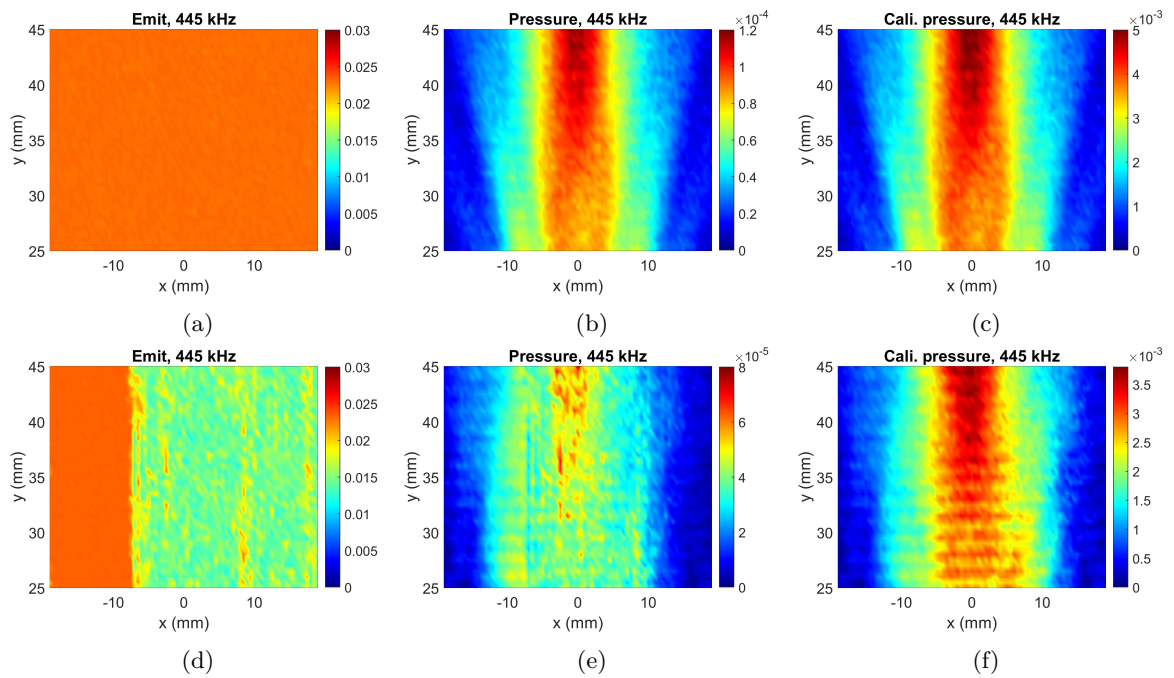Figure 1 shows the results of someting.

(a) (b) (c)

(d) (e) (f)

Figure 1: 2D experimental results at 445 kHz. Top row, without AMM (see Sec. 2.1); bottom row, with AMM (see Sec. 2.2). Left column, emitting signal which was fed into the source; middle column, signal received by the hydrophone; right column, calibrated signal of the middle column. To calibrate, the values in the middle column are divided by those in the left column.
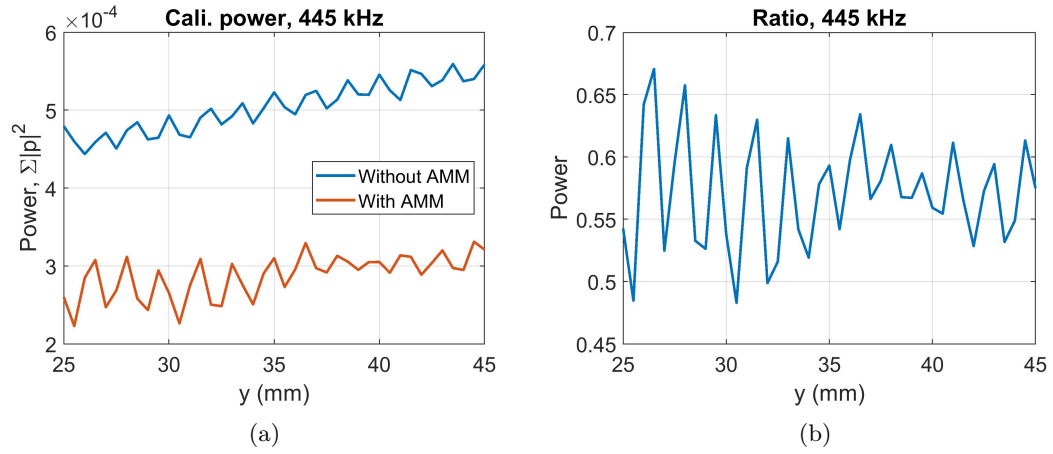
Appendix A TBD

References

Figure 2: (a) Calibrated acoustic power, approximated by a summation of the squared pressure along the line parallel to x axis, with and without AMM. (b) The ratio of the power with AMM to that without AMM.
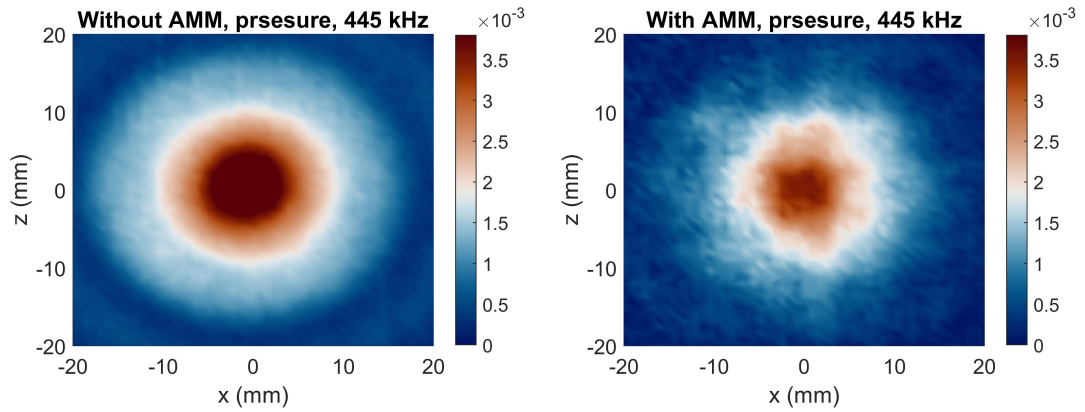

Figure 3: 2D pressure distribution at 445 kHz without (left) and with (right) the acoustic metamatrial (AMM). The region is located at 45 mm away from the transducer.
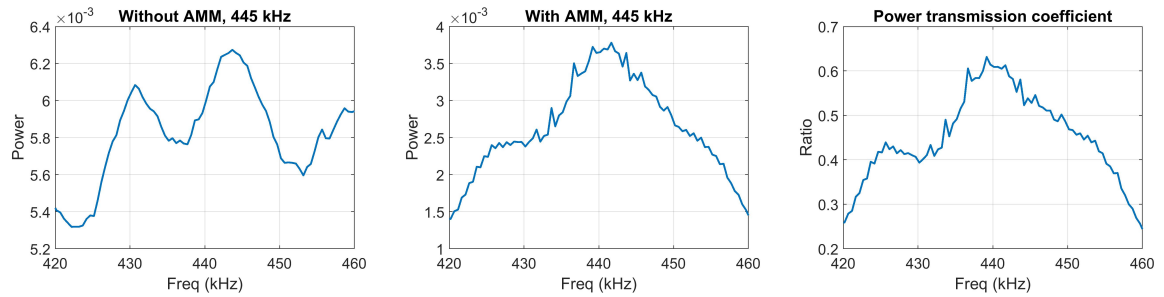

Figure 4: Sound power (left) without and (middle) with the AMM. (Right) Power transmission coefficient. The region is located at 45 mm away from the transducer.