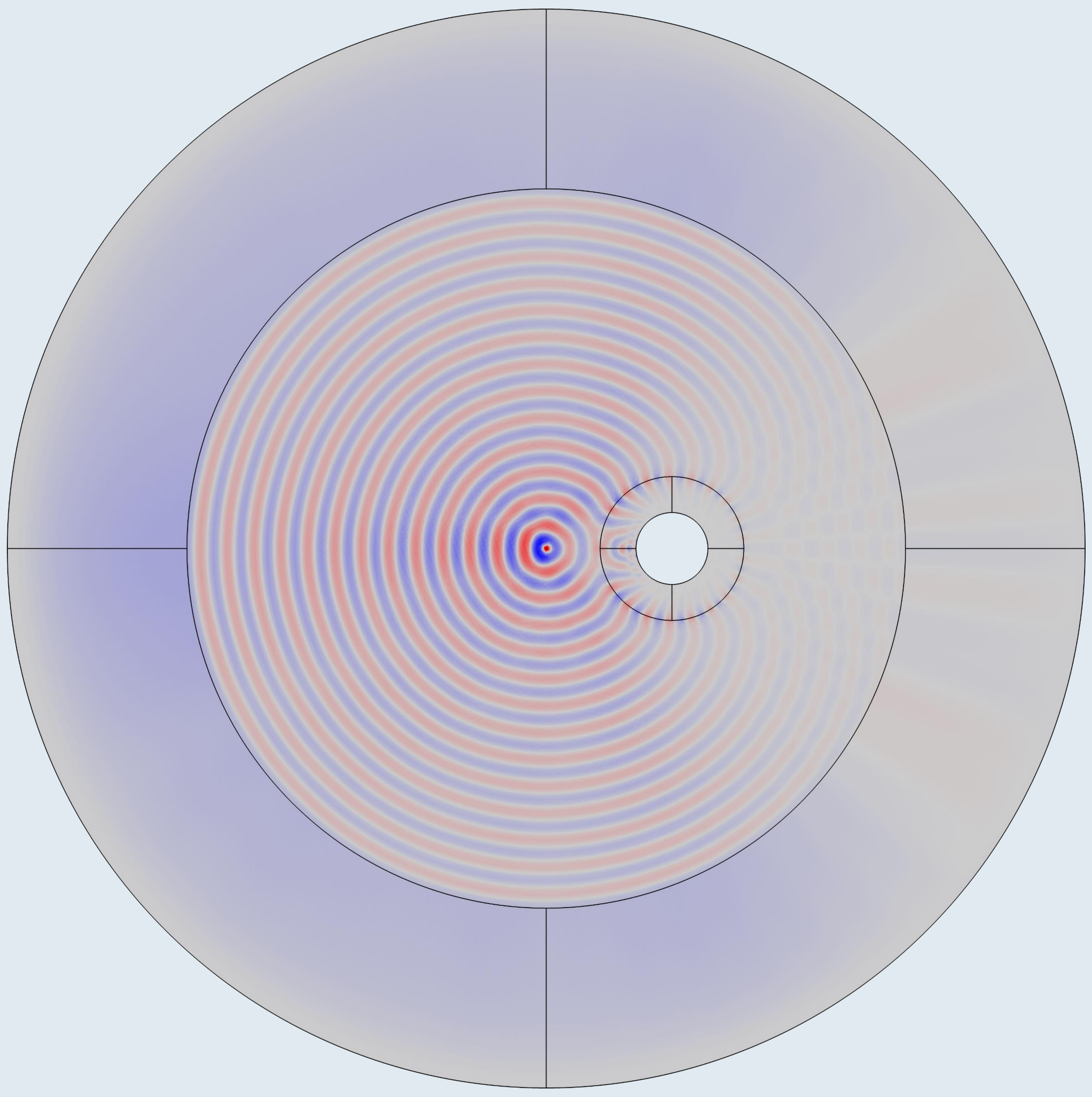

Acoustic Superscatterers For Passive Noise Control

Suppression of noise is vital to many branches of science and engineering, and various active and passive methods are reported in the literature and realised in practice for this purpose. This work proposes an acoustic superscatterer enabled passive noise control system.

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Abstract

This poster presents a passive noise control of sound emanated from a vibrating cylinder using acoustic superscatterers. Acoustic superscatterer is a type of metamaterial whose scattering cross-section is larger than its real size. Numerical studies are conducted using pressure acoustics module of COMSOL. Using coordinate transformation method, the anisotropic material indices of the acoustic superscatterer are derived and substituted in the COMSOL model. When the superscatterer is placed in the vicinity of the vibrating cylinder, the far-field radiated noise is attenuated considerably. This effect is much pronounced when the source lies within the enhanced boundary of the acoustic superscatterer due to the interaction between this boundary and the wavefield originating from the source. An analytical framework for this phenomenon is also derived which is cross verified against the COMSOL numerical simulation. We envisage that this technique of noise control will be useful in more strategic underwater applications such as reduction of radiated sound from a submersible.

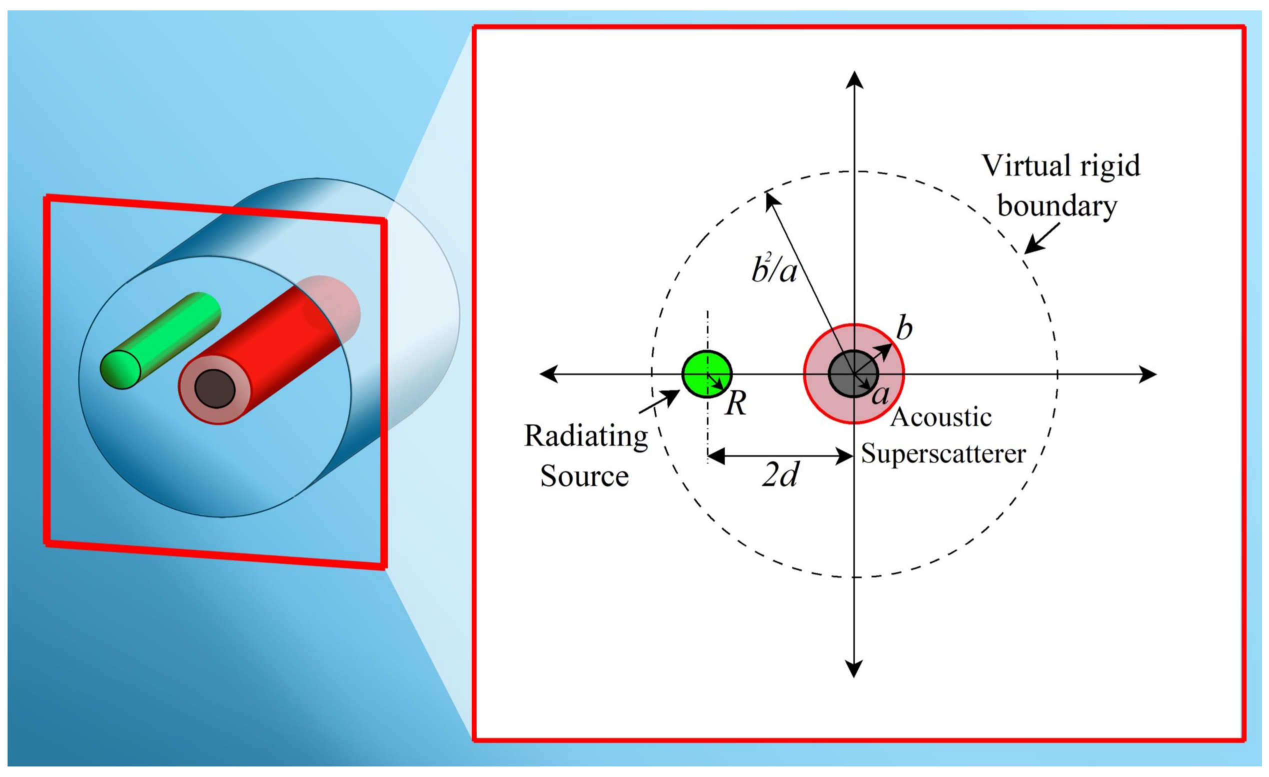

FIGURE 1. An illustration of the source, superscatterer and the virtual rigid boundary of the superscatterer

Methodology

The form invariance of the wave equation in transformation acoustics yields,

$$\rho_r = \frac{r}{f}\frac{\mathrm{d}f}{\mathrm{d}r} \qquad \rho_\theta = \frac{f}{r}\frac{1}{\left(\mathrm{d}f/\mathrm{d}r\right)} \qquad \lambda = \frac{r}{f}\frac{1}{\left(\mathrm{d}f/\mathrm{d}r\right)}$$

In order to satisfy the condition for a partially-resonant system;

$\lambda(r=b)\lambda_0 + \lambda_0 = 0$ the transformation function is, $f(r) = \frac{b^2}{r}$

$$\rho_r = -1, \rho_\theta = -1, \ \lambda = -\left(\frac{r}{b}\right)^4$$

Results

It can be observed in Figure 2 that the superscatterer (a=2 m, b=4 m) attenuates the total forward radiated sound at the far-field for both types of sources such as monopole and dipole sources compared to uncoated cases (a=2 m and a=4 m). Another interesting observation is that the superscatterer can scatter more effectively than a rigid scatterer of the same scale (a=4 m).

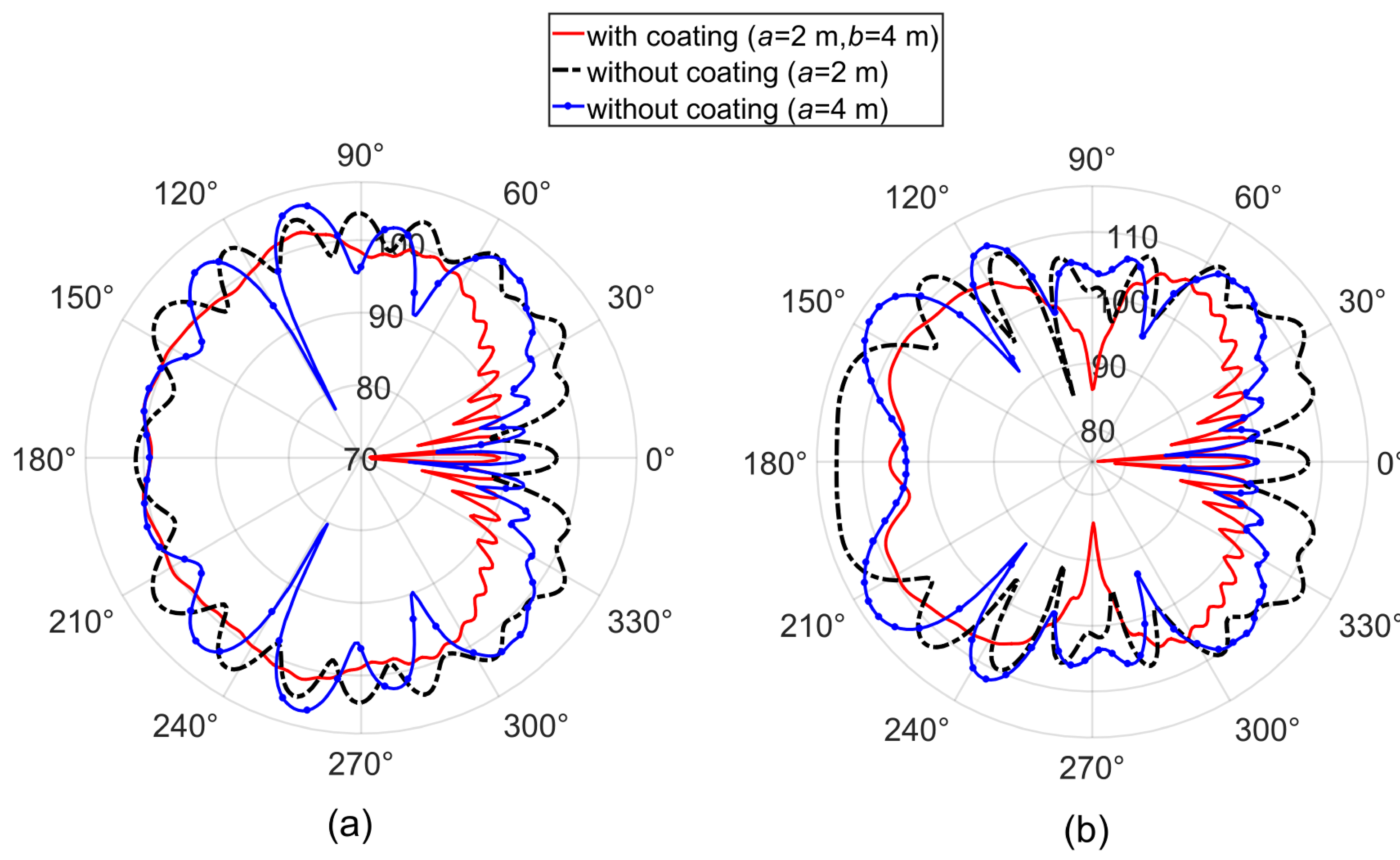

FIGURE 2. Left: Far-field SPL for a monopole source with and without coating. Right: Far-field SPL for a dipole source with and without coating.

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