Temperature Gradients Controlled Broadband Acoustic Omnidirectional Absorber

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Introduction： Previous research into acoustic omnidirectional absorber (AOA) has shown the feasibility of forming acoustic black hole to guide the incident wave into the central absorptive cavity[1]. However, major restrictions to practical applications exist due to the complexity of designing metamaterials or unchangeable working states[2-5]. As we all know, temperature will affect the sound velocity, which equivalently changes the refractive index of the medium. It is naturally to inspire us to utilize temperature gradients to obtain the desired refractive index to control the sound propagation[6, 7]. Two cylindrical, two-dimensional AOA schemes based on temperature gradients for airborne applications are presented in Figure 1.

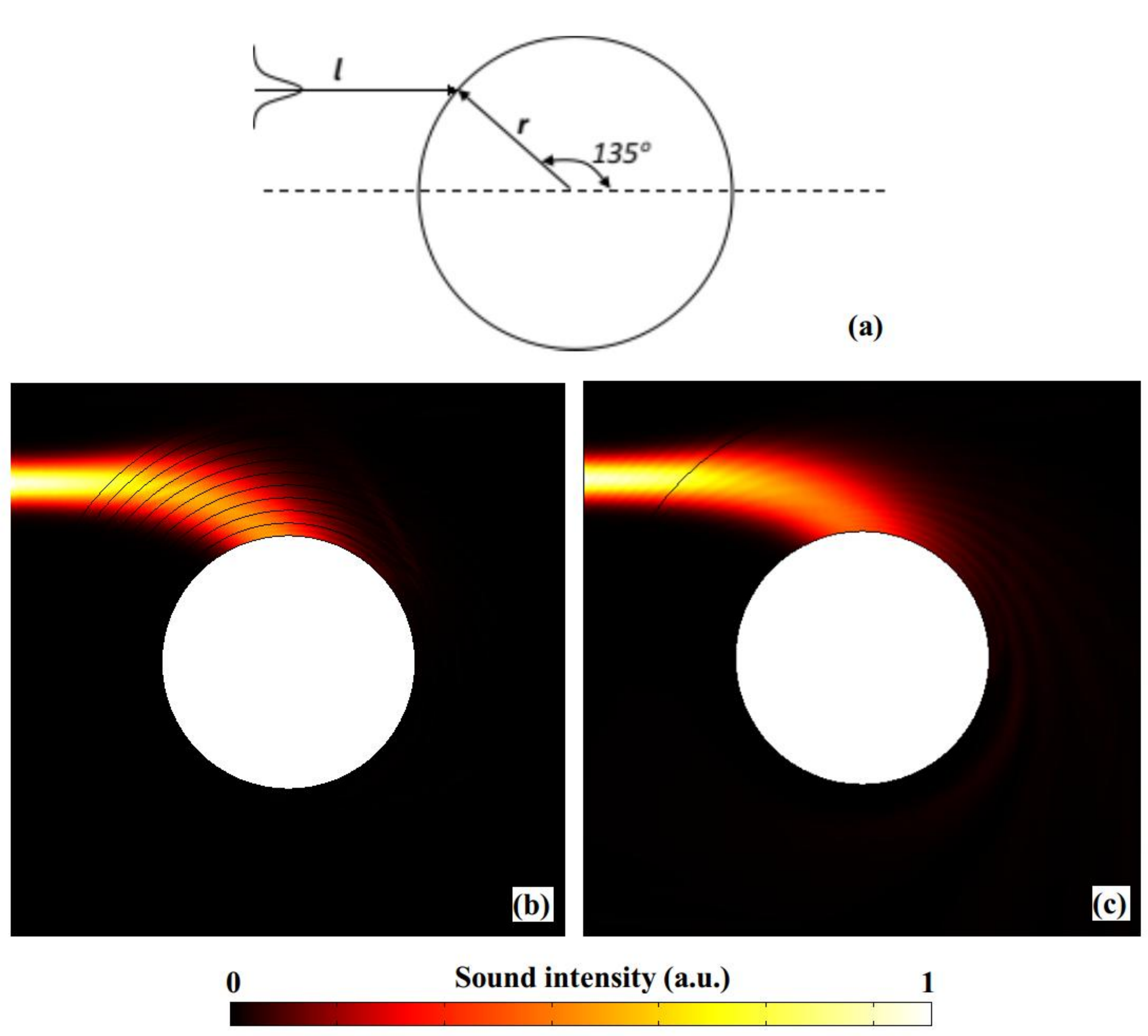

Figure 1: (a) Schematic diagram of the incident angle. (b), (c): respective intensity fields of the accurately designed and simplified TGAOA schemes with an incident 13000 Hz Gaussian wave.

Method: Both pressure acoustics (acpr) interface and general heat transfer (htgh) interface are used. The acoustic field and thermal field are coupled by COMSOL Multiphysics®. Geometric acoustics is used to obtain the refractive index distributions with different radii, which is then utilized to deduce the desired temperature gradients.

Result： One scheme with accurately designed temperature gradients has better absorption performance which can almost completely absorb the incident wave, while the other one with simplified configuration has low complexity which is much more easily to realize (Figure 2(a,b)). Both schemes are temperature-tuned with broad working bandwidth (Figure 2(c)). Since they doesn't base on resonant units, the schemes are supposed to be broadband.

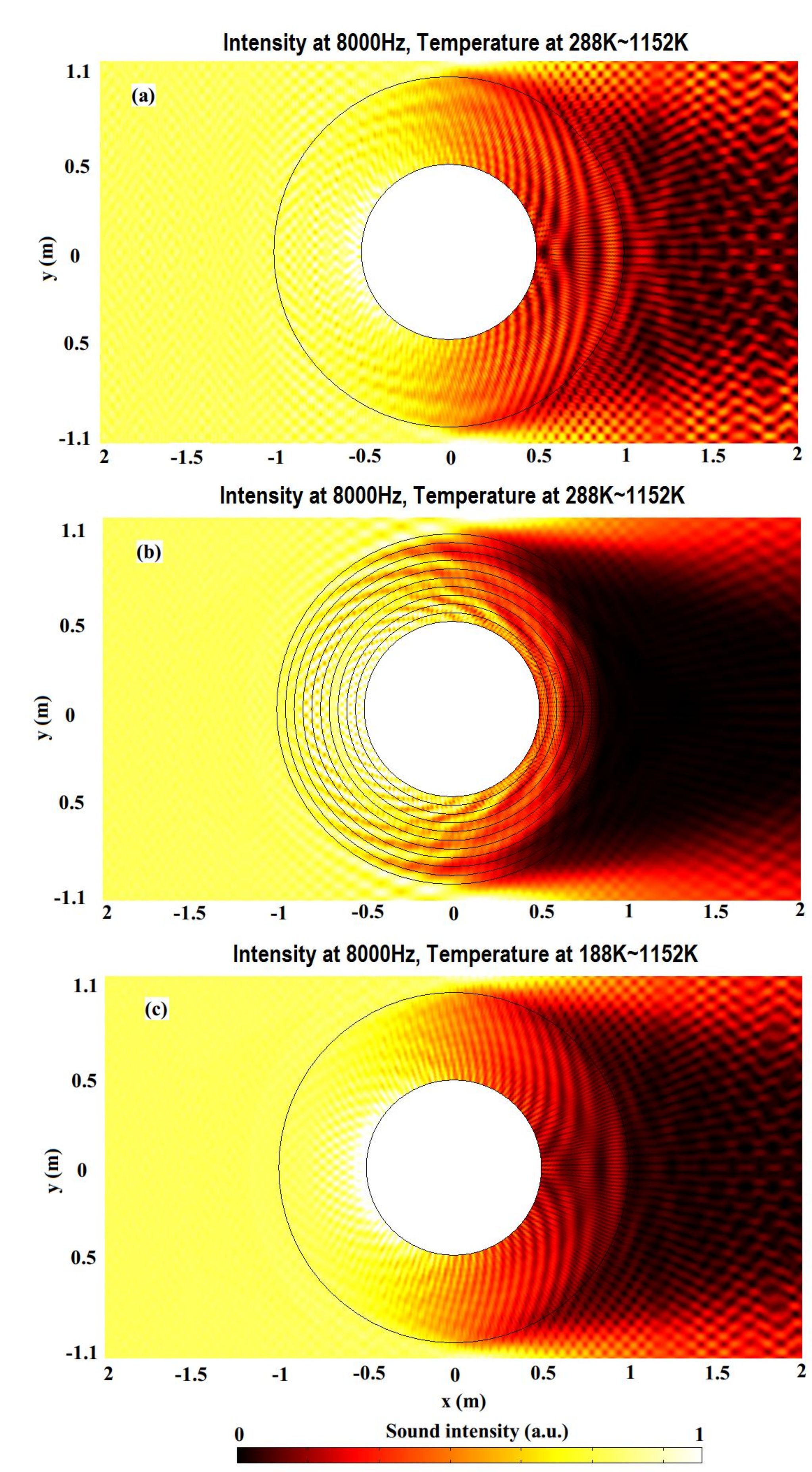

Figure2： (a), (b): respective intensity fields of simplified and accurately designed TGAOA schemes with an incident 8000Hz plane wave. The temperature at the inner radius is 288K; the one at the outer radius is 1152K. (c) Intensity field of simplified TGAOA schemes with an incident 8000Hz plane wave. The temperature at the inner radius is 188K; the one at the outer radius is 1152K.

Reference:

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