Numerical simulation of the far-field acoustic sounds by the finite difference lattice Boltzmann method

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Abstract (11 pt Times Bold)

In this study, we simulate the acoustic sounds generated by a uniform flow around a two-dimensional circular cylinder at Re=150 are simulated by applying the finite difference lattice Boltzmann method(FDLBM). The finite difference lattice Boltzmann method(Cao et al., 1997) developed from LBM is also one of the computational fluid mechanics methods. Here, a new model is proposed using the lattice BGK compressible fluid model in the conventional FDLBM for the purpose of speeding up the calculation as well as stabilizing the numerical schemes.

In the far-field acoustic sounds, a third-order-accurate up-wind scheme is used for the spartial derivatives, and a second-order-accurate Runge-Kutta scheme is used for the time marching. The results by capturing very small acoustic pressure fluctuation with same frequency of Karman vortex street compared with the pressure fluctuation around a circular cylinder. The propagation velocity of the acoustic sound shows that acoustic approaching the upstream due to the Doppler effect in the uniform flow slowly propagates, while it for the downstream quickly propagates. It is also apparent that the size of sound pressure is proportional to central distance $r^{-1/2}$ of the circular cylinder.

And some examples to examine the lattice dependence will be also presented.

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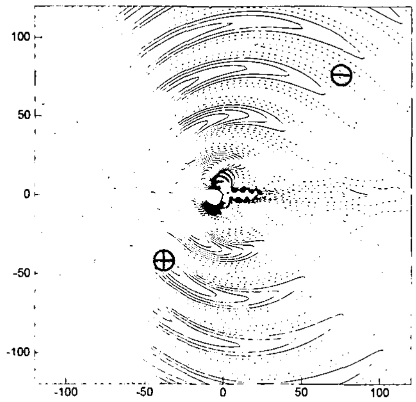

Fig. 1 Contours of sound pressure by FDLBM at t=133, Re=150 and M=0.2

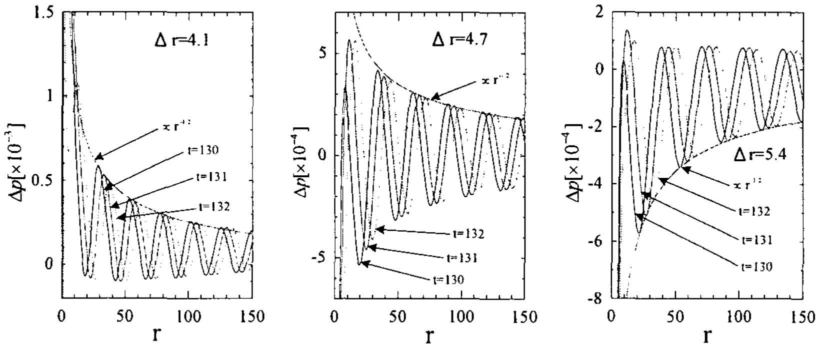

Fig. 2 Distributions and decays of sound pressure. Re=150, M=0.2