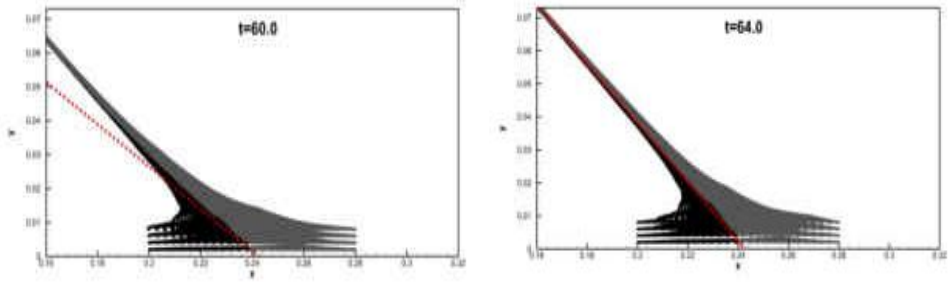
Numerical Study of Cavity Flows

Shuhai Zhang (张树海)
State Key Laboratory of Aerodynamics

Cavity flows have been of great interest in a lot of engineering applications, such as the landing gear well of airplane at landing and takeoff and window open conditions of cars. The cavity flows are very complex. They have the features of strong unsteady and multiscale. The strong unsteady flow can produce the strong fluctuation of pressure on the surface and result in the structural fatigue and damage the structure. It can also produce strong aerodynamic noise and pollute our environment. Using high order WENO schemes, we systematically study the cavity flow with direct numerical simulation and the flow structures are obtained with high accuracy. The mechanism of unsteady flow separation and sound generation are analysed. The numerical result verified our criteria for two dimensional periodic flow separation, it is the zero point of the finite time Lyapunov exponent (FTLE). It is found that there is essential difference in the mechanism of sound generation between the subsonic cavity flow and supersonic cavity flow. In the subsonic flow, the sound is mainly produced by the interaction of the shear layer and the rear wall. In the supersonic flow, the sound is generated by the shock waves. Figure 1 contains separating material spike in periodic lid-driven cavity flow and the leading-order separation profile. Figure 2 contains the numerical schlieren photographs of two dimensional cavity flow.



(a) t=60 (b) t=64

Fig.1 Separating material spike in periodic lid-driven cavity flow and the

leading-order separation profile.

(a) M=0.8 (b) M=1.2

Fig.2 The numerical schlieren photographs of two dimensional cavity flow.