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Large-Scale Structures in a Subsonic Mixing Layer

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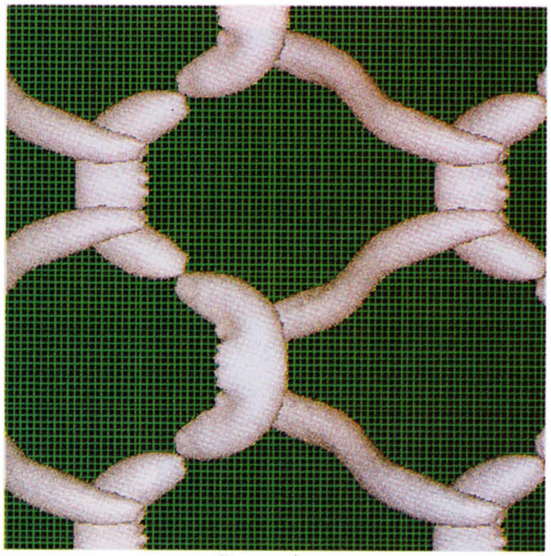

Figure 1. Projection of isopressure surfaces on the streamwise–spanwise plane. $Time=63\delta_0/U_0$, $P=0.84P_\infty$.

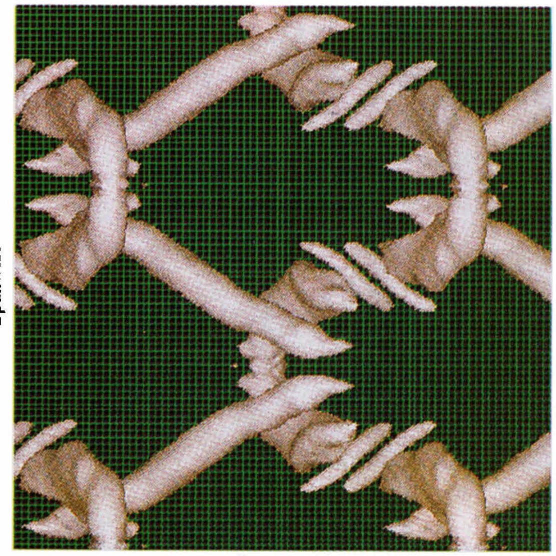

Figure 2. Projection of isopressure surfaces on the streamwise–spanwise plane. $Time=76\delta_0/U_0$, $P=0.84P_\infty$.

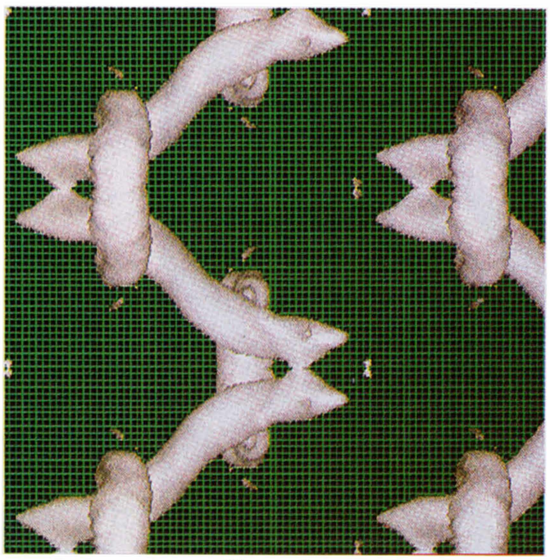

Figure 3. Projection of isopressure surfaces on the streamwise–spanwise plane. $Time=83\delta_0/U_0$, $P=0.84P_\infty$.

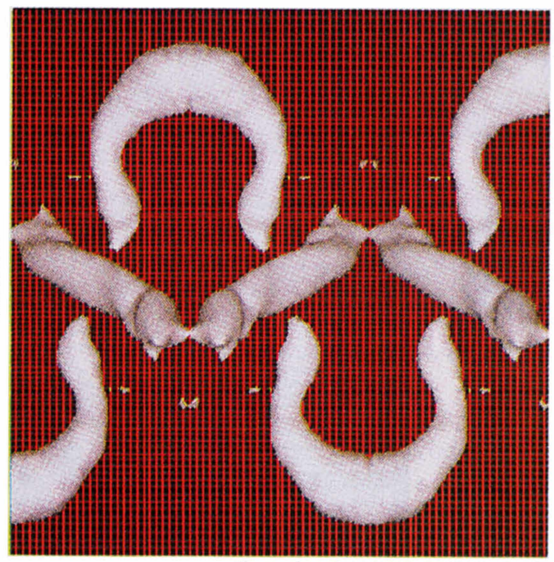

Figure 4. Projection of isopressure surfaces on the transverse–spanwise plane. $Time=83\delta_0/U_0$, $P=0.84P_\infty$.

LARGE-SCALE STRUCTURES IN A SUBSONIC MIXING LAYER

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Shown in the figures are instantaneous snapshots of the large-scale vortical structures in a temporally developing mixing layer obtained from a large eddy simulation. The flow is initialized with the most unstable 2-D linear stability wave and two oblique waves ($\pm 45°$). The simulation is for a high Reynolds number of 10 000 and a convective Mach number of 0.4. The reference length δ_0 is half the vorticity thickness of the initial mean velocity profile and the reference velocity U_0 is half the velocity difference between the two streams. Isopressure surfaces are used to show regions of organized vorticity. The Kelvin–Helmholtz (KH) instability in the mixing layer leads to the formation of 2-D spanwise vortex structures. The strain field between the rollers stretches the streamwise vorticity component leading to the generation of primary streamwise vortices. Once these streamwise vortices develop, they control the dynamics of the flow field. The KH vortices lose their suction pressure except at the bends. Figure 1 shows the KH rollers and the primary streamwise vortices. The primary streamwise vortices bend in the spanwise direction and in turn create secondary streamwise vortices in place of the original KH vortices. Simultaneously, these primary streamwise vortices twist and break down in the middle. Figure 2 shows the secondary streamwise vortices and the remains of the primary streamwise vortices. The remains of the primary streamwise vortices join with their neighbor to form hairpin shaped vortices. Figures 3 and 4 show the projection of the secondary streamwise vortices and the hairpin vortices on two different planes.

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