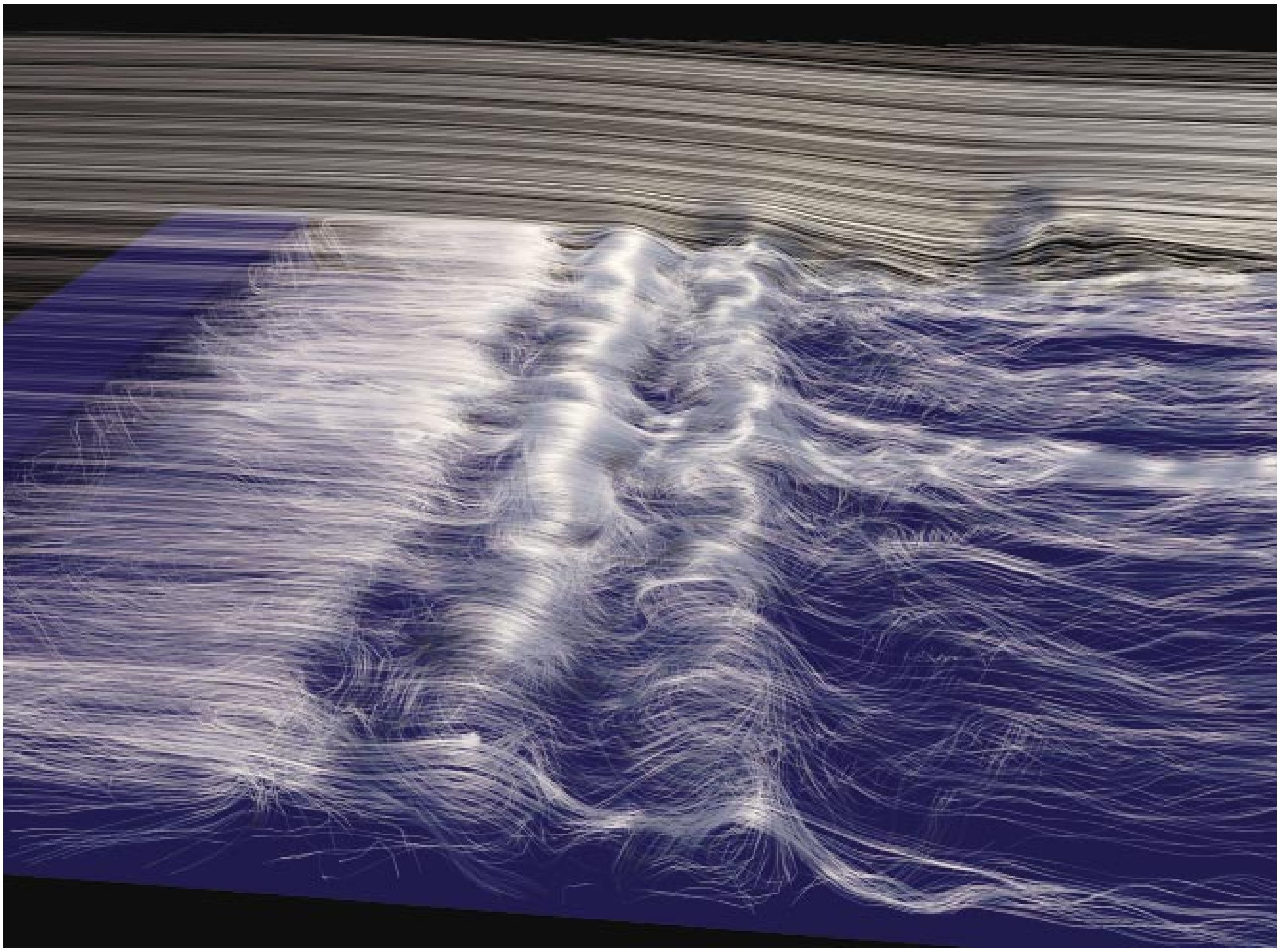

FIG. 1.

Coherent Structures in a Transitional Flow around a Backward-Facing Step

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The transitional flow around a backward-facing step is visualized using illuminated streamlines of a snapshot (Fig. 1). The flow separates at the corner of the step. The resulting shear layer rolls up in two Kelvin–Helmholtz vortices. In the downstream direction, the streamlines form bundles due to secondary streamwise vorticity. The fluid experiences a small backward flow in the upstream region below the shear layer. The flow field is obtained from a large-eddy simulation by Kaltenbach and Janke at a Reynolds number of $Re_H=3000$ based on oncoming velocity and on step height. The corresponding boundary conditions are described in Ref. 1.

The streamlines are illuminated in order to enhance the three-dimensional perception of the scene. This highly interactive, hardware-supported technique is described by Stalling, Zöckler, and Hege.[2]

The seeding of the streamlines is based on the mean curvature of surfaces which are locally perpendicular to the velocity field. As shown in Ref. 3, the mean curvature converges to infinity only near critical points of the considered vector field and vanishes in uniform flow. The mean curvature parametrizes a probability distribution used for seeding. Thus, streamlines passing only through regions of nearly uniform flow are blended out whereupon streamlines connected to critical points are emphasized. Additional streamlines are placed in a background slice in order to show how the coherent structures are embedded in the base flow.

[1]H.-J. Kaltenbach and G. Janke, ''Direct numerical simulation of flow separation behind a swept, rearward-facing step at $Re_H=3000$,'' Phys. Fluids **12**, 2320 (2000).
[2]D. Stalling, M. Zöckler, and H.-C. Hege, ''Fast display of illuminated field lines,'' IEEE Trans. Vis. Comput. Graph. **3**, 118 (1997).
[3]T. Weinkauf and H. Theisel, ''Curvature measures of 3D vector fields and their applications,'' J. Winter School of Computer Graphics **10**, 507 (2002).

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