

Figure 1

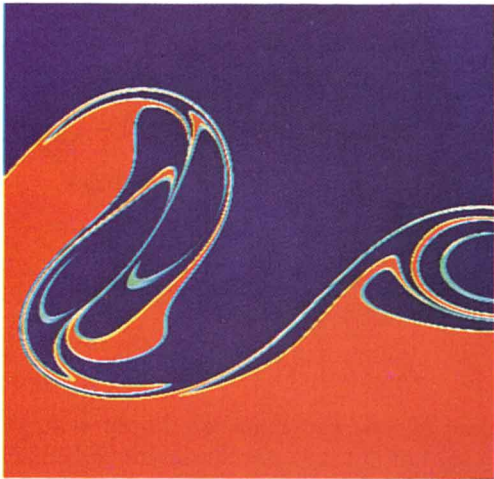


Figure 2

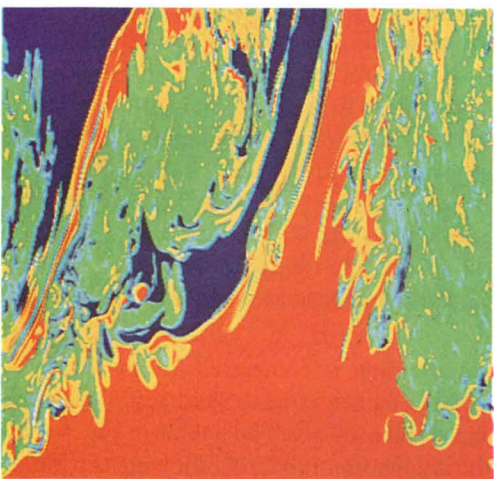


Figure 3

LASER-INDUCED FLUORESCENCE MEASUREMENTS OF THE COMPOSITION FIELD IN A LIQUID MIXING LAYER

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Laser-induced fluorescence (LIF) diagnostics and high-speed, real-time digital image acquisition techniques are combined to map the composition field in a water mixing layer.⁸ A fluorescent dye, which is premixed with the low-speed freestream fluid and diluted by mixing with the high-speed fluid, is used to monitor the relative concentration of high-speed to low-speed fluid in the layer.

The three digital LIF pictures shown here were obtained by imaging the laser-induced fluorescence originating from a collimated argon ion laser beam, extending across the transverse dimension of the shear layer, onto a 512-element linear photodiode array. Each picture represents 384 contiguous scans, each at 400 points across the layer, for a total of 153 600 point measurements of concentration. The vertical axis maps onto 40 mm of the transverse coordinate of the shear layer, and the horizontal axis is time increasing from right to left for a total flow real time of 307 msec. The pseudocolor assignment is linear in the mixture fraction (ξ) and is arranged as follows: red—unmixed fluid from the low-speed stream ($\xi = 0$); blue—unmixed fluid from the high-speed stream ($\xi = 1$); and the rest of the spectrum corresponds to intermediate compositions.

Photographs 1 and 2, a single vortex and pairing vortices, respectively, show the composition field before the mixing transition. The Reynolds number based on the local visual thickness of the layer and the velocity difference across the layer is $Re = 1750$ with $U_2/U_1 = 0.46$ and $U_1 = 13$ cm/sec. Note the large excess of high-speed stream fluid in the cores of the structures.

Photograph 3 shows the composition field after the mixing transition. The horizontal scale is reduced by a factor of about 5 compared to photographs 1 and 2. The Reynolds number is $Re = 23\,000$ with $U_2/U_1 = 0.38$ and $U_1 = 70$ cm/sec. Note that the composition of the mixed fluid is asymmetric and biased toward the high-speed fluid and that it is almost uniform across the entire transverse extent of the shear layer.