

## SECONDARY INSTABILITY IN TRANSITION OF PLANE POISEUILLE FLOW (“FLOWERS OF THE SEA”)

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This picture was obtained from a numerical simulation of the evolution of three dimensionality in laminar–turbulent transition of a plane Poiseuille flow. The three-dimensional development is caused by a “secondary” instability that leads to a spanwise peak–valley structure.<sup>5–7</sup> Shown is a “flow visualization” of the nonlinear interactions of two-dimensional Tollmien–Schlichting waves and two oblique waves resulting from a secondary instability. The flow is from bottom to top, and the view is in the direction normal to one plate. For the flow visualization, marker particles were emitted from 101 equally spaced locations at a fixed downstream position that corresponds to the horizontal lower margin of the photograph. The emission of such marker particles simulates, for example, the flow visualization using hydrogen bubbles that are emitted from a wire that is stretched in the spanwise direction perpendicular to the mean flow. The particle-emitting line is approximately at the critical layer.

The picture shown here can be thought of as a long-time camera exposure, where the particles were illuminated under stroboscopic light with approximately 13 illuminations per period of the disturbance wave. The color of the particles is assigned according to the total spanwise vorticity component ( $\omega_z$ ) at the instantaneous locations of the individual particles. The intensity of  $\omega_z$  increases from blue to red to yellow to white. The photograph covers seven Tollmien–Schlichting wavelengths in the downstream direction (bottom to top) and two wavelengths in the spanwise direction (left to right).

