Spatiotemporal boundary dissipation measurement by Diffusing-Wave Spectroscopy

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We report the first spatially and temporally resolved measurements of the dissipation rate at the outer surface of a Taylor-Couette flow, in the laminar regime and in the first unstable regimes (Taylor vortex and wavy vortex flows) [1]. These measurements are performed using a dynamic light scattering technique called Diffusing-Wave Spectroscopy (DWS) [2 3], which relies on the diffusive nature of the multiply scattered light in a turbid colloidal suspension. In a DWS experiment, the light intensity $I(t)$ is collected and its time autocorrelation $g_2(t) = \langle I(t_0)I(t_0+t)\rangle / \langle I(t_0)\rangle^2$ is computed. g_2 decays because of the phase shift of light in time at each scattering event. This decay is thus due to the Brownian motion of the scatterers and to the velocity gradients in the flow, and more precisely to the norm of the strain rate tensor $e_{i,j} = \frac{1}{2}(\partial_i v_j + \partial_j v_i)$ which can therefore be deduced [4 5]. By using a high-speed camera, we get a time-evolving quantitative map of $\Gamma = \sqrt{2\sum_{i,j} e_{i,j}^2}$, in addition to the global measurements already obtained by Bicout and Maret [6]. The Taylor vortices and their oscillations are therefore observed. This work validates the use of DWS to probe more complex flows where velocity gradients are unknown.

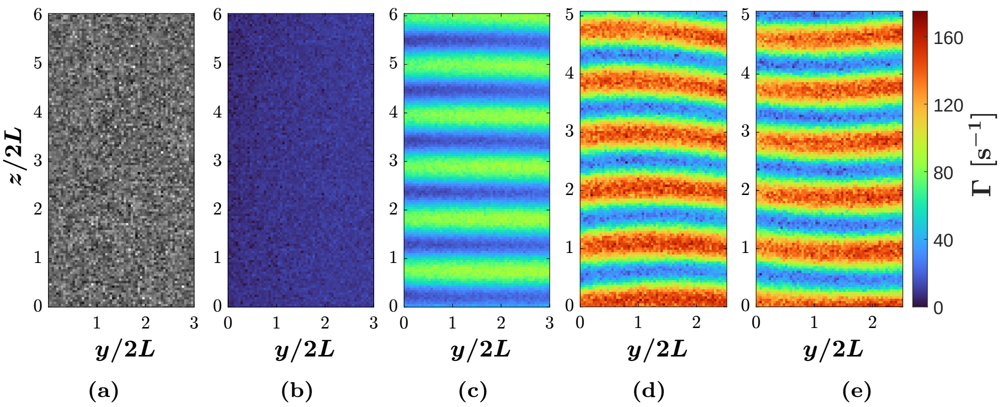

Figure 1 – **(a)** Snapshot of the speckle pattern directly measured by the camera (arbitrary units of intensity). **(b)** Spatially resolved map of Γ in the linear regime ($Ta = 188$), and **(c)** in the Taylor vortex regime ($Ta = 3012$). **(d)(e)** Two spatially resolved map of Γ (0.25 s apart), in the wavy vortex regime ($Ta = 4706$) where the oscillations of the vortices are clearly visible.

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