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Fluid Complex Flow

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ROUTES TO TURBULENCE FOR COMPLEX FLUID FLOWS IN PIPE

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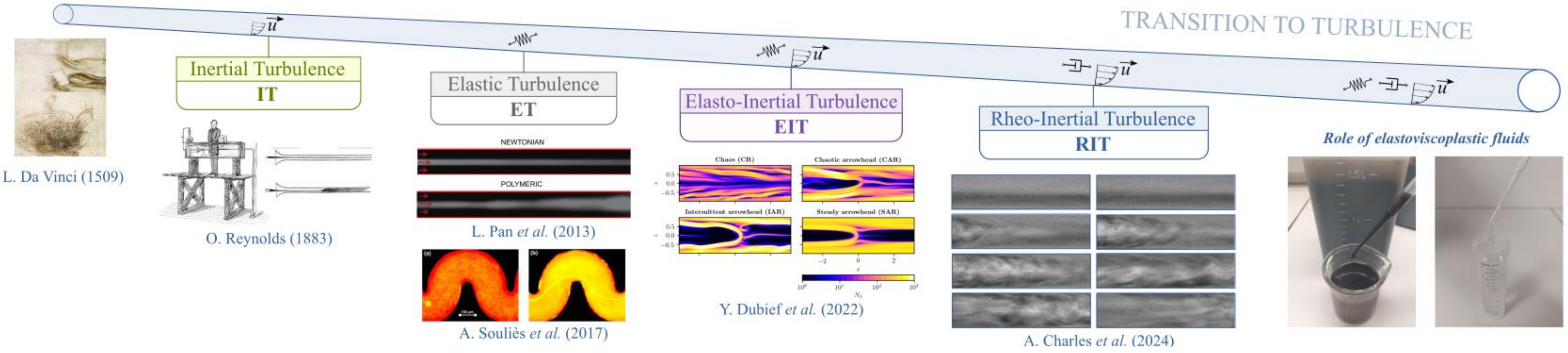
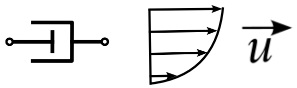
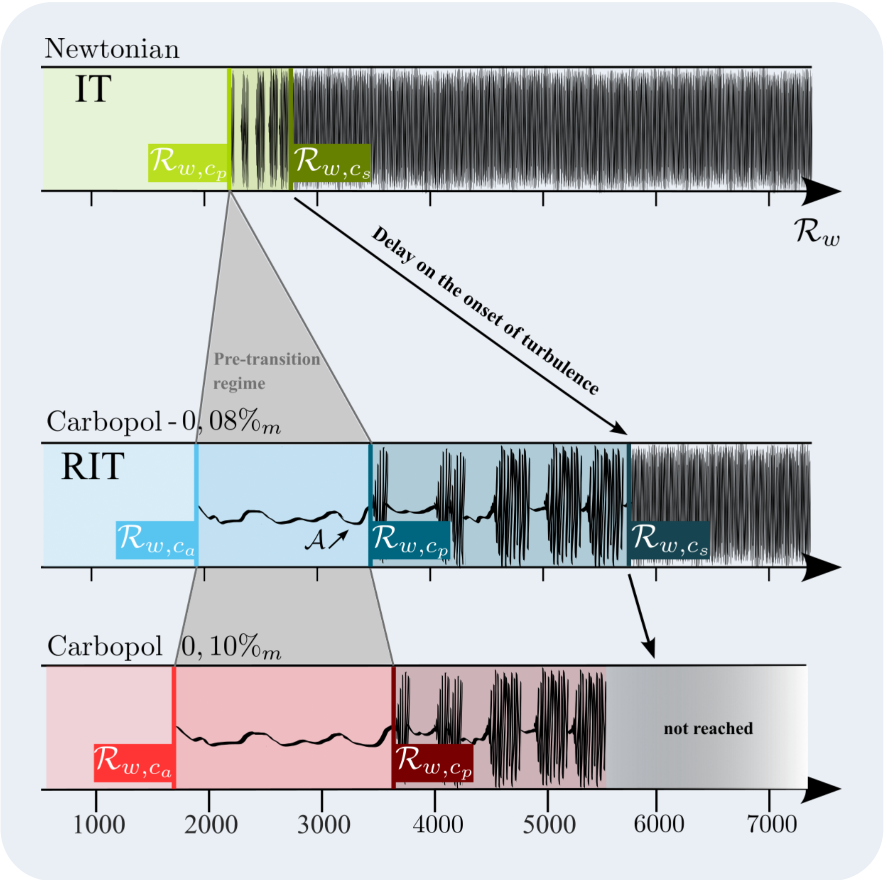
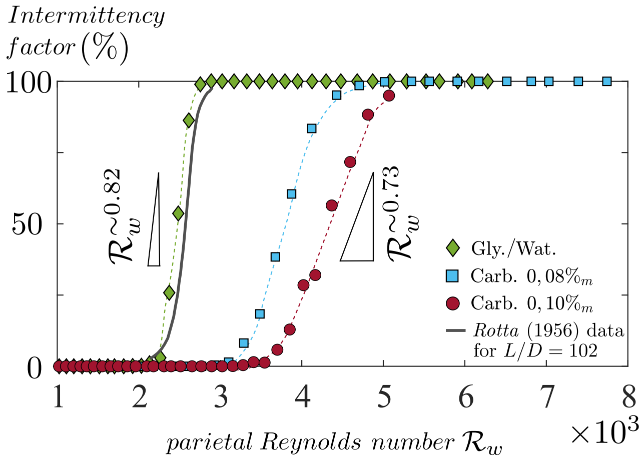


Rheo-Inertial Turbulence
RIT

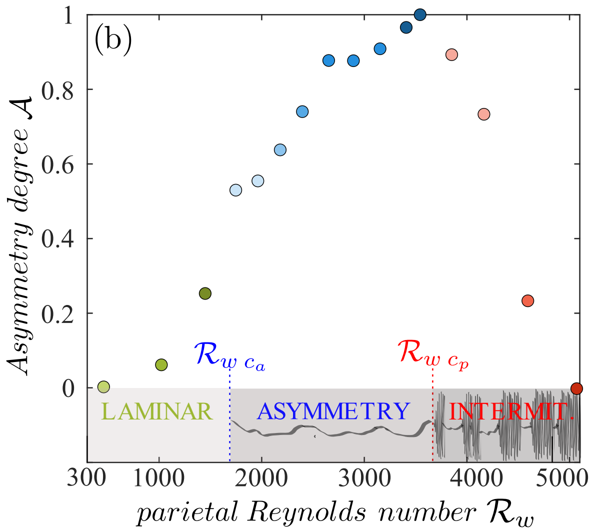




1) Delay on the onset of the turbulence



2) Flow asymmetry across the pipe axis



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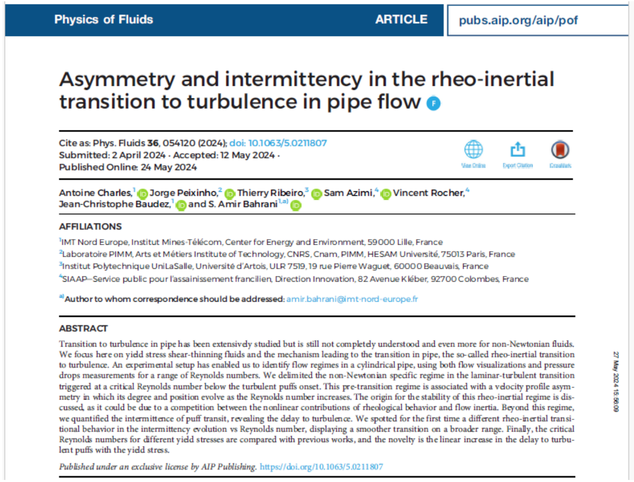

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Asymmetry and intermittency in the rheo-inertial transition to turbulence in pipe flow

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ABSTRACT

Transition to turbulence in pipe has been extensively studied but is still not completely understood and even more for non-Newtonian fluids. We focus here on yield stress shear-thinning fluids and the mechanism leading to the transition in pipe, the so-called rheo-inertial transition to turbulence. An experimental setup has enabled us to identify flow regimes in a cylindrical pipe, using both flow visualizations and pressure drops measurements for a range of Reynolds numbers. We delimited the non-Newtonian specific regime in the laminar-turbulent transition triggered at a critical Reynolds number below the turbulent puffs onset. This pre-transition regime is associated with a velocity profile asymmetry in which its degree and position evolve as the Reynolds number increases. The origin for the stability of this rheo-inertial regime is discussed, as it could be due to a competition between the nonlinear contributions of rheological behavior and flow inertia. Beyond this regime, we quantified the intermittence of puff transit, revealing the delay to turbulence. We spotted for the first time a different rheo-inertial transitional behavior in the intermittency evolution vs Reynolds number, displaying a smoother transition on a broader range. Finally, the critical Reynolds numbers for different yield stresses are compared with previous works, and the novelty is the linear increase in the delay to turbulent puffs with the yield stress.