LadHyX Seminar – December 2, 11:00, Room PC 44 and Zoom

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Two-dimensional absolute/convective instability analysis through the Riesz transform and application to draperies structures in limestone caves

We study the role of hydrodynamic instabilities in the morphogenesis of typical karst draperies structures encountered in limestone caves. This problem is analyzed using the long wave approximation for the fluid film that flows under an inclined substrate, in the presence of substrate variations that grow according to a deposition law. We numerically study the linear evolution of a localized initial perturbation both in the fluid film and on the substrate, i.e. the Green function. A novel approach for the spatio-temporal analysis of two-dimensional signals resulting from these linear simulations is introduced, based on the concepts of the Riesz transform and the monogenic signal, the multidimensional complex continuation of a real signal. This transform constitutes the two-dimensional analogue of the Hilbert transform. The deposition linearly selects stationary substrate structures aligned along the streamwise direction, left behind as the spatio-temporal response is advected away. Nonlinear selection mechanisms prevailing in pure hydrodynamic instabilities of thin films flowing on the downside of an inclined ceiling are finally discussed. We show that longitudinal structures, called rivulets, are non-linearly selected, and dominate in particular the leading wavefront. We suggest that these linear and nonlinear selection mechanisms contribute to the formation of draperies under inclined cave ceilings.