11:15 15 mins	Dispersive to nondispersive transition in the plane wake and channel flows *Francesca De Santi, Federico Fraternale, Daniela Tordella*	**tag**

Session: Instability and Transition 7
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Abstract:
By varying the wavenumber over a large and finely discretized interval of values, we analyse the phase and group velocity of linear three-dimensional travelling waves both in the plane wake and channel flows to get the transition between dispersive and non-dispersive behaviour. The dispersion relation is computed from the Orr-Sommerfeld and Squire eigenvalue problem by observing the least stable mode, see figure 2, panels (a,b) and the comparison with [1, 2, 4–11, 15, 16]. The group velocity vg is also shown. The Reynolds number varies in the 20-100, 1000-8000 ranges for the wake and the channel flow, respectively, while we consider wavenumbers in the range 0.1-10. The wake basic flow consists of the first two orders of the Navier-Stokes matched asymptotic expansion described in [3, 13, 14]. At low wavenumbers we observe a dispersive behaviour where the phase speed and the group velocity substantially differ. The relevant perturbed solution is amenable to the typical solution belonging to the left branch of the eigenvalue spectrum, see the two examples shown in figure 1 (channel flow: Re = 6000, k = 1; wake Re = 100, k = 0.7). By rising the wave number value, we observe a sharp transition from the dispersive to the nondispersive regime. This transition is located at a critical wave number kd which is a function of the Reynolds number Re, the wave angle φ, and the wake downstream observation point x0. Precisely, kd increases with Re and decreases with φ for the wake flow, while these trends are reversed for the channel flow, see tables 1,2. Beyond the wavenumber threshold, the observed least-stable mode belongs to the right branch of the spectrum. The asymptotic solutions in the dispersive region are wall modes for the channel flow , and in-wake modes for the wake flow. This means that, for both the flows, the dispersive behaviour is related to perturbations with high momentum variations (high vorticity) in correspondence to the base flow high-shear region. On the contrary, if k > kd the solutions are central modes for the channel case, and out-of-wake modes for the wake flow. In these cases, the disturbance has high variations outside the base flow high-shear region. To understand the physical mechanism of the dispersive-nondispersive transition we focused on time variation of the wave kinetic energy associated to the convective transport. Figure 2 (c,d) shows the convective term as a function of the wavenumber for the two least stable modes. We observe that the dispersive-nondisperive transition allows waves k > kd to keep the lowest possible temporal variation of kinetic energy, i.e. the lowest decay. This remains true also when all the other more stable modes are considered. In practice nondispersive waves maintain their convective energy with k.
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