Stability of coaxial swirling jets

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In order to improve the mixing properties of injectors, we investigate the potential synergy between azimuthal and axial shear. For this purpose, we examine the linear modal stability of a simplified analytical model which consists of a temporally evolving swirling jet surrounded by an annular jet with a different axial velocity. We denote $\Lambda = V_2/V_1$ the ratio between the axial velocity of the non-swirling annular jet V_2 and the axial velocity of the central jet V_1 ; and $q = \Omega_c\, r_1/V_1$ the swirl number of the central jet where Ω_c is the rotation rate on the jet axis and r_1 the radius of the central jet. The present study extends the results of Gallaire & Chomaz (2003) where a single swirling jet was considered. For all values of the swirl number up to $q = 2$, adding the outer non-swirling jet increases substantially the growth rate of the most amplified mode, which can be more than doubled when $\Lambda > 1$. This is the result of the collaborative axial and azimuthal shear instabilities localised in between the two jets. The mode selection of larger azimuthal wavenumbers with increasing q, identified by Gallaire & Chomaz (2003), is no longer observed when the outer jet is at least as fast as the central jet $\Lambda > 1$, the axisymmetric $m = 0$ mode being the most amplified.

References

Gallaire, F. & Chomaz, J-M. 2003 Mode selection in swirling jet experiments : a linear stability analysis. *J. Fluid Mech.* **494**, 223–253.