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Extention of Arnold's stability theory for planar viscous shear flows HARRY LEE, University of Michigan, SHIXIAO WANG, University of Auckland — A viscous extension of Arnold's inviscid theory for planar parallel non-inflectional shear flows is developed and a viscous Arnold's identity is obtained. Special forms of our viscous Arnold's identity are revealed that are closely related to the perturbation's enstrophy identity derived by Synge (1938) (see also Fraternale *et al.* 2018). Firstly, an alternative derivation of the perturbation's enstrophy identity for strictly parallel shear flows is acquired based on our viscous Arnold's identity. The alternative derivation induces a weight function, inspired by which, a novel weighted perturbation's enstrophy identity is established that extends the previously known enstrophy identity to include general non-parallel streamwise translation-invariant shear flows imposed with relaxed wall boundary conditions. As an application of the enstrophy identity, we quantitatively investigate the mechanism of linear instability/stability within the normal modal framework. The investigation finds that the critical layer is always a primary source of damping in disturbance's enstrophy and thus it enhances stability. Moreover, a control scheme is proposed that transitions the wall settings from the no-slip condition to the free-slip condition, through which a flow is quickly stabilized.

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