P230a Viscous Instability Triggered by Layered Accretion in Protoplanetary Disks

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Layered accretion is one of the inevitable ingredients in protoplanetary disks when disk turbulence is excited by magnetorotational instabilities (MRIs). In the accretion, disk surfaces where MRIs fully operate have a high value of disk accretion rate ($\dot{M}$), while the disk midplane where MRIs are generally quenched ends up with a low value of $\dot{M}$. Making use of the traditional viscous $\alpha-$parameter that was derived intuitively, layered accretion has been investigated extensively in 1D disk models. Significant progress on understanding MRIs has recently been made by a number of dedicated MHD simulations, which requires improvement of the classical treatment of α in 1D disk models. To this end, we obtain a new expression of α by utilizing an empirical formula that is derived from recent MHD simulations of stratified disks with Ohmic diffusion. It is interesting that this new formulation can be regarded as a general extension of the classical α. Armed with the new α, we perform a linear stability analysis of protoplanetary disks that undergo layered accretion, and find that a viscous instability can occur around the outer edge of dead zones. Disks become stable in using the classical α. We identify that the difference arises from $\Sigma-$dependence of $\dot{M}$; whereas Σ is uniquely determined for a given value of $\dot{M}$ in the classical approach, the new approach leads to $\dot{M}$ that is a multi-valued function of Σ. We confirm our finding both by exploring a parameter space and by performing the 1D, viscous evolution of disks. We finally discuss other non-ideal MHD effects that are not included in our present analysis.