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Linear Stability and Growth of Disturbances in Weakly-Rarefied Pulsatile Flows FRANCESCO FEDELE, NASA Goddard Space Flight Center, DARREN HITT, School of Engineering, University of Vermont — In this work we examine the response of pulsatile pipe flows to axisymmetric perturbations under weakly-rarefied flow conditions (slip regime) roughly defined by Knudsen numbers $Kn \leq 0.1$. Such perturbations can arise, for example, due to surface roughnesses on the solid boundaries. An Orr-Sommerfeld equation is derived and solved by means of a Galerkin projection onto the approximate functional space spanned by a finite set of eigenfunctions derived in the longwave limit of the Orr-Sommerfeld operator. For first-order slip boundary conditions, the results from Floquet stability analyses show that pulsatile slip flow is slightly more stable than the steady slip-flow for longwave disturbance; further, the stability characteristics are found to be only weakly-dependent on the Knudsen number. The flow structures corresponding to the largest energy growth are toroidal vortex tubes that are transported diffusively and convectively by the mean flow. The transient energy growth is found to slightly increase with the Knudsen number, indicating that the Orr-Sommerfeld operator for slip flow is more non-normal when compared to continuum-based no-slip flows. The impact of higher-order slip conditions at $O(Kn^2)$ will also be discussed.

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