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The Role of Cubic Nonlinearity in Limit Cycle Oscillations of Variable-Density Shear Flows[1] CHRISTOPHER DOUGLAS, BENJAMIN EMERSON, TIMOTHY LIEUWEN, Georgia Institute of Technology — This work is directed toward understanding the limit cycle features of globally unstable flows with variable density. Analysis of limit cycles in constant-density shear flows have revealed that oscillation characteristics are controlled by two key effects: mean flow distortions and harmonic interactions. Both of these effects are manifestations of the quadratic nonlinearity of the incompressible Navier-Stokes equations, and their respective roles vary in different flow configurations. However, in flows such as bluff body wakes, surprisingly accurate predictions of important limit cycle features such as frequency and amplitude are possible by neglecting the latter effect and performing a linear analysis about the mean flow. Crucially, even when its amplitude is not small, the quadratic nonlinearity does not allow the limit cycle fundamental to directly modify itself. Conversely, when the fluid density is not constant, a cubic nonlinearity arises and enables self-interactions which are independent from the other effects. This calls into question the validity of linear approaches in such contexts and motivates an investigation of the role of these triadic self-interactions in variable-density shear flows.

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