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Prediction of Combustion Instabilities using a WKB-Type Solution for the Wave Equation in Inhomogeneous Media VIJAYA KRISHNA RANI, SARMA RANI, Univ of Alabama - Huntsville — Linear modal analysis is a widely used reduced-order method to predict combustion instabilities. However, this method is only applicable under the assumption that a combustion system is comprised of chambers with homogeneous mean-flow properties. A well-known analytical solution approach to the one-dimensional (1-D) wave equation in inhomogeneous media is the Wentzel-Kramers-Brillouin (WKB) method, which is based on the assumptions of high frequency and slowly varying flow properties. In this study, a novel WKB-type methodology is developed by relaxing the latter assumption. Solutions are derived for the quasi 1-D wave equation in ducts with varying cross-sectional area and inhomogeneous mean-flow properties. Numerical simulations of the wave equation were also performed. Both the current and classical WKB solutions are compared with the numerical results, as well as known exact solutions. The WKB solution is then applied to predict the longitudinal instabilities in a dump combustor with an area discontinuity. The predicted unstable frequencies are found to be in good agreement with prior experimental and analytical results.

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