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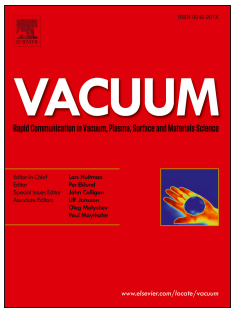

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Three-dimensional linearized stability analysis of Burnett equations for a monatomic gas

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Burnett equations were originally derived in 1935 by Burnett by employing the Chapman-Enskog expansion to Classical Boltzmann equation to second order in Knudsen number *Kn*. Since then several variants of these equations have been proposed in the literature; these variants have differing physical and numerical properties. In this papers, we considered four such variants which are known in the literature as 'the Original Burnett (OB) equations, the Conventional Burnett (CB)'equations, 'the Augmented Burnett (AB)' equations and the recently formulated by the authors 'the Simplified Conventional (SCB) equations.' One of the most important issues in obtaining numerical solutions of the Burnett equations is their stability under small perturbations. In this paper, we perform the linearized stability (known as the Bobylev Stability) analysis of three-dimensional Burnett equations for all the four variants (OB, CB, AB, and SCB) as far as the authors are aware for the first time in the literature on this subject. By introducing small perturbations in the steady state flow field, the trajectory curve and the variation in attenuation coefficient with wave frequency of the characteristic equation are obtained for all four variants of Burnett equations to determine their stability. The results show that the 3-D Augmented Burnett (AB) equations and the Simplified Conventional Burnett (SCB) equations are unconditionally stable under small wavelength perturbations. However, the Original Burnett (OB) and the Conventional Burnett (CB) equations are unstable when the Knudsen number becomes greater a critical value and the stability condition worsens in 3-D when compared to the stability condition for 1-D and 2-D equations. The critical Knudsen number for 3-D OB and CB equations is 0.061 and 0.287 respectively. It should be noted that although both AB and SCB equations are unconditionally stable, SCB equations are much simpler to use numerically compared to AB equations without compromising accuracy.

Keyword: Burnett equations, Linearized stability, Hypersonic flow

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