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Aerodynamic noise generation in boundary layer flows. YI ZHANG, MARTIN OBERLACK, Chair of Fluid Dynamics, TU Darmstadt, Otto-Berndt-Str. 2, 64287 Darmstadt, Germany — Based on the linearized Euler equation and the normal-mode approach, the Pridmore-Brown equation for acoustics of parallel shear flows is solved analytically for a boundary layer flow with an exponential velocity profile. The general solution to this equation is given in terms of the confluent Heun function (CHF). Together with the boundary conditions of vanishing disturbances at infinity, and zero wall-normal velocity, the boundary value problem is converted to an algebraic eigenvalue problem. The eigenvalues obtained by the CHF-based solution does not involve any spurious numerical modes, which are always difficult to distinguish from physical modes. In the temporal stability analysis, the first three acoustic modes are computed as functions of Mach numbers and wavenumbers, where the first mode is always the most unstable one of all, and the present critical Mach number of acoustic instability is close to 2.2. The unstable modes reveal a mechanism of resonance, where waves spatially grow towards to wall. Defining an acoustic boundary layer thickness, which essentially quantifies how far eigenfunctions reach into the area far from the boundary layer, we find that sound is especially for large Mach numbers beyond 2 and large wave numbers are widely audible.

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