Contribution ID: **17** Type: **not specified**

# Sound of rigidly moving fluids: on linear waves in inhomogeneous equilibrium configurations

We propose a method to find local plane wave solutions to linearized equations of motion of relativistic hydrodynamics in inhomogeneous backgrounds, i.e., when fluid is rigidly moving with nonzero thermal vorticity in equilibrium. Our method is based on extending the conserved currents to the tangent bundle, using Wigner transforms. The Wigner-transformed conserved currents can then be Fourier transformed into the cotangent bundle to obtain the dispersion relations for space-time-dependent eigenfrequency. We show that the connection between the stability of hydrodynamics and the evolution of plane waves is not as straightforward as in the homogeneous case and is restricted to the equilibrium-preserving subspace of the cotangent bundle, which is determined by thermal vorticity. We apply this method to MIS theory and show that the interplay between the bulk viscous pressure and the shear stress tensor with acceleration and rotation leads to novel modes, as well as modifications of the already known ones.

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