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Stability Analysis on Compressible Navier-Stokes Equations with Strong Boundary Layer

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It is a classical problem in fluid dynamics about the stability and instability of different hydrodynamic patterns in various physical settings, in particular in the high Reynolds number limit of laminar flow with boundary layer. However, there are very few mathematical results on the compressible fluid despite of the extensive studies when the fluid is governed by the incompressible Navier-Stokes equations. In this talk, we will present a new approach to study the compressible Navier-Stokes equations in the subsonic and high Reynolds number regime. The key observation is to introduce two new decompositions that involve a quasi-compressible and Stokes approximations. And then an iteration scheme is defined by applying the decompositions for solving the linearized compressible Navier-Stokes equations. As a byproduct, an analog of the classical Orr-Sommerfeld equation is derived in the compressible setting.

With the above analytic tools, we show the spectral instability of subsonic boundary layer that is related to the Tollmien-Schlichting waves with critical Gevrey index $\frac{3}{2}$ in the compressible setting that has been well investigated for the incompressible flow, cf. [1, 2].

The talk is based on a recent joint work with Zhu Zhang[4]. The most relevant references are listed below and one can find the other references therein.

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References

[1] Grenier, E., Guo; Y., Nguyen, T.: Spectral instability of characteristic boundary layer flows. *Duke Mathematical Journal* **165**, 3085–3146, 2016.

[2] Gérard-Varet, D., Maekawa, Y., Masmoudi, N.: Gevrey stability of Prandtl expansions for 2D Navier-Stokes flows. *Duke Mathematical Journal* **167**(13), 2531-2631, 2018.

[3] Liu, C.-J., Yang T., Zhang, Z.: Analysis on Tollmien-Schlichting wave in the Prandtl-Hartmann regime. *to appear in Journal de Mathématiques Pures et Appliquées*, arXiv 2110. 04979, 2021.

[4] Yang T. and Zhang Z.: Linear instability analysis on compressible Navier-Stokes equations with strong boundary layer. arXiv, 2203.17195, 2022.

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