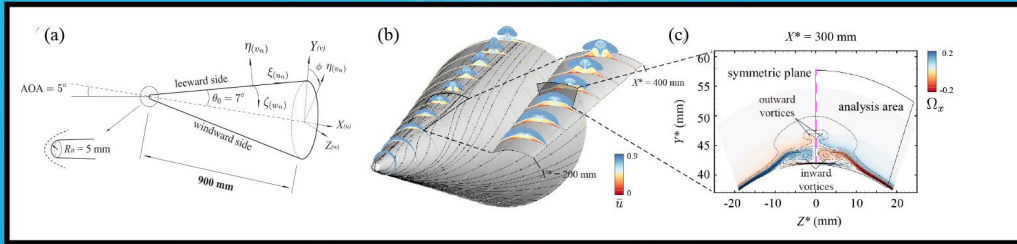


Stability analysis of streamwise vortices over a blunt inclined cone under a hypersonic flight condition

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● Introduction

The transition mechanism is vital to the design of hypersonic vehicles, whereas three-dimensional boundary layer transition is still far from fully understood. The streamwise vortices over a blunt cone with an angle of attack are typical three-dimensional flow structures, yet their stability under flight conditions has not been fully characterized by scholars, which leads to the purpose of our work.



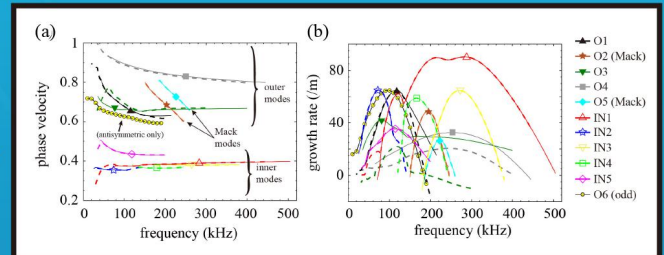
Note: This figure shows
 a) the cone model;
 b) an overview of the streamwise vortex;
 c) a slice of the streamwise velocity (black lines) & vorticity (colored)

The analysis shows:
 • The unstable modes can be categorized by 'Inner', 'Outer' and 'Mack' modes by their phase velocities and shapes.
 • Inner modes amplify rapidly at downstream stations.

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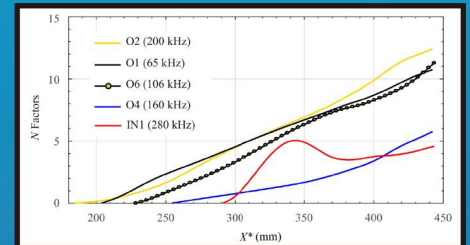
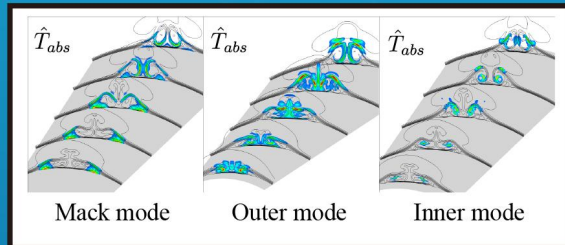
Note: The figure only displays the BiGlobal analysis results of one station.

Mode Analysis



PSE3D

Note: The mode shapes of each category are analogous, thus only the most amplified ones are displayed here.



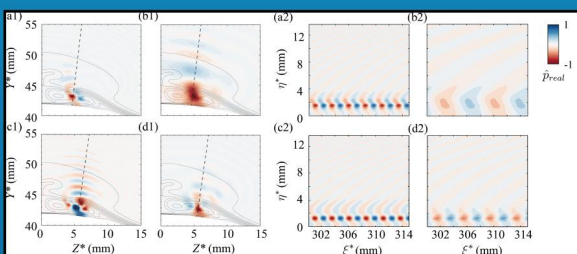
Conclusions

- Three types of modes are found to exist in the streamwise vortices by BiGlobal and PSE3D analysis, and the characteristics of the modes are shown in detail.
- Mack modes are found early upstream and are most amplified for the condition in our study.
- Inner modes are found to have acoustic radiates out into the freestream.

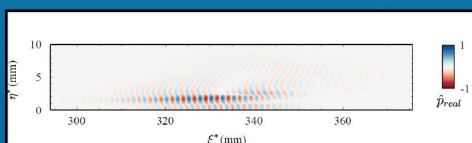
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Acknowledgements

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PSE3D



Note: This picture displays the pressure fluctuation of inner modes, which indicates an acoustic radiation.

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