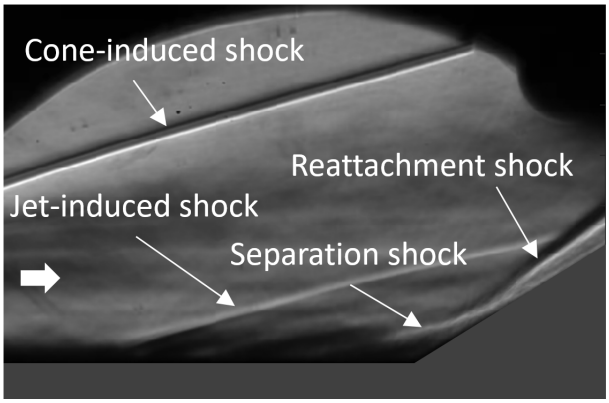
RWTH AACHEN UNIVERSITY

Institute of Aerodynamics and Chair of Fluid Mechanics

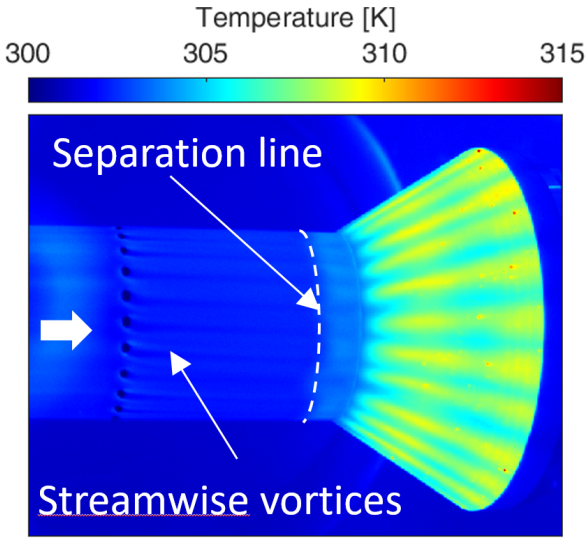
Bachelorarbeit / Masterarbeiten

Separation control in a hypersonic shock wave / turbulent boundary layer interaction using air-jet vortex generators

Flow field around hypersonic vehicles are typically characterised by frequent occurrence of shock wave / boundary layer interactions. A strong shock wave imposes a large adverse pressure gradient on the boundary layer and can induce large scale separation. This interaction is quite detrimental in nature and can lead to high fluctuating pressure and thermal loads on the surface. Hence, proper control of this interaction is necessary for cheaper and more efficient air and space transportation. A promising approach for control follows injection of air jets into the cross flow to alter the incoming boundary layer characteristics favourably. The streamwise vortices generated by these air-jets redistributed the momentum within the boundary layer, making it more resistant to separation. The effectiveness of air-jet vortex generators in mitigating flow separation has already been verified in subsonic, transonic and supersonic flow conditions. An experimental investigation was carried out to study the influence of air-jet vortex generators on a hypersonic shock wave / turbulent boundary layer interactions, the results of which will be analysed in the context of this thesis.



(a) Schlieren visualisation of air-jet injection at Mach 5.15 crossflow



(b) Surface temperature distribution measurement using infrared thermography

Experiments were carried out at Mach 6 in the Hypersonic Ludwig tube (HLB) at the Institute of Fluid Mechanics in Braunschweig. Flow visualisation (schlieren, oil-flow visualisation) and heat transfer measurements (using infrared thermography) were carried out to study the interaction region. The acquired data will be evaluated using state-of-the-art processing algorithms to better understand the influence of air-jet vortex generators in a hypersonic shock wave boundary layer interaction This project is embedded in the Emmy Noether Program of the German Research Foundation, details of which can be found in `http://gepris.dfg.de/gepris/projekt/326485414`.

Requirements

- Good Knowledge of Fluid Mechanics (Heat transfer and compressible flows is an added plus).
- Experience with CAD designing (Catia/Inventor) (bonus).

- Experience with Matlab (preferable).
- Preference to write the Master thesis report in English.
- Enthusiasm to work in a project that would one day pave the way for efficient supersonic and hypersonic aircrafts.

Tasks

- A brief literature survey on separation control in high speed flows and various heat transfer data reduction techniques.
- Analysis and post-processing of the obtained data.
- Discussion of the results and comparison with literature.
- Submission of final thesis report.

Contact:

If you have any questions / are interested and would like to know more about the project, feel free to send an email with your CV or pass by our office.

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