

# **Lecture**

## **Aerothermal Design of Space Transportation Systems**

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# Content /1

- Aerothermal problems of space vehicles
  - Space transportation missions and vehicles
  - Atmospheric properties of different planets
  - Flow regimes
- Aerothermodynamic design approach
  - Launcher performance prediction
  - Aerothermal design of re-entry flights
  - One dimensional supersonic flow relations
- Methods of preliminary spacecraft design
  - Prandtl-Meyer Expansion und Isentropic Compression
  - Newtonian Flow
  - Tangent Wedge Method
  - Tangent Cone Method
  - Shock Expansion Method
  - Taylor Maccoll method

# Content /2

- Effects of viscous hypersonic flows on spacecraft design
  - Boundary Layer Flow
  - Main Properties of Viscous Flow
  - Strong and weak viscous interaction
- Effects of boundary layer transition on spacecraft design
  - Methods to predict boundary layer transition
  - Heat flux augmentation caused by boundary layer transition
  - Methods to mitigate boundary layer transition effects
- Effects of strong interaction phenomena on spacecraft design
  - Flow separation
  - Shock-Shock-Interaction
  - Shock-Boundary-Layer-Interaction
  - Examples from Space Transportation Mission

# Content /3

- Aerodynamic stability of spacecraft
  - Basics of aerodynamic stability
  - Static and dynamic stability
  - Methods to determine aerodynamic stability
- High enthalpy effects during hypersonic flight
  - Dissociation and recombination effects
  - Thermal und chemical non-equilibrium
  - Heat flux augmentation due to surface catalysis
- High temperature materials
  - Ablative thermal protection materials
  - Re-usable ceramic composite materials
- Fluid-Structure-Interaction during hypersonic flight
  - Thermal fluid-structure interaction
  - Structural fluid-structure interaction

# Content /4

- Design and Performing Hypersonic Flight Experiments
  - Design of hypersonic flight experiments
  - Critical aspects of hypersonic flight experiments
  - Post flight analysis
- Design of Interplanetary Missions
  - Design of interplanetary flight vehicles
  - Critical aspects of interplanetary flight
  - Post flight analysis
- Simulation and Verification Tools
  - Numerical tools
  - Ground testing facilities and measurement techniques
  - Visit of laboratories at DLR Cologne