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# Hypersonic Flow Research Overview

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# Self Introduction



B.S. in Aerospace Engineering  
with double minor in Mathematics (2009-2013)  
M.S in Aerospace Engineering (2013-2015)



Korean Language School (2015-2016)



Ph.D. in Aerospace Engineering (2016-2020)



Research Assistant Professor  
in Aerospace Engineering (2020-Present)

Current Research Project:

- Multi-Scale Catalytic Modeling in Hypersonic Flow  
(Principal Investigator, NRF Project, 2021-2024)

# Outline

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- Introduction to Hypersonic Flow
- Research Focus

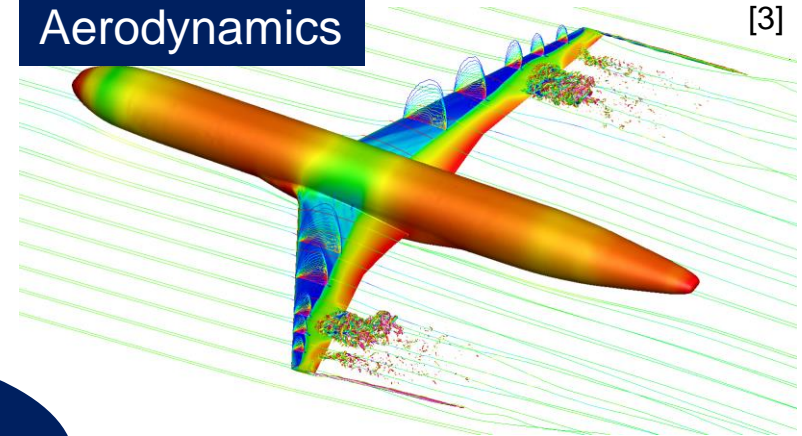
# Aerospace Engineering



## Propulsion

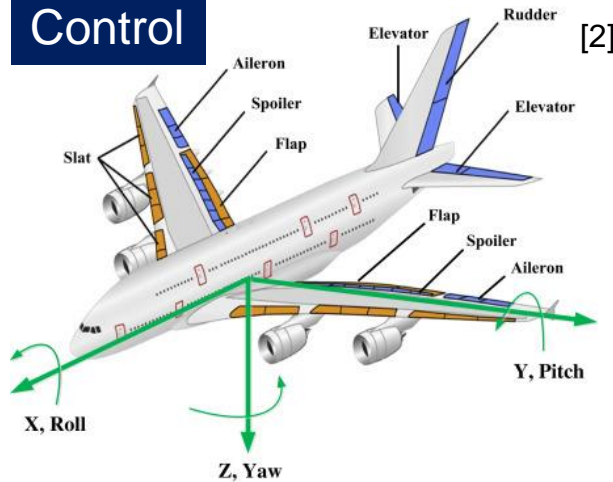


## Aerodynamics

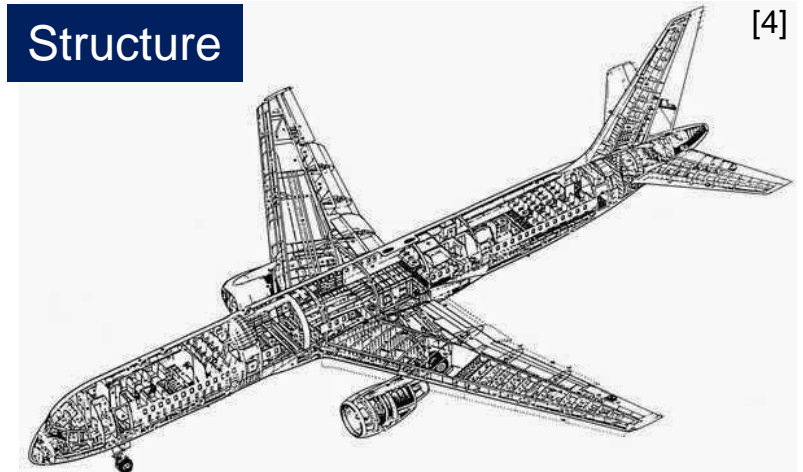


## Aerospace Engineering

## Control



## Structure



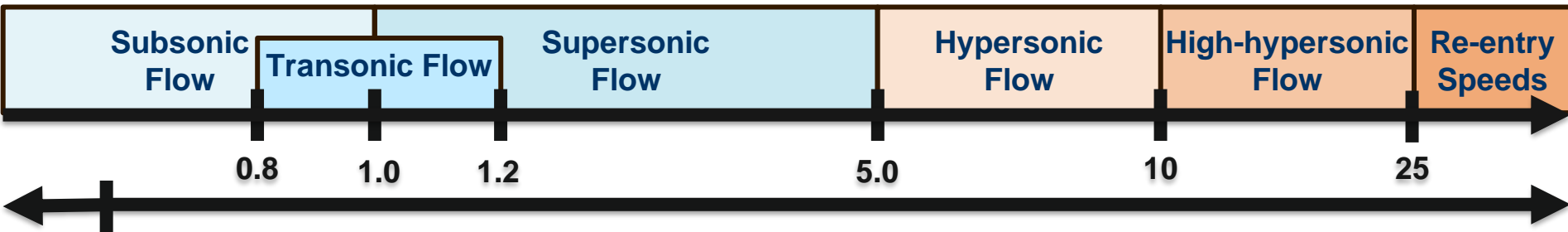
[1] <https://www.timeshighereducation.com/cn/student/subjects/what-can-you-do-aerospace-engineering-degree>, Retrieved: 5<sup>th</sup> March 2021

[2] Wang et al., *Commercial Aircraft Hydraulic Systems*, Shanghai Jiao Tong University Press Aerospace Series, 2016.

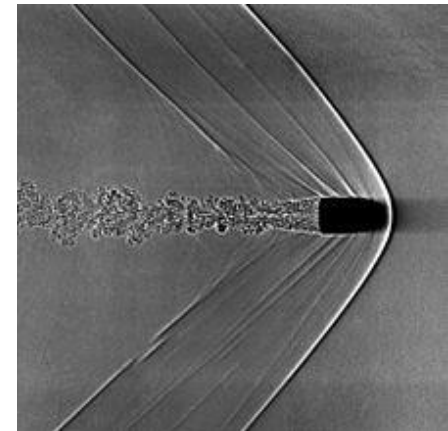
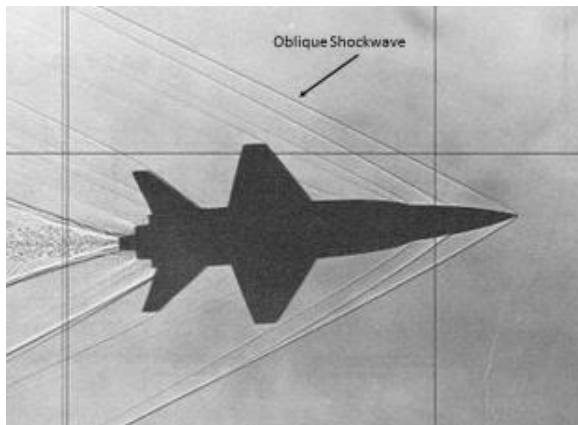
[3] <http://www.cfd4aircraft.com/>, Retrieved: 5<sup>th</sup> March 2021

[4] <http://collegestudentslive.blogspot.com/2015/02/aeronautical-project-report-on-aircraft.html>, Retrieved: 5<sup>th</sup> March 2021

## Flow regime depending on Mach number



- ◆ Formation of **shock wave** in supersonic condition ( $Ma > 1$ )
- ◆ Drastic **increase of temperature** and pressure across the shock wave

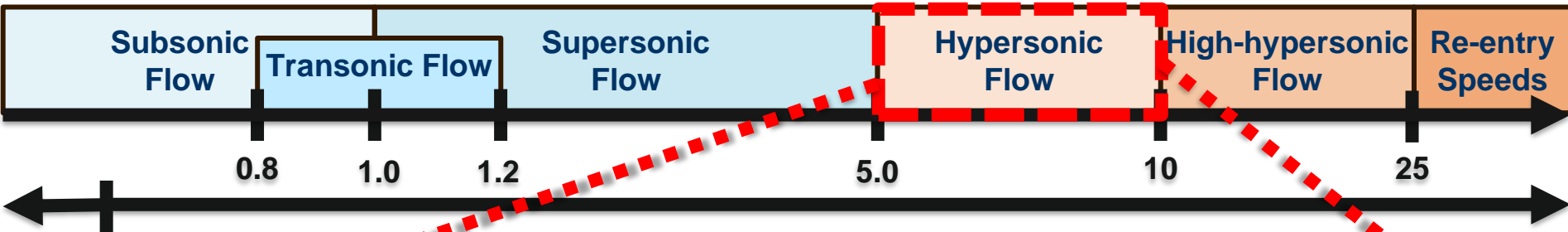


[1]

# Hypersonic Flow

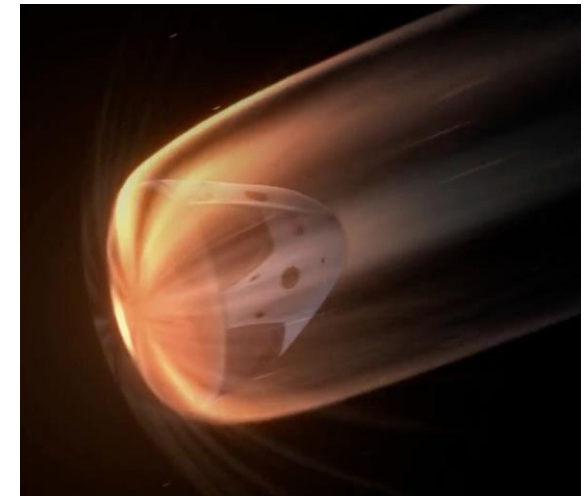


Flow regime depending on Mach number

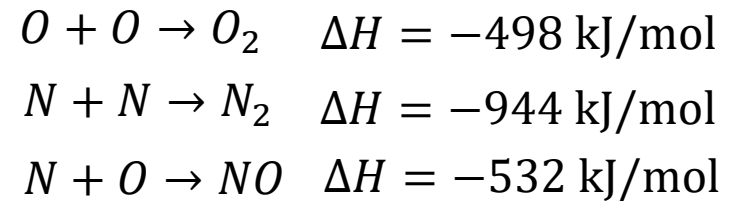
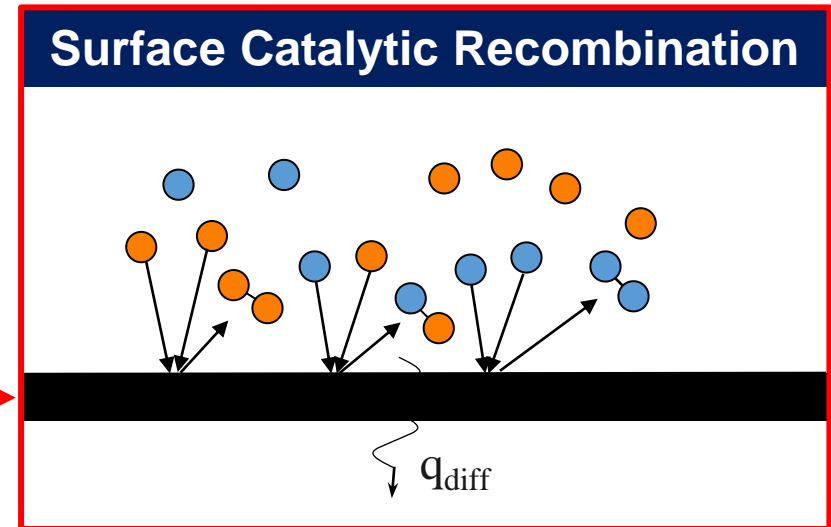
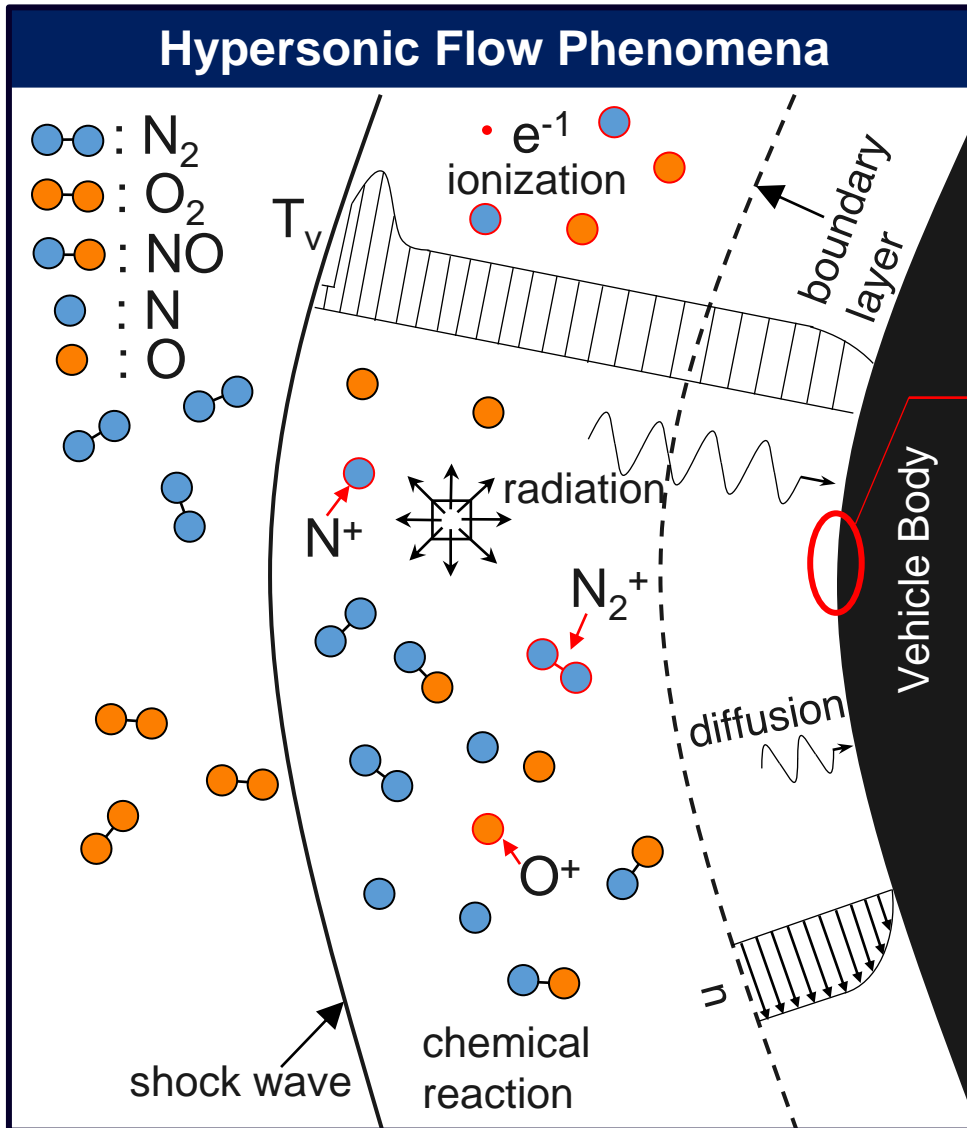


## Characteristics of **HYPERSONIC** flow

- ◆ Aerodynamic Heating
- ◆ Real Gas Effect (Molecular dissociation & Ionization)
- ◆ Shock Layer
- ◆ Entropy Layer

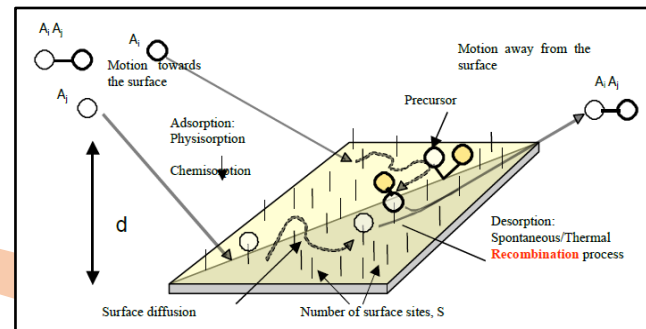
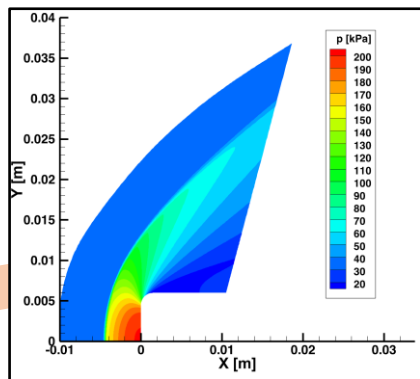
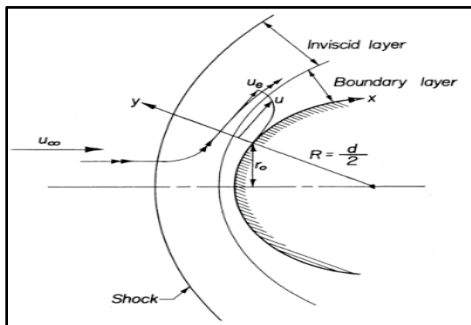


# Research Focus and Interest



**Surface catalytic** is important for the heat transfer estimation

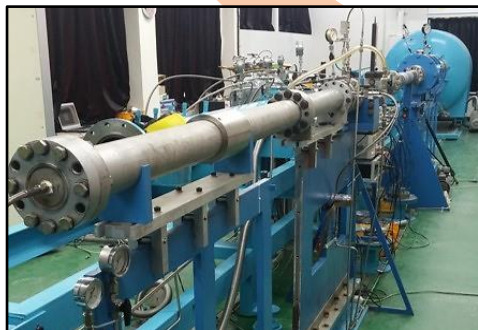
# Research Focus and Interest



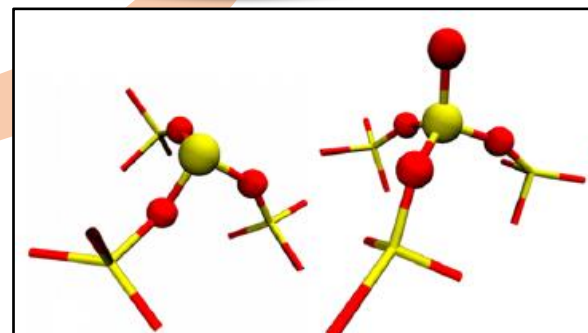
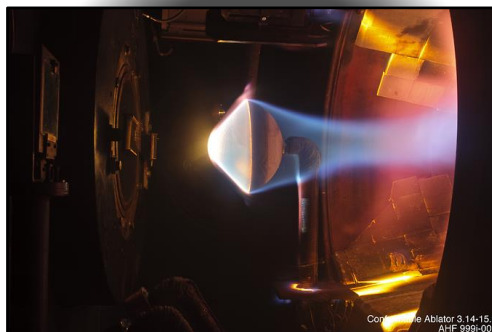
Theoretical Analysis

## Hypersonic Flow Analysis

Numerical modeling



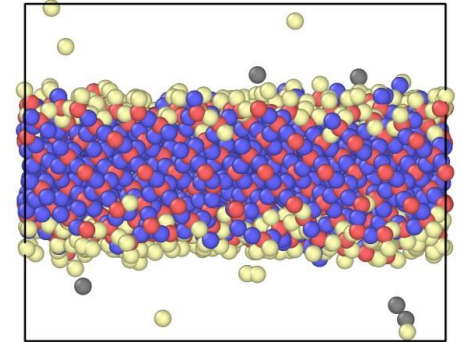
Experimental analysis





## Gas-Surface Interaction

- ◆ Modeling gas-surface interaction in hypersonic flow with an **in-house CFD solver**.
- ◆ **Molecular dynamics** analysis of gas-surface interaction in hypersonic flow.



## Aerothermodynamics Analysis

- ◆ Estimation of heat transfer for **re-entry vehicles** and **satellites** through **CFD** or **DSMC** (Direct Simulation Monte Carlo) analysis.
- ◆ **Fluid-Thermal-Structural** coupling analysis for hypersonic flow.
- ◆ Atmospheric re-entry analysis for **other planets** (Mars and Uranus).

# Thank You

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