



# Solving Hypersonic Flow Problems

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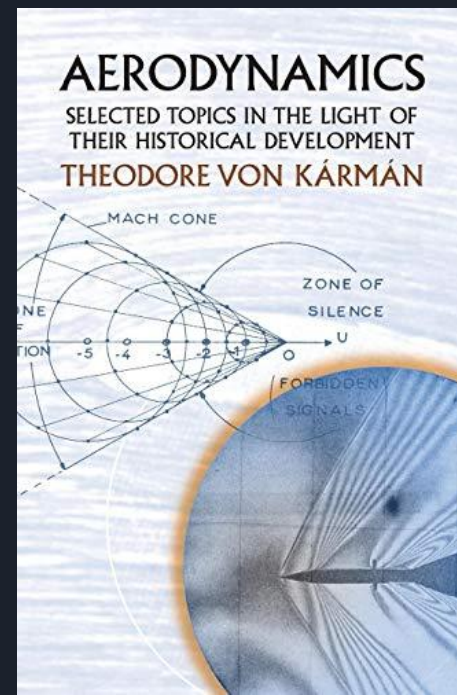
# General Overview

- June 8 - July 31
  - 3 weeks research
  - 2 weeks Capstone
  - 3 weeks Paraview
- 100% virtual
  - Zoom meetings 3 times a week at 10:30
- University of Maryland at College Park
  - Department of Aerospace Engineering
- Using varying softwares to visualize and study hypersonic flow problems

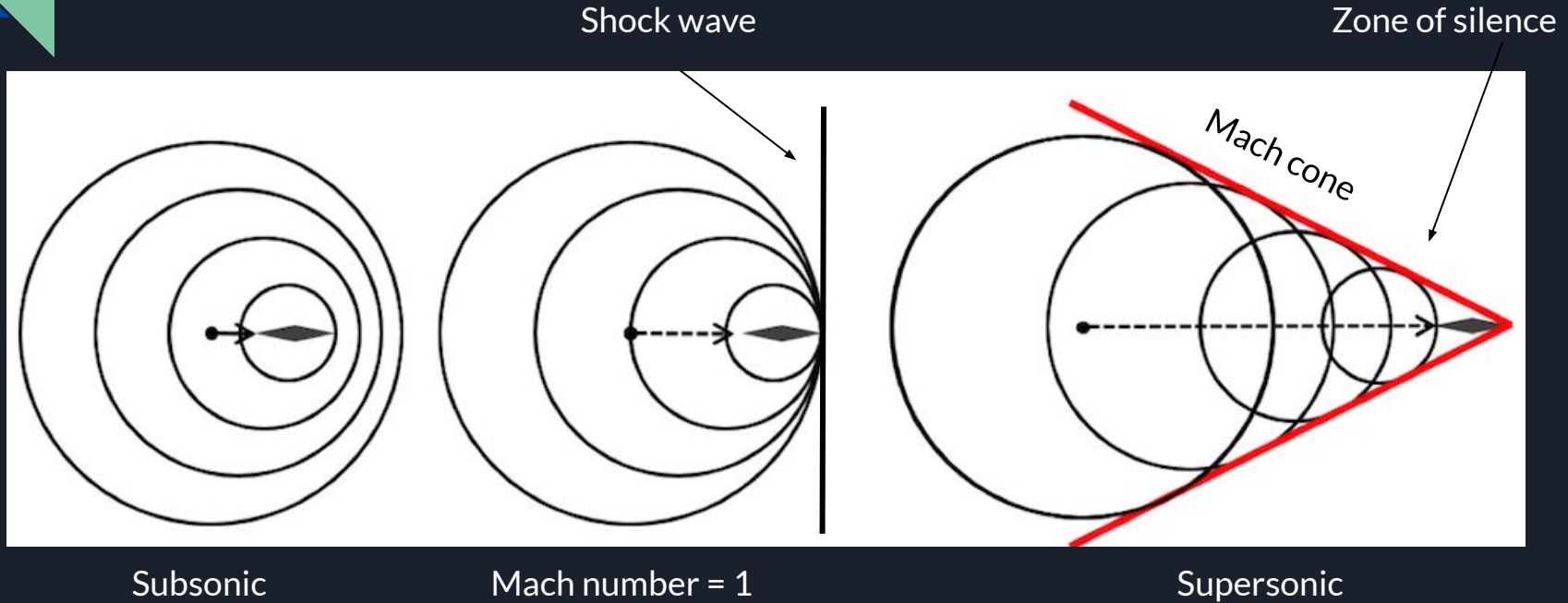


# Background

- Mach number → ratio of the speed of the body to the speed of sound in the surrounding medium
- Subsonic < speed of sound < supersonic
  - Hypersonic ~ Mach number of 10 or greater



# Supersonic Flow



# Capstone

Software to make geometry and mesh

The screenshot displays the Capstone software interface. The main window shows a 3D model of a cone and a sphere assembly. The interface includes a top toolbar with various tools, a left sidebar with navigation icons, and a right sidebar with analysis and explorer panels. The bottom status bar shows system information and file paths.

**Analysis: DefaultAnalysis**

Show Only Selection

Vertex:  Search

Feature Root:

**Model**

- 1 Brep, 0 Selected, 1 visible
- 2 Regions, 0 Selected, 2 visible
- 7 Faces, 0 Selected, 7 visible
- 12 Edges, 0 Selected, 12 visible
- 8 Vertices, 0 Selected, 8 visible
- Features
  - cone
  - sphere
  - sphere1
  - cone1
  - sphere2
  - sphere3
  - sphere4
  - face
  - cone2
  - copy

**Create Reader Timings**

Reader	: cpu = 8.868e-02s	wall = 8.87e-02s
Geometry	: cpu = 4.728e-02s	wall = 4.73e-02s
Mesh	: cpu = 3.446e-02s	wall = 3.45e-02s
Attribution	: cpu = 1.435e-03s	wall = 1.44e-03s
PostProcessing	: cpu = 2.970e-04s	wall = 2.97e-04s

**GetModelUnits**

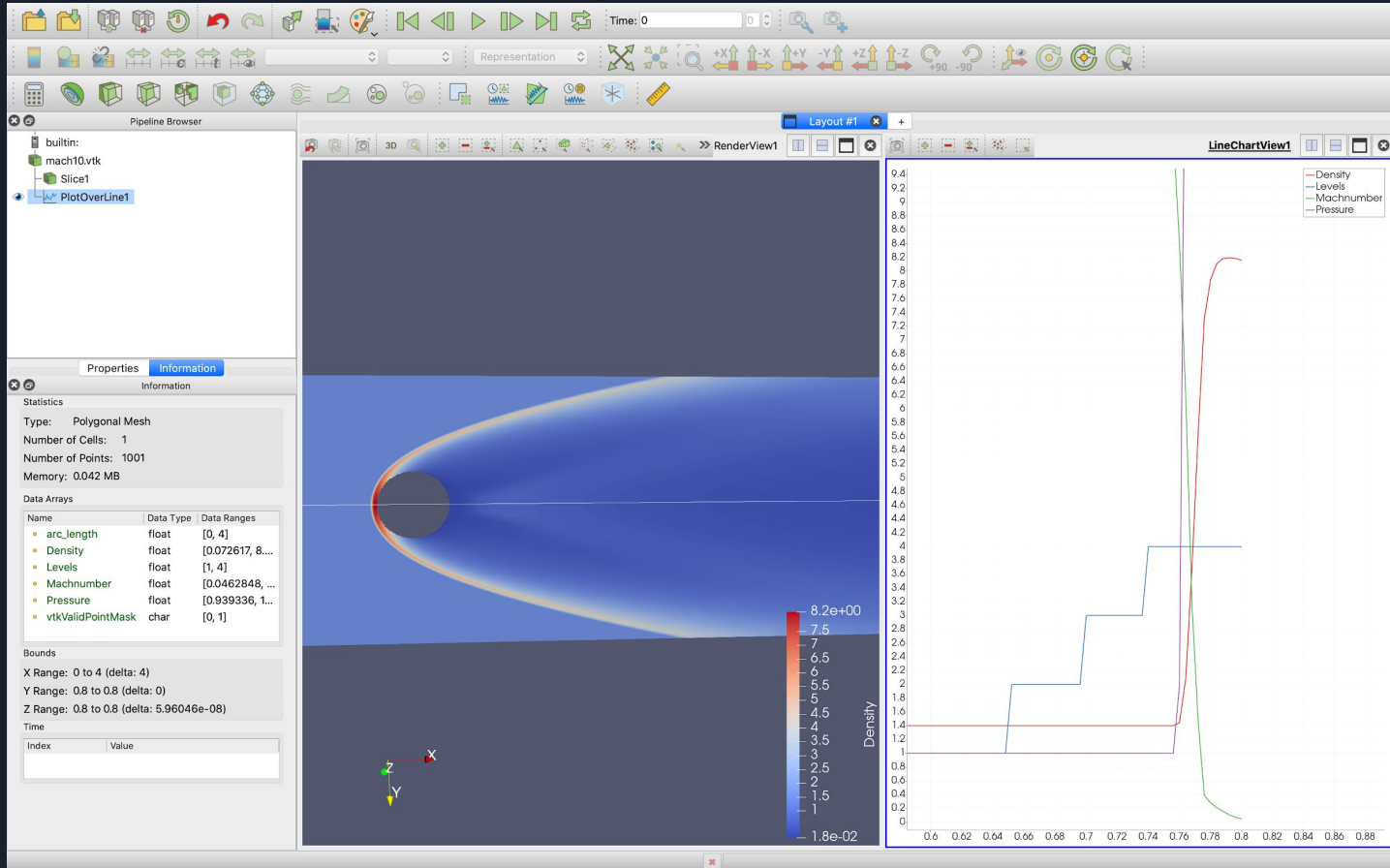
**Save States**

- \* Debug Info
- \* Recent Files

/Users/mollyadams/Desktop/orion.cre    Geometry Database : Native Kernel | Mesh Database : Create | Attribution Database : Create    Units: m|kg|s|K    Topology Workflow

# Paraview

Software to visualize the effects of hypersonic flow



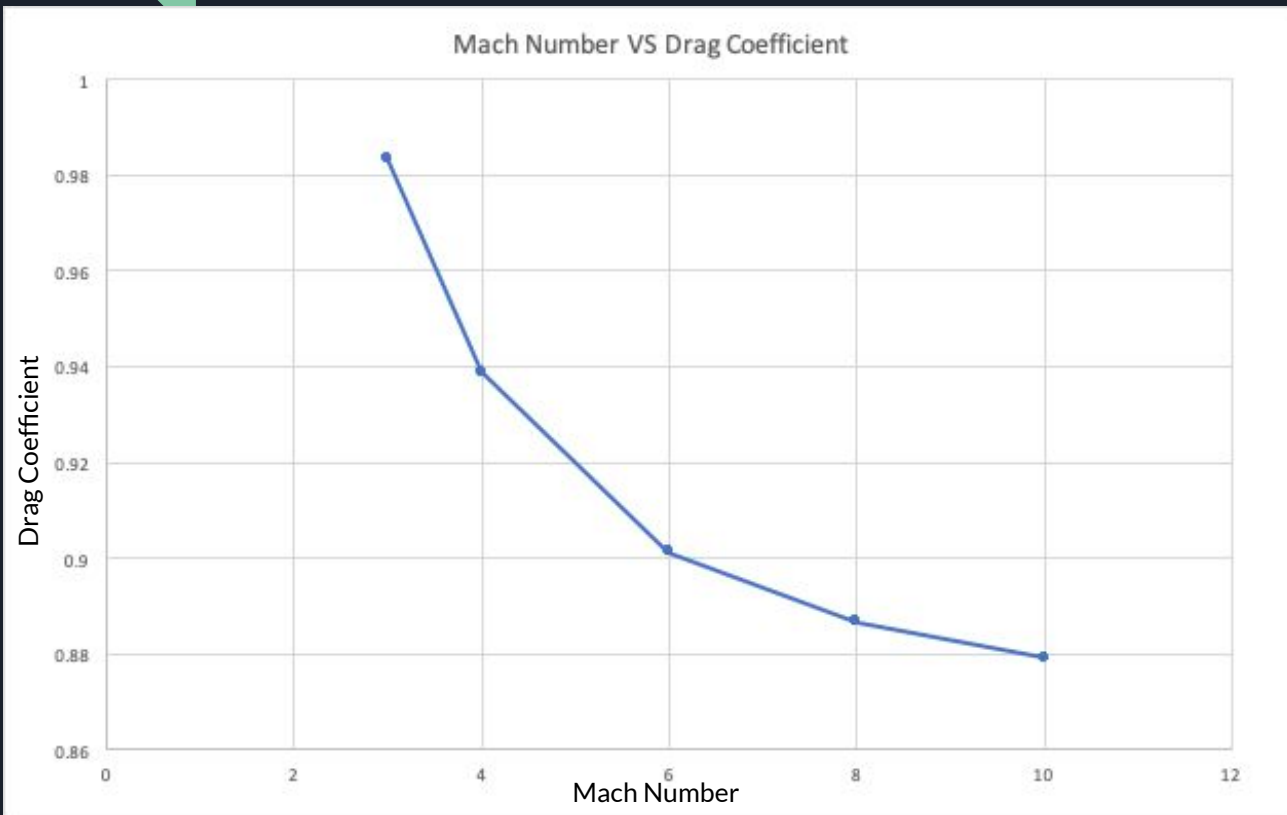


# The Effect of Mach Number on Drag Coefficient

- Drag Coefficient → quantity to represent the drag (resistance) of an object in a fluid environment
  - Usually determined experimentally
- Mach number independence principle → the drag coefficient should become constant as the Mach number increases
- As Mach number increases, drag coefficient decreases

$$C_d = \frac{D}{\rho A (V^2/2)}$$

# Results



Mach Number	Drag Coefficient
3	0.98349
4	0.93873
6	0.90121
8	0.88659
10	0.87913



## Mistakes Made

- Waking up late for meetings
- Taking notes on my desk
- Using the wrong density to calculate drag coefficient

## Lessons Learned

- Ask questions
- Positive growth mindset
- Independence and responsibility
  - Time management
- Patience with yourself



# Acknowledgements

- Dr. Stuart Laurence
- Dr. Krug

Questions?