Graduate Special Subject
Spring 2016
16.S199 *Analytical High Speed Aerodynamics*
Units: 3-0-3, G-Level
Prerequisites: 2.25, 18.085, or permission of instructor
Schedule: MW9:30-11, Room 33-422

Instructor: W.L. Harris

This subject is designed to inform students on the analytical foundations of inviscid transonic, supersonic, and hypersonic aerodynamics. A primary goal of this subject is to equip students with the scientific rigor, applied mathematical complexity, and *physical understanding* that form the foundation of classical aerodynamics. Perturbation methods that both simplify mathematical complexity and expand physical understanding of critical phenomenon in fluid flow provides a framework for the subject. The topics treated in this subject complement the well-established computational methods and tools regularly exploited in today's aerospace research and development in the academy and industry.

Analysis of external inviscid, transonic, supersonic, and hypersonic flows over thin airfoils and lifting bodies of revolution. Analyses formulated using singular perturbation and multiple scale methods and parametric differentiation. Non-linear, unsteady transonic flow [shock excursion, local linearization, integral methods]. Prandtl-Meyer flow. Flow past a wave-shaped wall. Body of minimum wave drag. Sonic boom [Whitham]. Hypersonic equivalence principle [Hayes]. Hypersonic similarity rule (matched asymptotic expansions).

Students are expected to have had exposure to a graduate level subject in fluid dynamics and a graduate level introduction to engineering applied mathematics.

Students successfully completing a six (6)-unit module will be able to:

1. Formulate well-posed boundary-value and initial-value problems of external inviscid flow over slender bodies or channels with small amplitude waviness

2. Generate analytical solutions and rigorous approximations to well- prosed problems of external inviscid flow over slender bodies

3. Provide analytically based limits to establish confidence in results obtained using computational tools

4. Describe conceptually experiments to verify the impact of higher order physical effects on external flow over slender bodies.

Instructor: Prof. Wesley Harris (weslhar@mit.edu)

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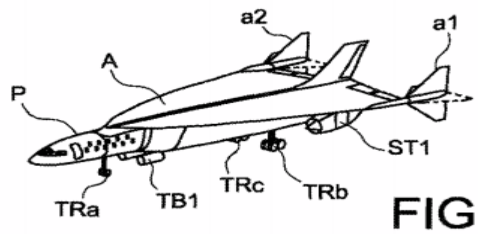

FIG. 15

Airbus/USPTO perspective view of an ultra-rapid air vehicle according to the invention.