Aircraft in Other Atmospheres

Extra Credit Project

AAE 334 Spring 2017

Due Friday, April 28, 2017
Please submit your report through Blackboard

The object of this optional extra credit project is to design autonomous airplanes to fly on other large bodies in the solar system to collect scientific data. You may be familiar with the NASA ARES-2 Mars airplane concept (Braun et al., 2006), as shown in Fig. 1. Autonomous air vehicles have also been considered for Venus (Landis et al., 2002) and Saturn's moon Titan (Stewart and Palac, 2007). Some preliminary design for other atmospheres has been done by Munroe (2014); he was somewhat pessimistic (Fig. 2).

Your project is to design your own airplanes to fly on Mars, Venus, and Titan. Assume that your mission requirements are like the ARES-2: the craft must have at least a 500 km range and it must fit within an aero-shell of about 3.0 m diameter for deployment. Recovery of the vehicle is not necessary. Take the delivery system as given, and design for the aircraft cruise condition.

Use the techniques that you have learned in class to do a conceptual aerodynamic design, choosing the simplest analytical approach that answers your design questions. Select an airfoil shape as appropriate, and compute lift, induced drag, viscous drag, compressibility effects, and other relevant aerodynamic parameters. I want you to be very specific about the aerodynamics, but you can use order of magnitude estimates for other design choices. You can make any design choices that you want if you justify them. For example, a buoyant airship is a legitimate choice. Research the gravity and atmospheres of the target solar system bodies, and pick a reasonable cruising altitude for collecting scientific data. Specify the size and speed of the vehicle, and quantify lift, weight, drag, and thrust. Select an appropriate energy source for propulsion. Consider the speed regime and the source of lift, to include buoyancy. Consider requirements for heating and protecting the vehicle from pressure and corrosion.

Write a short report on your project, typed, and about 5 pages double spaced, including figures and equations. Explain your assumptions. Use whatever resources you can find, but include references to all of them in your report. Use a consistent style for the references (see: https://owl.english.purdue.edu/owl/section/2/). You are free to work together, but each student must write and hand in an individual report. List all your collaborators at the end of your report. This optional project will be worth up to 5% extra credit on your final grade. Credit will depend on innovation, level of effort, and quality of the report.

References

1. G. A. Landis, A. Colozza , and C. LaMarre, "Atmospheric Flight on Venus," AIAA Paper 2002-0819, January 2002.
2. R. D. Braun, H. S. Wright, M. A. Croom, J. S. Levine, and D. A. Spencer, "Design of the ARES Mars Airplane and Mission Architecture," Journal of Spacecraft and Rockets, Vol. 43, No. 5, pp. 1026-1034, 2006.
3. M. E. M. Stewart and D. T. Palac, "Titan Atmosphere Breathing Propulsion," AIAA Paper 2007-5124, July 2007.
4. R. Munroe, **What If? Serious Scientific Answers to Absurd Hypothetical Questions**, Houghton Mifflin, Harcourt, New York, 2015, "Interplanetary Cesna," pp. 137-141, https://what-if.xkcd.com/30/

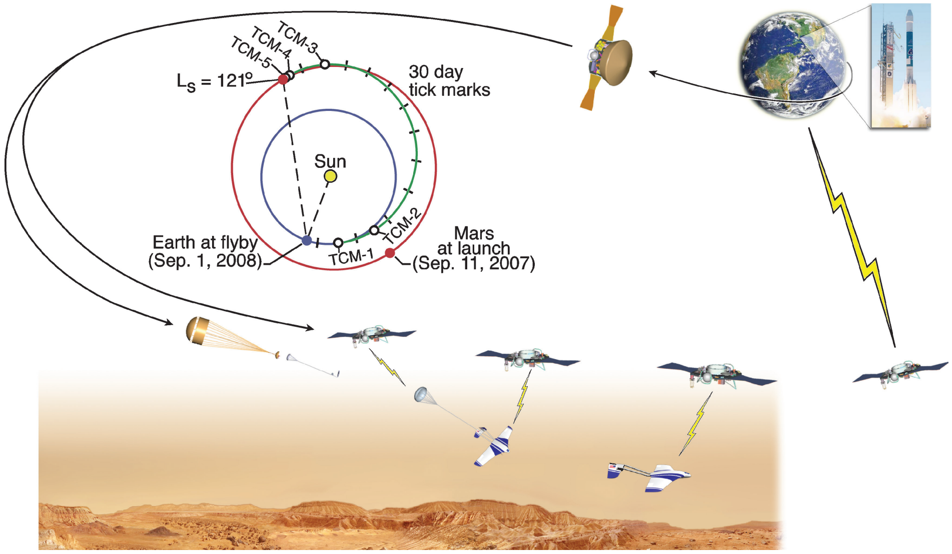

Figure 1: Mars airplane mission overview (Braun et al., 2006).

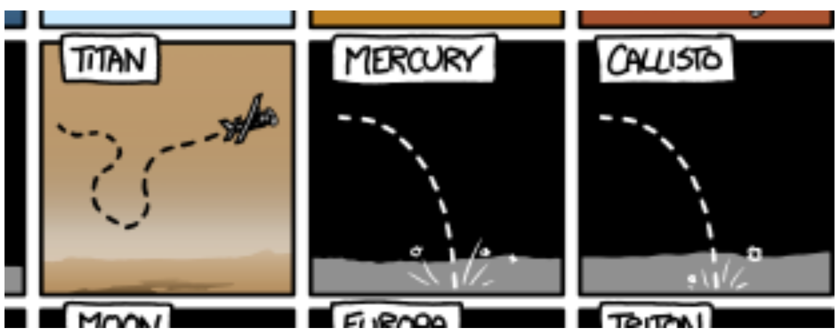

Figure 2: Calculated trajectory of a Cesna 172 Skyhawk on other large bodies in the solar system. Detail of figure in Munroe (2014).