Planetary Balloons and Aerobots

Innovations in materials, structures, and systems concepts have enabled buoyant vehicles to play an expanding role in NASA’s Solar System Exploration Program. Balloons and airships will carry scientific payloads on Mars, Venus, Titan, and the outer planets in order to investigate their atmospheres in situ and their surfaces from close proximity. Their envelopes will be subject to extreme environments and must support missions with a range of durations. Proposals are sought in the following areas:

**Hot Air (Montgolfiere) Balloons for Titan**

NASA is considering the use of hot air (Montgolfiere) balloons for Titan using waste heat from the radioisotope power source (RPS). Proposals are sought for concepts and prototypes for this balloon that have the following nominal characteristics: 2000 Watts of available RPS waste heat, a 100 gm/m² balloon envelope material, 160 kg of payload mass (including the RPS but excluding the balloon), and a controllable altitude over the range of 0 to 10 km with the ability to maintain a +/- 20 m tolerance near the surface (93K, 1.46 bar). It is important that the balloon be storable in a typical entry vehicle for transport to Titan and be deployed and inflated upon arrival. Preference will be given to proposals that include cryogenic testing to validate the thermal performance models upon which the design is based.

**Apex Valve for Montgolfiere Balloons**

Solar-heated Montgolfiere balloons are an attractive platform for the exploration of Mars, particularly the polar regions which experience long periods of solar illumination during summer solstice. These balloons can be altitude controlled through selective venting of the heated gas through a valve located at the apex of the balloon. Proposals are sought for concepts and prototypes for this valve to be used on a solar-heated balloon on Mars. Typical specifications include large flow area (10 m²), low mass (few kilograms), packaged into a small volume for transport to Mars (3) and consume minimal electrical energy.

**Aerial Deployment Modeling Tool**

Planetary aerobots at Mars, Titan, and Venus will likely be aerially deployed and inflated during parachute descent after arrival at the destination. Proposals are sought that would provide computer modeling tools that can simulate this complex process. Of particular importance is the ability to model the balloon shape and material stresses as a function of time, taking into account the aerodynamic forces generated by the parachute and by the uninflated or partially inflated balloon, as well as transient loads during balloon deployment from its storage container. The balloons can be either polymer film or polymer film plus reinforcing fabric laminates.
Metal Bellows for High Temperature Venus Balloons

Cylindrically-shaped metal bellows are a potential solution to the problem of making balloons that can tolerate the 460°C temperatures near the surface of Venus. Commercial off-the-shelf metal bellows are limited in diameter to approximately 0.4 m. NASA seeks proposals for metal bellows technology that can produce prototypes in the range of 1 - 2 m in diameter and 5 - 10 m long; tolerant of sulfuric acid; good fatigue properties at 460°C; and areal densities of up to 1 kg/m².