NASA SBIR 2005 Phase I Solicitation

S4.02 Terrestrial and Extra-Terrestrial Balloons and Aerobots

Lead Center: GSFC

Participating Center(s): JPL

Innovations in materials, structures, and systems concepts have enabled buoyant vehicles to play an expanding role in NASA’s Science Mission Directorate and Exploration Systems Mission Directorate. A new generation of large, stratospheric balloons, based on advanced balloon envelope technologies, will be able to deliver payloads of several thousand kilograms to above 99.9% of the Earth's absorbing atmosphere and maintain them there for months of continuous observation. NASA is seeking innovative and cost-effective solutions in support of terrestrial balloons in the following areas:

- Innovative concepts for reducing the UV degradation of flight components including balloon membranes, load carrying members, and parachute components;
- Innovative concepts for the measurement of strain in a thin film during flight;
- Innovative sensor concepts for balloon gas or skin temperature measurements;
- Innovative concepts for trajectory control and/or station keeping for effectively maneuvering large terrestrial balloons in either the horizontal latitude or vertical altitude plane or both;
- Innovative low-mass, high-density, and high-efficiency power systems for terrestrial balloons that produce 2 kW or more continuously;
- Innovative power systems that enable long duration, sunlight independent missions for durations of 30 days or more;
- Innovative floatation systems for water recovery of payloads;
- Innovative guided or gliding parachutes systems for use in thin atmospheres;
- Innovative balloon design concepts for long duration missions that can provide any or all of the following: reduced material strength requirements, increased reliability, enhanced performance, reduced manufacturing time, reduced manufacturing cost, or improved mission flexibility; and
- Smaller scale, but similarly designed, balloons and airships will also 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:

Aerobot Surface Sample Acquisition Device

NASA is soliciting concepts and prototypes for surface sample acquisition devices that can be used on aerobots to collect icy material from Titan and Mars. Typical sample volumes range from 1 to 2 cubic centimeters, with preference for a solid ice core as well as possible granular material. Collection depths of 0 to 2 cm are desired. Preferred techniques do not require close proximity of the aerobot balloon skin to the ground to reduce the probability of damaging the vehicle during sample acquisition. Examples include tethered collection devices deployed from modest altitudes (10s to 100s of meters) or short duration "touch and go" sampling from directional and/or altitude controlled aerobots. Proposed devices can be disposable (single use), but if reusable must avoid cross-contamination between samples. All devices must include solid sample transfer functionality to an analysis chamber on the aerobot itself. Concepts will be preferred that feature low mass (few kilograms or less), small volume (~1 liter) and low electrical power consumption drawn from the aerobot.

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 films 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.