BALLOONS FOR CONTROLLED ROVING/LANDING ON MARS

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Up to now, the only practical balloon systems proposed to explore the Martian atmosphere and surface have been super-pressure balloons, which fly at a constant altitude, or short-lived zero-pressure helium balloons, which precariously drag a snake through all types of surface weather, or a day/night combination of the two. Wind-driven surface balloon "beach balls" have been proposed for Mars, but none that contain a simple control mechanism for stopping the balloon at desired locations. **For the first time, two novel atmospheric balloon systems now appear quite viable for controlled balloon landings on selected Martian surface locations, and a simple controlled stopping mechanism is proposed for wind-driven surface rolling balloons.**

1. Solar Hot Air Balloons: An atmospheric balloon system would employ solar hot air balloons for landing at the Martian poles during summer or for shorter duration flights at lower latitudes. The extremely long Martian summer polar days (up to 0.95 Earth years) and high Martian axis inclination (23.6 degrees) makes "solar polar" hot air ballooning ideal for long periods. Recent tests have already confirmed ease of altitude deployment and filling of these solar hot air balloons. Furthermore, actual landings and re-ascents of solar hot air balloons have been recently demonstrated by JPL over a desert dry lake using a novel, lightweight, top air vent that is radio-controlled. For a Martian solar hot air balloon, total system masses have been calculated to be about 60 kg for a 15 kg payload, and onl y about 7.5 kg for a 2.S kg payload.

2. Variable Emissivity Balloons: A second atmospheric balloon system uses a variable emissivity superpressure helium balloon that can land at night at any Martian latitude. The variable emissivity balloons would be gold-coated, super pressure helium balloons during both night and day. They could land at prescribed targets by exposing a section of upper white balloon surface to the radiant cooling of deep space during the night. This reduces the temperature and pressure in the balloon to create negative buoyancy, thus causing descent, while replacement of the gold cover top causes re-ascent. Specific areas could be targeted for landings by using atmospheric currents at various altitudes, similar to techniques used by Earth balloon enthusiasts. For a Martian variable emissivity balloon, total floating mass has been calculated to be about 93 kg for a 15 kg payload, and about 20 kg for a 2.5 kg payload.

3. Roving Wind Balloons: These wind-driven "beach ball" balloons are by far the simplest of balloons for exploring the surface of Mars. The balloons simply roll on the ground and are driven by wind to various locations. A very simple means of stopping the balloons has been proposed wherein the center of mass is moved a small amount. For example, a 1 meter diameter "wind ball" that weighs 0.5 kg and contains a 2.5 kg payload, would have to move the center of mass only by 13 cm in order to stop the motion of the balloon in Martian winds as strong as 30 m/sec. With a centered mass system, however, the balloons would be able to ascend even steep 10" Martian slopes with more moderate 20 m/see winds. Full motion control over almost any terrain could be attained using a more complicated internal treadmill.

Combined Atmospheric/Surface Mission: A solar hot air balloon would explore the Martian atmosphere with repeated landings for a period of up to about ten hours. When a desired final landing location is found, it would soft lard a one meter diameter "wind ball", which would then blow to various surface locations and stop at will. Similar Earth tests are planned by JPL in October, 1997 for a solar hot air balloon that will soft land simple, uncontrolled windballs. For a Mars mission with 2.5 kg payload, total floating mass including balloon and windball, is 10 kg.