### Lightweight Liquid Helium Dewar for High-Altitude Balloon Payloads

**A factor-of-five or better reduction in mass is achieved.**

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Astrophysical observations at millimeter wavelengths require large (2-to-5-meter diameter) telescopes carried to altitudes above 35 km by scientific research balloons. The scientific performance is greatly enhanced if the telescope is cooled to temperatures below 10 K with no emissive windows between the telescope and the sky. Standard liquid helium bucket dewars can contain a suitable telescope for telescope diameter less than two meters. However, the mass of a dewar large enough to hold a 3-to-5-meter diameter telescope would exceed the balloon lift capacity.

The solution is to separate the functions of cryogen storage and in-flight thermal isolation, utilizing the unique physical conditions at balloon altitudes. Conventional dewars are launched cold: the vacuum walls necessary for thermal isolation must also withstand the pressure gradient at sea level and are correspondingly thick and heavy. The pressure at 40 km is less than 0.3% of sea level: a dewar designed for use only at 40 km can use ultra thin walls to achieve significant reductions in mass.

This innovation concerns new construction and operational techniques to produce a lightweight liquid helium bucket dewar. The dewar is intended for use on high-altitude balloon payloads. The mass is low enough to allow a large (3-to-5-meter) diameter dewar to fly at altitudes above 35 km on conventional scientific research balloons without exceeding the lift capability of the balloon.

The lightweight dewar has thin (250-micron) stainless steel walls. The walls are too thin to support the pressure gradient at sea level: the dewar launches warm with the vacuum space vented continuously during ascent to eliminate any...