Precision Portable Cryogenic Blackbody Target for Microwave/Millimeter Wave Receiver Calibration

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Passive tropospheric remote sensing of temperature and water vapor profiles is often accomplished with radiometer receivers in the microwave and millimeter wavebands. The K-Ka (18-33 GHz) and G (170-210 GHz) water profiling bands are related to water vapor resonances. In 1963 Dr. Westwater demonstrated that the V-band (60 GHz oxygen band) tropospheric emissions could be utilized for temperature profiling. Water vapor contains other resonances to a Terahertz and beyond.

The tropospheric radiometer receivers spectrally resolve trillionths of a watt and typically have gains of 70 or more dB, with high stability and accuracy required. Absolute measurement accuracies of 0.5K or better in blackbody temperature measurements are sought, requiring accurate calibration standards. Receiver noise figures of 3 to 8 dB (300 to 1600K) are not uncommon.

It is desired that calibrations include the entire radiometer system, and that the calibration references span the range of operational observables. For tropospheric downwelling radiation observed by ground-based radiometers, the sky blackbody temperatures range from 20 or so Kelvins to slightly above ambient surface temperatures. For two-point calibrations of a linear receiver an ambient and a cryogenic target of precisely known blackbody temperature are therefore desired.

A precision cryogenic blackbody target is presented that utilizes liquid nitrogen and is estimated to be accurate to several tenths of a Kelvin around 77K.