Contribution ID: **577** Type: **Contributed Oral**

C3Or4A-02: A vanadium superconducting heat switch for very low temperatures

Wednesday 12 July 2023 16:30 (15 minutes)

High sensitivity astrophysics detectors such as transition edge sensor (TES) bolometers or microwave kinetic inductance detectors (MKIDs) require sub-Kelvin operating temperatures for observing low energy photons in infrared and x-ray ranges. Continuous Adiabatic Demagnetization Refrigerators (CADRs) are presently the state of the art solution for providing cooling to these detectors below as low as 50 mK. The CADR shuttles heat through a series of paramagnetic stages from a 50 mK heat load to a 1-6+ K heat sink, using heat switches between stages to "switch" between thermal isolation and thermal communication. A superconducting heat switch is required between the two lowest temperature stages and is considered a critical system component as it determines recycling time and cooling power of the lowest temperature stage. A figure of merit for this technology is the "switching ratio": the ratio of the thermal conductivity in the on and off states. This ratio is a function of temperature, fixed material properties, and the purity and anneal state of the metal. Lead is most commonly used in this type of thermal switch because it is readily available as a high purity material. However, an analysis of the material properties of other superconducting material suggests that vanadium could achieve a significantly higher switching ratio - as high as 20x that of lead. Increasing the switching ratio could allow for shorter recycling times and reduce the parasitic load on the lowest temperature stage. This work discusses the design of a vanadium superconducting heat switch and compares predicted performance in the CADR against the presently used lead switch.

Author: GUNDERSON, Chloe (University of Wisconsin-Madison)

Co-authors: JAHROMI, Amir (NASA); MILLER, Franklin Keith; HOLMES, Warren (Jet Propulsion Laboratory, California Institute of Technology)

Presenter: GUNDERSON, Chloe (University of Wisconsin-Madison)

Session Classification: C3Or4A: Aerospace Coolers I: Sub-2 Kelvin