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C4Or1A-01: Vibration-heating in ADR Kevlar suspension systems

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The cryogenics group at NASA's Goddard Space Flight Center has a long-standing development and test program for laboratory and space-flight adiabatic demagnetization refrigerators (ADRs). These devices are used to cool components to temperatures as low as 0.05 K. At such low temperatures the ADR systems can provide a few micro-Watts of cooling power, so it is important to minimize the conduction of heat to these cold stages from the surroundings. The cold ADR elements are held in place by thin tensioned strings made of Kevlar, chosen for its high strength and stiffness and low thermal conductivity. During laboratory testing, we have observed that occasional significant additional heat loads on the coldest ADR stages correlate with unusually high vibration levels in the cryostat due to a noisy mechanical cryocooler. We theorized that this heat results from plastic deformation of the Kevlar fibers and frictional interactions among them, driven by the cryostat vibrations. We describe tests and calculations performed in attempt to confirm this source of the heating, and we discuss possible strategies to reduce this effect in future ADR suspension systems.

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