
SESSION 5: Sub-Kelvin Coolers

Paper 5.3

Tuesday ORAL Session

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Refrigeration Performance of Single-Stage Adiabatic Demagnetization Refrigerator Using GGG Crystal

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As an important refrigeration technology in the temperature range of sub-Kelvin, the adiabatic demagnetization refrigeration is widely used to cool bolometric infrared detectors and cryogenic X-ray detectors for low background astronomy because of its high efficiency, gravity independence, and high reliability. The adiabatic demagnetization refrigerator (ADR) mainly consists of the salt pill, superconducting magnet and thermal switch. In the salt pill, the magnetocaloric materials used are mainly rare-earth oxides and hydrated salts, such as $\text{Gd}_3\text{Ga}_5\text{O}_{12}$ (GGG), $\text{Dy}_3\text{Ga}_5\text{O}_{12}$ (DGG), GdLiF_4 (GLF), $\text{CrK}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ (CPA) and $\text{Fe}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ (FAA). The GGG, commonly used as a working material in magnetic refrigerators in the temperature range from 0.5 to 20 K, is a good quality crystal with high thermal conductivity and chemical stability. Besides, GGG crystal can be produced at a reasonable cost. Therefore, in an ultra-low temperature ADR, GGG crystal crystals are usually used as high-temperature working materials (such as from 4 K to 0.8 K). In this paper, in order to accurately study the refrigeration performance of GGG, a single-stage ADR using 252 g GGG crystal was built and experimentally tested. In the single-stage ADR, a G-M mechanical refrigerator was selected to provide a 4 K heat sink, and a gas gap heat switch was used to control heat transfer between the heat sink and GGG.