Multi-stage ADRs for Current and Future Astronomy Missions: Performance and Requirements for Cryogen-Free Operation

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ABSTRACT

The cooling requirements for current (e.g. Astro-H) and future (e.g. IXO and ASP) astronomy missions pose significant challenges for the sub-Kelvin cooler. In particular, the use of large detector arrays increases the cooling power needed, and the variety of cryocoolers that can be used for pre-cooling greatly expands the range of temperatures at which the sub-Kelvin cooler can be designed to reject heat. In most cases, there is also a need for a stable higher temperature stage for cooling amplifiers or telescope components. NASA/GSFC is currently building a 3-stage ADR for the Astro-H mission, and is developing a 5-stage ADR suitable for IXO and ASP, as well as many other missions in the early planning stages. The architecture of these ADRs allows them to be adapted rather easily for different cooling requirements and to accommodate different cryocooler capabilities (operating temperature and cooling power). This paper will discuss the performance of these ADRs, which operate in both continuous and single-shot cooling modes, and the minimum cryocooler capabilities needed to meet the requirements of future missions.