

Design of the PIXIE Cryogenic System

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Abstract:

The Primordial Inflation Explorer (PIXIE) is a proposed mission to study the polarization of the remnant cosmic microwave background with the goal of finding and understanding primordial gravity waves. The instrument has been designed to capture this information across the entire sky by rejecting foreground signals and suppressing systematic error by multiple differencing methods. The instrument operates at a temperature very close to the Cosmic Microwave Background of 2.7 K, while the detectors operate at 0.1 K. The PIXIE cryogenic system provides this in low Earth orbit by making use of 3 subsystems. Lightweight, simply deployed shields provide protection against the Earth and Sun while passively cooling wiring and instrument supports at 150 K. A mechanical cryocooler precools wires and supports at 68, 17, and 4.5 K while its compressors operate at room temperature. And finally two adiabatic demagnetization refrigerators cool the instrument from 4.5 to 2.7 K and cool the detectors to 0.1 K. Staged cooling in this manner allows a thermodynamically efficient use of relatively mature technologies that can be fully demonstrated before flight.

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