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Cold Probes of the Hot Universe

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High-resolution x-ray spectroscopy is becoming a powerful tool for studying the hot (1 - 100 MK) and dynamic universe. The grating spectrometers on the XMM and Chandra satellites have sparked a new era in x-ray astronomy, but there is need to deploy instrumentation that can provide higher spectral resolution with high throughput in the Fe-K band (around 6 keV) and for extended sources. These new spectrometers will be based on arrays of microcalorimeters operated at 0.1 K and below. A microcalorimeter measures a small amount of heat in a weakly heatsunk thermal mass by sensing a temperature change in the presence of thermodynamically unavoidable temperature fluctuations. Low temperature operation is required in order to minimize this thermal noise and to reduce the heat capacity. The most advanced microcalorimeter technology to date is based on using a temperature-dependent resistance for the thermometer element, either a semiconductor thermistor or a superconducting transition-edge sensor (TES). At Goddard, we have been developing microcalorimeters for x-ray astrophysics since our pioneering work in 1984, and we have pursued both silicon and TES technology, and optimizations for different telescopes and energy bands. In our latest TES design, we have achieved a resolution of 2.5 eV at 6 keV. I will review the microcalorimeter research at Goddard and will discuss prospects for getting such an instrument deployed in orbit.