**X-ray Missions based on LTD Technologies**

Microcalorimeter arrays used as imaging spectrometers will enable ground-breaking science in X-ray astrophysics. Their development has been one of the driving applications of the low temperature detector community since the early 1980s. While their application in space remains in relative infancy, we are on the verge of an era in which microcalorimeter spectrometers are likely to dominate instrumentation for high-energy astrophysics missions. NASA sounding rocket experiments such as the X-ray Quantum Calorimeter (XQC) and Micro-X have now paved the way for orbital observatories. JAXA’s Astro-H gave us a glimpse of this fantastic new capability before its unfortunate demise. The launch of XRISM later this year should finally demonstrate the sort of large suite of observations that X-ray microcalorimeter arrays will make major contributions to. In the mid-2030s, we will see the launch of ESA’s flagship Athena mission, that will further advance the imaging and spectroscopic capabilities for the high-energy X-ray community enormously. Numerous other potential new mission concepts using X-ray microcalorimeters have been studied in detail such as NASA’s Lynx and the Light Element Mapper (LEM), JAXA’s Super-DIOS, and China’s Hot Universe Baryon Surveyor (HUBS). In the first half of this presentation, I will review the development and desired requirements of the X-ray microcalorimeter missions and concepts, and describe the current progress and status missions being implemented and proposed.

In the second half of this presentation, I will focus on The Line Emission Mapper (LEM) which is a probe-class mission concept under study by NASA that is designed to provide unprecedented insight into the physics of galaxy formation, including stellar and black-hole feedback and flows of baryonic matter into and out of galaxies. LEM incorporates a light-weight X-ray optic with 10” angular resolution and a large-format microcalorimeter array with a 15” pixel pitch over a 29’ field of view (FOV). The main microcalorimeter array and readout design takes advantage of mature technology that has been developed for Athena X-IFU. The central 7’ region of the array consists of ~ 800 transition-edge sensors (TESs), optimized for a bandpass of 0.3-2 keV and with an energy resolution of 1.2 eV at 1 keV. The rest of the FOV is covered by 4-pixel TES hydras with 2.5 eV energy resolution at 1 keV. Hydras are position-sensitive (‘thermally multiplexed’) detectors that enable extremely large numbers of effective pixels in an array, without a commensurate increase in the number of wires, bias circuit, and readout components. In total the array will have ~ 4k TESs with ~ 14k imaging elements on a 290 micron-pitch. The array will be read out with state-of-the-art time-division multiplexing (TDM), implement with 59 pixels (and 1 dark pixel) in each of the 69 TDM columns. Here we present a detailed overview of the baseline microcalorimeter detector design and present first results from both single pixel TESs and 4-pixel hydras. Our prototype LEM pixels utilize 15um x 50um Mo/Au TESs with a transition temperature of around 58 mK. These pixels incorporate high-fill-factor Au absorbers of thickness 0.54um. We have demonstrated an energy resolution of 0.90+/-0.02 eV and 1.90 +/-0.02 eV at 1.5 keV for single pixel and 4-pixel hydras, respectively, meeting the performance requirements of LEM. We show how the position discrimination in the hydra pixels can be achieved, down to energies of a few 100 eV, using the measured pulse rise-times. Finally, we will show that the properties of the LEM pixels are well optimized for the proposed TDM read out architecture.