

Phase 2 Development of the HEAT Observatory at Ridge A, Antarctica

Based on the results of an NSF-funded design study in 2006 and successful deployment in 2012, we propose the second development phase for the High Elevation Antarctic Terahertz (HEAT) telescope system, a robotic, 0.6-meter THz observatory at the summit of the Antarctic plateau. HEAT observes the brightest and most diagnostic spectral lines from the Galaxy. It is tasked with the dual purpose of performing both site testing and leading-edge terahertz astronomy. The (first) telescope was deployed in 2012 with the University of New South Wales' PLATeau Observatory (PLATO-R) to Ridge A, the driest, calmest and clearest point on the summit. The facility operates with no direct human contact for a year at a time between servicing missions, with commands and data being transferred to and from the experiment via satellite daily. The site is truly exceptional, and HEAT has already made the most sensitive large-scale maps in the 370 micron line of neutral carbon and performed landmark observations at 200 microns, unveiling a population of "CO dark" molecular clouds and new regions where molecular clouds may be forming. With an established facility, we propose here the next level of instrument development, namely the augmentation of a hot electron bolometer (HEB) receiver operating at 4K, whose increased sensitivity will allow the facility to map the Galaxy >10 times faster. This effort is the second phase of development for this novel robotic facility. This proposal requires fieldwork in the Antarctic.

What is the intellectual merit of the proposed activity? The HEAT telescope forges entirely new capabilities for ground based infrared and submillimeter astronomy which otherwise would be unachievable except via expensive airborne or space-based platforms. HEAT and PLATO-R represent a new generation of polar instrumentation that permits the excellent conditions available from remote sites like Ridge A to be harnessed without the costs and hazards associated with manned operations. The unparalleled stability, exceptional dryness, low wind and extreme cold make Ridge A a site without equal for astronomy at infrared and submillimeter wavelengths. HEAT operates in the far-IR atmospheric windows in which the most crucial astrophysical spectral diagnostics of the formation of galaxies, stars, planets, and life are found. HEAT is addressing timely and fundamental questions about the evolution of the interstellar medium and star formation. In particular, through large-scale Galactic surveys, the measurement and impact of the Galactic environment on the life cycles of interstellar clouds and their relation to star formation are gradually being realized. The proposed upgrades of mixer, local oscillator, low-noise amplifier, cryogenic, and DSP technologies will play essential roles in future Terahertz observatories. This pioneering mission paves the way for future astronomical investigations from the high plateau and beyond.

What are the broader impacts of the proposed activity? HEAT's key project is to map, with great sensitivity and precision, portions of the Southern Galactic Plane in the spectral light of the dominant coolants of the interstellar medium. Already, comprehensive science products from the survey and its collaborations are being freely made available to the astronomy & aeronomy community with no proprietary period. These survey products enhance the value of numerous contemporary surveys. Beneficiaries include Legacy programs from the Spitzer Space Telescope, Key Projects from Herschel, the most recent HI and CO surveys of the Galactic Plane, and the 2MASS & UKIDSS infrared sky surveys. The wide-field terahertz surveys provided by HEAT place Herschel, ALMA, SOFIA and balloon-borne observations in a broader, richer context. Thus, HEAT will serve both as a scientific and technological pathfinder for contemporary and future suborbital and space-based missions. As a portable, accessible terahertz observatory, the local copy of the HEAT telescope transforms into an outstanding educational and outreach tool. Furthermore, the HEAT project uniquely captures the kind of high adventure spirit that attracts many to science in the first place, and we aim to provide video and photographic documentation of our experience for everyone via PBS's NOVA program. Finally, the design and fabrication of HEAT has been an interdisciplinary team effort involving students from astronomy, optical sciences, and electrical engineering. Astronomical instrumentation is becoming ever more complex, requiring the talents of many individuals to bring them to fruition. Providing students with both technical training and team-work experience increases their probability of success, both in science and in society.