PROJECT SUMMARY

High Elevation Antarctic Terahertz (HEAT) telescopes for Dome A and Ridge A

Based on the results of an NSF-funded design study in 2006 and the successful deployment of a full prototype to Antarctica in 2007, we propose to develop and deploy two automated, 0.6-meter THz observatories for remote operation at the summit of the Antarctic plateau with the dual purpose of site testing and performing leading-edge terahertz astronomy. These High Elevation Antarctic Terahertz (HEAT) telescopes will operate from 158 to 372 μm, and observe the brightest and most diagnostic spectral lines from the Galaxy. The HEAT heterodyne instrument packages will utilize established mixer, local oscillator, amplifier, cryogenic, and digital signal processing technologies. In December 2010, the first telescope will be deployed to replace Pre-HEAT, the NSF-funded prototype 450 μm tipper & spectrometer that was successfully deployed to Dome A in 2007-8 with the University of New South Wales' PLATeau Observatory (PLATO). The second telescope will deploy one year later to Ridge A, a promising site 150 km from Dome A. Together, they will operate autonomously for over a year at a time, with commands and data being transfered to and from the experiment via satellite daily. At both sites, HEAT will see good atmospheric transmission at $200^{+}\mu$m during much of the winter, and usable transmission in the pivotal 160 μm window for $>$10% of the winter. The Ridge A site is undeveloped but may actually be the driest, calmest and clearest point on the summit; the HEAT telescope will test this hypothesis while obtaining important astronomical spectra.

What is the intellectual merit of the proposed activity?

The HEAT telescopes will forge 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 represent a new generation of polar instrumentation that permits the excellent conditions available from remote sites like Dome A to be harnessed without the costs and hazards associated with manned operations. The unparalleled stability, exceptional dryness, low wind and extreme cold make Dome A and Ridge A ground-based sites without equal for astronomy at infrared and submillimeter wavelengths. HEAT will operate in the atmospheric windows between 158 and 370 μm, in which the most crucial astrophysical spectral diagnostics of the formation of galaxies, stars, planets, and life are found. HEAT will answer 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** will finally be realized. The receiver system itself serves as a flexible testbed for heterodyne Terahertz components. Future upgrades of mixer, local oscillator, low-noise amplifier, cryogenic, and digital signal processing technologies are planned and will play essential roles in future Terahertz observatories. This pioneering mission will pave the way for future astronomical investigations from the high plateau.

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. Definitive and comprehensive science products from the survey and its many synergistic collaborations will be made available to the astronomical community via the Web in a timely manner. These survey products will enhance the value of numerous contemporary surveys. Beneficiaries include the GLIMPSE and "C2D" Legacy programs from the Spitzer Space Telescope, the most recent HI and CO surveys of the Galactic Plane, and the 2MASS infrared sky survey. The wide-field terahertz surveys that the HEAT telescopes provide will place more focused Herschel and SOFIA observations in a broader, richer context. The proposed terahertz observations also complement the survey to be performed by the Stratospheric Terahertz Observatory. Thus, HEAT will serve both as a scientific and technological pathfinder for contemporary and future suborbital and space-based missions. Finally, the design and fabrication of HEAT will be 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 of success not only within astronomy, but society as a whole.