PROJECT SUMMARY

Overview:

In recent years, a multitude of infrared and (sub)mm continuum surveys have provided a rich census of interstellar clouds and star formation in the Galaxy. However, the corresponding spectroscopy needed to transform these surveys into a comprehensive understanding of Galactic structure and dynamics remains an urgent need. Here, funds are requested to operate Supercam, the world's largest, most powerful submillimeter-wave heterodyne array receiver for use at the 10-meter Heinrich Hertz Telescope (HHT), in support of a Galactic Plane Spectroscopic Survey in CO J=3-2 and HCO+ J=4-3. Indeed, this key project was the scientific foundation for Supercam's design and construction through NSF's MRI program. This 64-beam imaging spectrometer operates in the astrophysically rich 850 micron atmospheric window, where the HHT has high aperture efficiency and good atmospheric transmission more than 50% of the winter season. With Supercam's successful engineering runs at the HHT in May 2012 and 2013, the promise of rapid, large-scale spectroscopic mapping at submillimeter wavelengths is now realizable.

Intellectual Merit :

The high throughput, mapping speed, and good angular resolution achievable with Supercam at the HHT uniquely probes the evolution of the interstellar medium in our Galaxy. This effort, the northern portion of the Galactic Plane Survey, will span from l=0 to 90 degrees with |b|<1 degree, with targeted observations spanning an additional 60 square degrees in the Outer Galaxy. In these regions, Supercam will map every major star forming complex, infrared dark cloud, star(less) cloud core, and sense the complex kinematics associated with Galactic rotation, cloud dynamics, collisions, and protostellar outflows. Supercam's surveys will dramatically improve our understanding of interstellar matter and the relationship between stars and gas in the Galaxy; they will explore the life cycles of molecular clouds -- how they form, evolve and are disrupted, and how material cycles between the phases of the ISM. They will relate how and under what conditions molecular clouds form stars, and how outflows, shocks, turbulence and radiation regulate star formation. To put Galactic observations into broad extragalactic context, a template of Milky Way star formation will be constructed. These observations, combined with existing CO and HI data, will help establish the use of the Milky Way as a ''Rosetta Stone'' for understanding the large-scale interplay (feedback) between stars and gas, which can then be applied to distant galaxies.

Broader Impacts :

The proposed surveys with Supercam are especially timely. They build on the massive legacy of continuum surveys from Spitzer, Herschel, 2MASS, BGPS and UKIDSS. They will provide a crucial spectroscopic counterpart; definitive spectral maps of the Galaxy will be compared to terahertz observations from Herschel and SOFIA, and serve as ideal 'finding charts' for high-resolution follow-up with ALMA. These data therefore are highly complementary and have broad applicability. To maximize their impact, the Supercam surveys will be broadly disseminated to the astronomical community without a proprietary period. Supercam will also be available as a PI instrument at the HHT; the existing outside observer program provides access. Finally, constructing the Supercam array has been a interdisciplinary, team effort involving students from astronomy, optical sciences, and electrical engineering. Operating and optimizing such instrumentation for science is similarly complex, requiring the talents of many individuals to bring them to fruition. Providing students with technical and scientific training, and team-work experience increases their probability of success not only within astronomy, but society as a whole.