PROJECT SUMMARY

Georgia State University's Center for High Angular Resolution Astronomy (CHARA) operates an optical/near infrared interferometric array on Mount Wilson, CA. The CHARA Array has six 1-m aperture telescopes in a Y configuration providing 15 baselines from 33 to 331 meters, and 10 closure phases. In terms of the number and size of its telescopes, the length of its baselines, the broad range of wavelength regimes and spectral resolutions covered by its beam combiners, its imaging capabilities, and broad group of collaborators and users, the CHARA Array is among the most powerful facilities of its type and is unique in the world. This proposal seeks funding to improve the sensitivity and scientific throughput of the CHARA Array by adding Adaptive Optics (AO) systems to each of the six telescopes.

Intellectual Merit - Since beginning full-time scientific operations in 2005, the CHARA group has published 43 papers in the refereed literature, with five more in preparation. Among its "firsts" are: first direct detection of gravity darkening on a single star (α Leo); first direct measurement of the "P-factor" in the Baade-Wesselink method (δ Cep); first angular diameter for a halo population star (μ Cas A); first image of a single, main-sequence star (Altair); first direct image of an interacting binary (β Lyr); and imaging the eclipse event of ε Aur for the first time resolving a century old mystery. CHARA is now the primary U.S. center for astronomical research using closure-phase model-independent ground-based interferometric imaging at optical and near IR wavelengths. Almost every new measurement from optical interferometry is showing us some way in which our understanding of stars was incorrect or too simple. As interferometry becomes widely used, stellar astrophysics will be changed forever.

As the first CHARA facility upgrade proposed since construction, the group carefully studied various options and this proposal reflects the only viable approach to increase the sensitivity in a cost-efficient manner. The enhanced wavefront control made possible by AO will improve the near-IR strehl ratios by factors of 2-3. Just as importantly, the redesigned tip-tilt/wavefront sensor will be 50x more sensitive than the current system in R-band by using new detectors and eliminating 19 reflections. Since the telescopes are small (1m) and the field of view is tiny (1 arcsecond), only a simple on-axis AO system with a small number of actuators is required, and the AO-specific components are commercially available. This upgrade provides radically better sensitivity for reddened objects such as protoplanetary disks around young stars, and we outline a key science program focusing on T Tauri disks that would not be possible at any other facility. Furthermore, the NIR sensitivity boost will open up new discovery areas in active galactic nuclei (AGN) and microquasar/BH-NS systems for the first time with a sub-milliarcsecond angular resolution. This investment will ensure the competitiveness of US interferometry for the next decade with respect to the better funded and larger groups in Europe operating at the VLTI.

Broader impact is enhanced in four ways. First, CHARA is actively training the next generation of scientific and technical experts in the field of interferometry. A significant fraction of GSU astronomy graduate students are pursuing their PhD research with the Array. CHARA staff members have participated in many of the NASA/JPL Michelson Summer Schools, and CHARA has published on its website more than 150 Technical Reports and other documents available to the international community. Second, CHARA is enhancing science awareness in the large and diverse undergraduate community at GSU by incorporating results from the Array in undergraduate astronomy courses, which enroll approximately 700 students per semester. Third, CHARA actively participates in informal science education through such efforts as the collaboration with the American Museum of Natural History that resulted in the display of the historic 20-ft Michelson Stellar Interferometer at the AMNH in New York in 2007 as well as through CHARA's own Exhibit Hall located in the CHARA Operations Center on Mount Wilson. Finally, access to CHARA now extends beyond the ~70 participating consortium scientsts, and we are offering open observing time to the general astronomical community through the normal NOAO-TAC process. This program was oversubscribed by a factor of 3.7 in 2010, and we plan to continue, and expand, this program of community access to the CHARA Array. The increase in sensitivity and science throughput gained from AO will greatly increase the number of potential targets, as well as help provide more time for external users.