Title of Investigation: Adaptive Optics System for the 1.6 Meter Solar Telescope in Big Bear
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Project Summary

New Jersey Institute of Technology (NJIT), in collaboration with the University of Hawaii (UH) and the Korean National Observatory (KAO), is building the world's largest aperture solar telescope. The 1.6-m aperture, off-axis, New Solar Telescope (NST) will replace Big Bear Solar Observatory (BBSO)'s principal telescope with its 65-cm aperture. The project is well under way; first-light is anticipated at the end of 2006. Under prior NSF/MRI support to NJIT, in collaboration with the National Solar Observatory (NSO), we have successfully developed two 76-element Adaptive Optics systems (AO-76) for the current BBSO 65-cm telescope and the NSO 76-cm Dunn Telescope.

To fully utilize the scientific capability of NST as early as possible, we propose to transfer the AO-76 system, with modifications, to the NST immediately after it is installed. This proposal seeks funding for that task. AO-76 is a high-order system for the 65-cm BBSO telescope, which is successfully operating in both the visible and near infrared (NIR) ranges. We understand that when integrated into the NST, the AO-76 will be a lower order AO in the visible. However, we anticipate that it will have full capability of correcting the seeing in the NIR. More specifically, under median seeing conditions at BBSO, the predicted Strehl ratio at $1.6\mu m$ is above 0.8. For about 10% of the time, the predicted Strehl ratio at $0.5\mu m$ is above 0.5. Therefore, our initial scientific focus for the NST will be in NIR studies of the solar atmosphere and its activity. Diffraction limited observations will also be made during the good seeing periods in the visible. The key tasks in this proposal include the optical design and subsequent setup/testing of the AO system for the NST. Both the refractive and reflective designs will be considered.

Over the last two years, we have developed a state-of-art NIR imaging magnetograph system (IRIM) that has attained its first scientific light at BBSO. The specific scientific objectives are: (1) High cadence, high resolution studies of solar flares; (2) Evolution of magnetic fields associated with solar activity; and (3) Dynamics of Kilo-gauss magnetic flux tubes.

In sum, we directly address the two criteria required in any NSF proposal:

(1) Intellectual merit: The AO equipped NST will be the largest aperture solar telescope, located in one of the best observing sites. It will enable new, cutting edge science. We have already demonstrated our abilities by developing the two most successful solar AO systems in the world.

(2) Broad Impact: The development of the proposed AO system is the first solid step toward an even higher-order AO system for the NST, which will also enable us to further explore Multi-Conjugate Adaptive Optics (MCAO). This effort is highly relevant to the development of MCAO systems for the nighttime telescopes. The scientific results will be extremely important in the understanding of the dynamics of magnetic fields on a fine spatial scale, as well as space weather monitoring and forecasting. The scientific objectives will also be closely linked to several key research topics in nighttime astronomy: the physics of stellar coronal heating, stellar magnetic fields and stellar flares. This project has strong integrated research and education components. A post-doc, a Ph.D. student and an undergraduate will participate in the project. Our data will be open to the scientific community.