Robotic Adaptive Optics Facilities for 2-m Class Telescopes

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The next decade of astronomy will be dominated by large area surveys (see the detailed discussion in the Astro-2010 Decadal survey). Ground-based optical transient surveys such as LSST and space-based exoplanet, supernova, and lensing surveys such as Kepler and WFIRST will join the GAIA all-sky astrometric survey in producing a flood of data that will enable leaps in our understanding of the universe. New and current transient projects such as PanSTARRs, the Catalina Real-Time Survey, and the Palomar Transient Factory are already producing observations of thousands of new optical transients, from which the most interesting are selected for follow-up characterization. There is a clear need for a facility capable of rapidly characterizing interesting transients without using costly large telescope observing time. Simple detections are insufficient; characterization through high angular resolution images, deeper images, spectra, or observations at different cadences or periods than the main surveys, will be required. Such follow-up characterization must be well matched to the particular surveys, and requires sufficient additional observing resources and time to cover the extensive number of targets.

Robotic laser adaptive optics systems, like the Robo-AO instrument currently deployed at Palomar Observatory's 60-inch (1.5 m) telescope (see Figure 1), can uniquely upgrade the US telescope system to exploit the tremendous amount data produced with wide-field surveys. Robo-AO was specifically engineered for 2-m class telescopes; by using economical and primarily off-the-shelf components, the Robo-AO instrument can be duplicated for less than $1M in equipment costs. The instrument comprises an affordable microelectromechanical-systems based deformable mirror used in conjunction with a pilot-safe ultraviolet Rayleigh scattering laser guide star, serving visible and near-infrared cameras used for both science and as tip-tilt sensors for fast image stabilization. Robo-AO incorporates a single computer to simultaneously control the dynamic queue of targets, the adaptive optics system, all science cameras, the telescope and laser guide star, all completely autonomously – minimizing observatory support costs.

By observing at the visible and near-infrared diffraction limit (see Figure 2), robotic laser adaptive optics systems will make the vital difference between simply confirming transients and disentangling them from their environments by answering key questions: Is there a faint galaxy host? Are they associated with a precursor noted in HST images? Are the light curves contaminated by nearby sources? Full visible and infrared characterization and light-curve measurement of tens and hundreds of distant transients per night become practical and affordable on modest sized telescopes equipped with robotic laser adaptive optics systems. I therefore endorse installing Robo-AO clones on 2-m class US telescopes as an extremely cost effective way to leverage existing infrastructure in support of the community’s highest-priority facilities and science objectives.

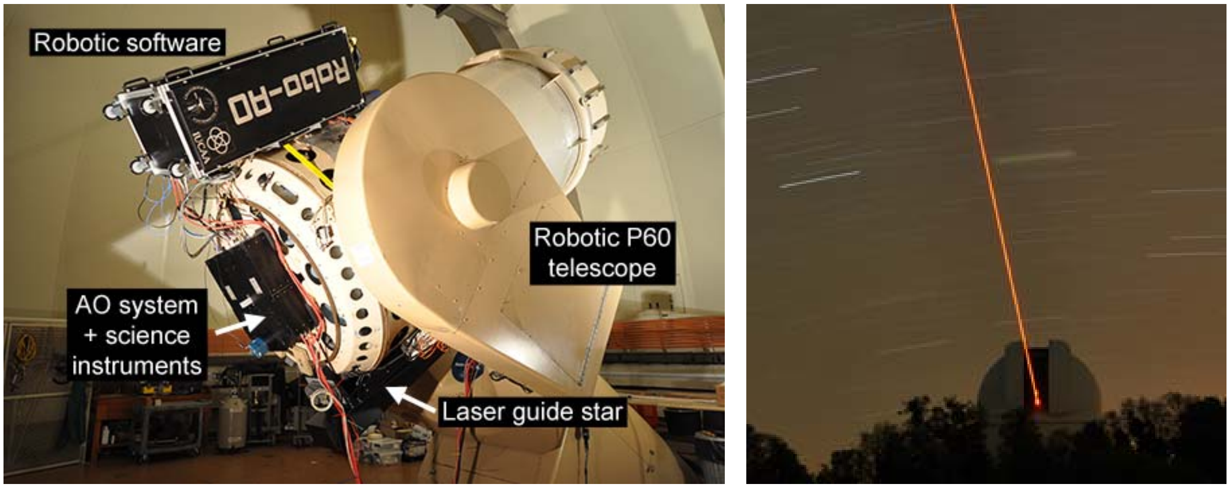

Figure 1. Left: the full Robo-AO system as installed on the 1.5 m P60 telescope. Right: the pilot-safe Robo-AO ultraviolet laser.

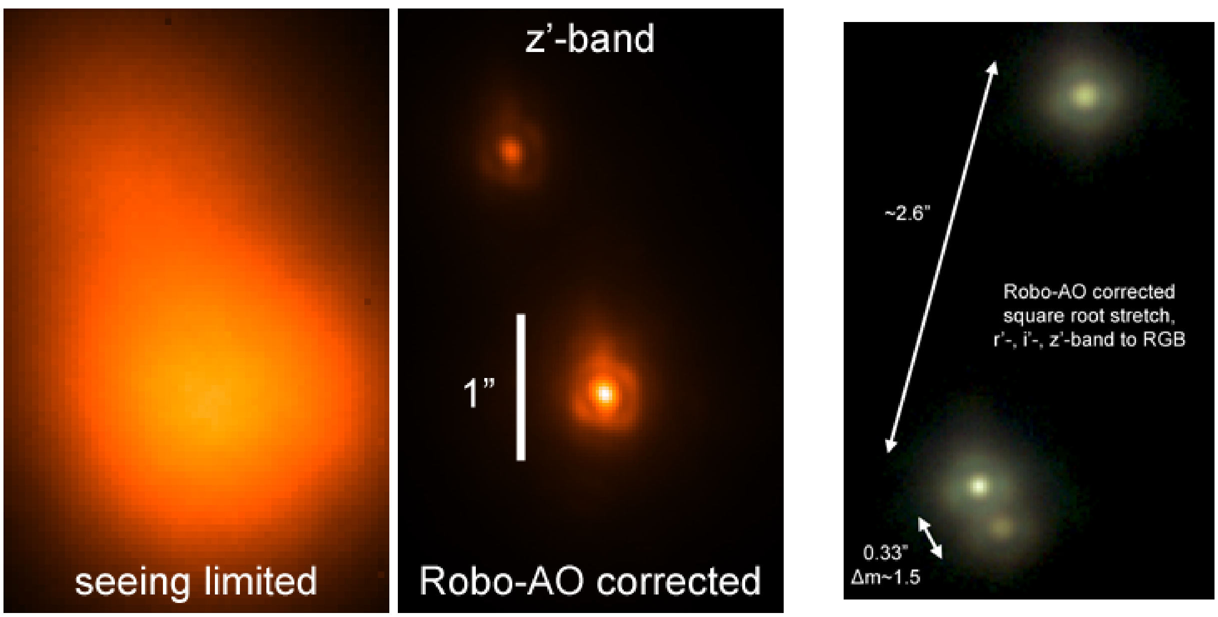

Figure 2. Left: Robo-AO images of the red dwarf binary system Kruger 60 with and without adaptive optics correction. Right: A recent triple star system observed by Robo-AO in r'-, i'- and z'-bands; shown in square root stretch.