The CHARA Array in 2040

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Abstract

The CHARA Array has been upgrading its facilities and instrumentation. Adaptive optics systems for all six telescopes are now online. New beam combiners expand the 6-beam imaging capabilities across multiple wavelength bands (R, H, K) and push toward greater sensitivity. Our mobile 7th telescope (T7) has achieved first light and is undergoing the installation of its adaptive optics system. Optical fibers with lengths of 650m now connect S1, S2, and S3/T7 to the lab and have achieved fringes with a lab light source. The S4 mobile site will be commissioned in 2025 and will extend the maximum baseline out to 550m.
Extrapolating these trends to 2040: AO systems could be optimized for correcting visible wavelengths atmospheric distortions. A central 2m telescope (C0) and 7th delay line system could be completed. This would improve sensitivity and imaging capabilities for extended objects. C0 will also serve as a testbed to replace the existing 1m telescopes with 2m telescopes. The next generation of beam combiners will push toward greater sensitivity, higher contrast, and multi-wavelength imaging capabilities. Building on T7, we have identified sites that extend the maximum baseline out to 1 km. Beam transport technologies may be tested at the Array, perhaps direct optical with adaptive optics for open-air transport and/or quantum entanglement technologies.
Simultaneous multi-wavelength imaging, beam transport, and control upgrades will improve stellar diameter measurement precision, exoplanet host diameter and limb darkening measurements, and high contrast binary detection. New insights into stellar outflow and ejection/dimming events and the relation between mass ejection/outflow and Be star circumstellar disks may be revealed. Priorities will include stellar system evolution: planetary formation and young stellar objects, imaging the sites of planet formation in the inner region of circumstellar disks, and measuring the contraction of pre-main sequence stars. Longer baselines and improved sensitivity would allow for imaging of more contact and interacting binaries. Greater sensitivity will access dozens of AGN targets, where the dust sublimation region could be resolved, and km baselines would directly resolve the accretion disk and investigate possible binary black holes at the center. Imaging exoplanet transits remains a challenging possibility, accessible only through $>$ 1 km baselines. Direct imaging of a hot Jupiter would require a new phase referencing mode of a nearby star. Finally, the CHARA Array, VLTI, and other interferometers should continue to host educational workshops in the same vein as the VLTI and Michelson Schools.

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