An abstract submitted in response to the 2013 Astrophysics Roadmap RFI for Science Challenges

Science Challenges Requiring Sub-Mas Angular Resolution UV/Optical Spectral Imaging Observations

21 March 2013

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We highlight here some illustrative science challenges, in both galactic and extragalactic science, which can only be pursued with the acquisition of sub-milliarcsec (sub-mas) UV/Optical space-based, spectral imaging observations. Such space-based observations provide wavelength coverage (UV & IR), very large baselines, continuous observing, rapid Fourier uv-plane coverage, and measurement accuracies that cannot be obtained with ground-based facilities.

Understanding the formation, structure, and evolution of stars and stellar systems remains one of the most basic pursuits of astronomical science, and is a prerequisite to obtaining an understanding of the Universe as a whole. The details of the many dynamic processes (e.g., variable magnetic fields (stellar activity), accretion, convection, shocks, pulsations, winds, and jets) that affect the formation, structure, and evolution of these stars and stellar systems can only be revealed, however, via sub-mas angular resolution, UV/Optical spectral imaging observations. At these resolutions, not only can many important structures be directly resolved (Fig. 1), but hours to weeks between successive images will detect dramatic changes in many objects, e.g., mass transfer in binaries, pulsation-driven surface brightness variation and convective cell structure in giants and supergiants, jet formation and propagation and the changes in debris disks/shells in young planetary systems due to orbiting resonances and planets, non-radial pulsations in and winds from stars, and the structure, evolution, and interaction with the ISM of the core regions of nearby supernovae.

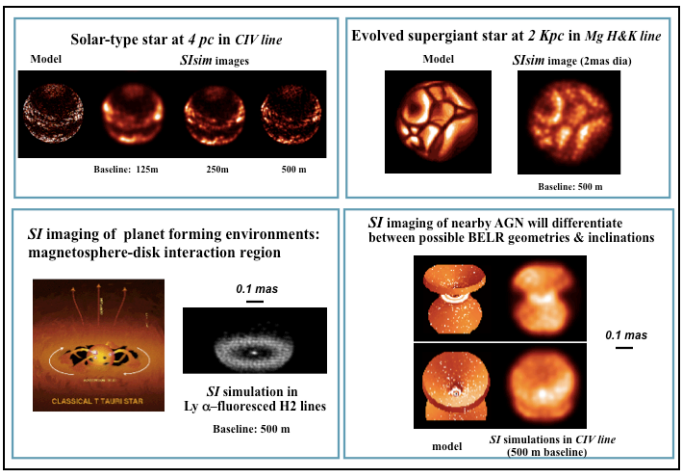

Fig. 1: Sub-mas UV/Optical observations enable a broad range of science investigations.

On larger scales, nuclear super-massive black holes (SMBH) are a fundamental constituent of galaxies and their growth as active galactic nuclei (AGN) produces a significant fraction of the luminosity in the universe. Moreover, the masses of galactic bulges and SMBHs appear to be correlated, which suggests the importance of the AGN in galaxy evolution (e.g., via AGN feedback). We face a similar basic observational limitation here as well - AGN have been the archetypical "point sources" for 50 years: no spatial structure has been resolved in the inner regions in which the winds and jets involved in feedback processes arise, even with the largest ground-based interferometers. There are several key questions as to the nature and origin of AGN in particular that can be addressed only by probing their central regions with sub-mas angular resolution at UV/optical wavelengths. These include 1) what initiates the active phase, 2) the duration of the active phase, and 3) the effect of the AGN on the host galaxy.