High Resolution Imaging of Stars and Interacting Binary Systems

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The need for the highest possible angular resolution has been a driving force in the observational astronomy since Galileo pointed the first telescope toward the sky almost four centuries ago. This quest has been characterized by ever-increasing telescope apertures and interferometer baselines, aiming toward diffraction-limited resolution and image information recovery from the degrading effects of the Earth's atmosphere. Despite the resulting extraordinary gains in spatial resolution over the past century, so far very few stellar surfaces and interacting binary systems have been resolved using ground- or space-based imaging. Furthermore, high-angular resolution observations of powerful astrophysical processes with dominant signatures at X-ray and UV wavelengths, such as accretion or coronal activity, are only possible from space. The next major observational advances in stellar astronomy will require orders of magnitude leaps in angular resolution.

Presently, the Sun is the only star for which we have a detailed picture of the stellar activity resulting from multi-wavelength direct imaging of magnetic structures. In other stars, ranging from dwarfs to giants, star spots have only been inferred through light-curve modeling and the presence of emission lines and UV/X-ray emissions, indicating active chromospheres and coronae. Even for nearby stars, sub-milliarcsecond resolution is necessary to image the structures associated with stellar activity, and to measure their sub-surface structure via spatially-resolved astroseismology.

Currently, most of our binary accretion model paradigms are based on time-resolved spectroscopic observations of interacting systems. Direct imaging of a wide range of interacting binaries, facilitating the study of their individual components and mass flows, is the key to advancing our understanding of the accretion processes, mass loss characteristics of the components, and the system dynamics as a function of time. Our understanding of these phenomena will provide key inputs to stellar evolutionary models, and revolutionize our view and understanding of the Universe.

I will describe the science case for high resolution imaging of stars and binary systems, and highlight science drivers and challenges of several future missions with a potential for ultra-high resolution imaging at UV/Optical and X-ray wavelengths.