Future High-Angular Resolution UV-Optical Imaging Capability From Space

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Why has the Hubble Space Telescope (HST) has completely transformed the field of astronomy and astrophysics and inspired the worldwide public over the past two decades? The history of astronomy shows that new phenomena are discovered every time the resolution, sensitivity, or survey area of new instruments increase by factors of ten or more and HST provided that transformational UV/Optical capability. Over the next decades, JWST and giant ground-based telescopes will provide commensurate order-of-magnitude gains in their respective domains, especially at near- and mid-infrared wavelengths. However key questions will remain in a post HST era that are likely to remain inaccessible with these facilities; is there life on planets around other solar-type stars, how do galaxies and the local interstellar medium interact to mediate the process of star formation? The UV, Optical and near infrared remain a rich observational regime in terms of astrophysical diagnostics: many types of stars, galaxies, and gas emit much or most of their light at UV and Optical wavelengths. From the study of the interstellar gas (where all but two of the key diagnostic spectral lines are emitted in the rest-frame ultraviolet region) to the transformational detection of biomarkers such as molecular oxygen and vegetation signatures, new observational capabilities will be needed in the UV-Optical beyond the original capabilities of HST. To access the new observational capability-space of unprecedented angular resolution and stability, for sensitivity to the most important physical gas diagnostics, and to enable NASA to answer transformational questions in science beyond the capabilities of JWST and future ground based facilities, we will require a large space-based UV/Optical telescope.

A UV/Optical space telescope with substantially larger aperture than Hubble would enable transformative research in at least three key areas: (1) The search for diagnostic biomarkers such as molecular oxygen and vegetation features in the spectra of earth-like planets around ~100 nearby solar-type stars within 20 parsecs of the Sun and the mapping of the land-to-ocean surface area ratios on these exoplanets. (2) Unraveling the "fossil record" of galactic star formation, IMFs, and chemical enrichment at every mass scale from ultra-faint dwarf galaxies around the Milky Way to the nearest giant elliptical galaxies using resolved stellar populations (most of which are beyond the reach of HST or JWST). (3) Following the diffuse interstellar and circumgalactic gas flows that drive accretion and feedback and influence the properties of galaxies and the stars within them, all for a representative sample of galaxies in the local volume but at a level of detail far beyond the reach of HST.

The first of these scientific objectives requires extremely sensitive and stable spectroscopy, time-series broadband photometry, and high spatial resolution (8-15 milliarcsec, close to an order of magnitude beyond HST and JWST), the second requires that this resolution be maintained with an extremely stable imaging PSF, and the third requires sensitive, high-resolution UV spectroscopy (40-150 times the current spectroscopic grasp of HST). These are demanding requirements, but they are all achievable with a single facility that would then be poised to make transformative advance in these areas, and beyond. An even greater number of as-yet-unimagined discoveries would also be enabled.

The NASA 30-year Roadmap must include a plan to continue the important observational capabilities provided by a UV-optical space telescope with an aperture significantly larger than our present 2.4-m facility.