Technological Challenges for a UV-optical Flagship Mission

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Many exciting scientific opportunities for the coming three decades will be approached with a large UV-optical telescope. A large aperture provides both collecting area for high sensitivity and angular resolution for separating closely-spaced objects, revealing fine details and measuring small motions. Research areas will include resolved stellar populations in nearby galaxies, the environments of galactic nuclei harboring black holes, UV spectroscopy of the intergalactic medium, imaging exoplanet systems with high-contrast coronagraphy, and characterization of exoplanet atmospheres with transit transmission, reflection or emission spectroscopy.

Segments: The aperture will be larger than can be realized with a monolithic primary mirror, so a segmented architecture will be needed. JWST spent several years investigating options and resolving trade studies for the number of segments, their sizes, materials and fabrication techniques. Similar studies are needed regarding segments for a UV-optical telescope.

In-space assembly: The primary will be larger than any foreseeable launch vehicle fairing. Assembly in space will allow more efficient packaging of components for launch, and can decouple requirements for bearing launch loads and delicate, high precision alignment later. It also creates synergies between NASA's science missions, space operations and human activities.

Wave Front Sensing and Control: A UV-optical telescope will have wave-front error and stability requirements factors four to sixteen times more difficult than JWST. Nanometer level WFE will require subnanometer accuracy in the control of the optics. Architectures, sensors, actuators and algorithms will all require development and demonstration.

Fine guidance and jitter control: Image motion will need to be controlled to sub-milli-arc second levels in order to take advantage of the inherent angular resolution of the telescope. Affordable and high precision fine guidance sensors will be integrated with the pointing control system of the observatory and high resolution fine steering mirrors in the payload.

Large Focal Plane Arrays: Critical sampling of the point spread function will require very large arrays to sample even modest fields of view. For a 20m telescope with 10mas images, a Giga-pixel array (32k X 32k) would cover about 3 X 3 arc min. Detectors, electronics, modular packaging, data management algorithms, thermal control and other elements will be needed.

In-orbit servicing: Robotic or human servicing will add value to a mission by replenishing any expendable commodities, replacing limited lifetime elements, repairing malfunctions and upgrading the instrument suite and other subsystems. Servicing is an opportunity for collaborations between the Science, Space Technology and Human Exploration and Operations Mission Directorates.