IAF SYMPOSIUM ON FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS (A7)
Space Agency Strategies and Plans (1)

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THE FUTURE OF SPACE ASTRONOMY WILL BE BUILT: RESULTS FROM THE NASA-CHARTERED IN-SPACE ASSEMBLED TELESCOPE (ISAT) STUDY

Abstract

Major advances in astrophysics will require increasingly large light-collecting apertures for both better resolution and to study extremely faint objects such as nearby exoplanets and the very distant Universe. Without a major paradigm change in the near future, space astronomy will face the challenge of developing ultraviolet/optical/infrared (UVOIR) telescopes with apertures larger than about twice that of JWST's 6.5 meters at the same time that ground-based telescopes operate with apertures 30 – 40 meters in diameter. Current designs for the largest future UVOIR space observatories have adopted JWST-type semi-autonomous self-deployment, a design that is constrained by the payload mass and fairing volume limits of available launch vehicles: for the Space Launch System Block 2 Cargo, apertures may be limited to diameters no greater than 15 meters. Because metrics for science productivity often depend upon a high power of the aperture, advances in space astronomy may be severely curtailed when this limit is reached. For example, in the search for nearby life-bearing exoplanets, the yield – the number of candidates – increases approximately as the square of the telescope diameter. At the other extreme – the most distant galaxies in the cosmos – both high spectroscopic sensitivity and angular resolution are necessary to investigate in depth the birth of the earliest stellar systems, which require very large apertures. Therefore, major scientific advances require alternatives to self-deployment. Such an alternative is in-space assembly (iSA), taking advantage of increasing capabilities of space robotic systems, subsystem modularization, rendezvous and proximity operations, and lower-cost existing medium-lift launch vehicles. Moreover, iSA offers the potential for innovative optical and structural designs, as well as upgrading and servicing not available to observatories packed and launched as a single unit. In a study funded over the past two years by the NASA HQ Astrophysics Division, we have developed and critically assessed an initial design for space assembly of a 20-meter UVOIR telescope, as well as capabilities that could be applied to smaller-aperture missions. Our work includes preliminary estimates of costs and risks in comparison with self-deployed options, priority technology investments, and demonstration missions. Our work to date may be found at https://exoplanets.nasa.gov/exep/technology/in-space-assembly/ .