Dear Dr. Clampin and APAC:

The Hubble Space Telescope is a phenomenal observatory whose unique capabilities place it at the forefront of astrophysics today. It is currently the only instrument capable of answering some of the most important open questions about the nature of planets, stars, gas, galaxies, dark matter and the universe. With a record 1053 peer-reviewed publications in 2023, and typical oversubscription by a factor of 7 each observing cycle, the scientific productivity of Hubble continues to show strong growth in its extended mission.

We, the Hubble Space Telescope User Committee (STUC), are concerned about the current budget situation and especially the plan for an unprecedented cut to the Hubble budget. We are writing to express our worry about the impact such cuts will have on astrophysics research and Hubble’s ongoing science productivity. Any reconfiguration of the Hubble operating paradigm needs to be science-driven, requiring a thorough analysis of the scientific impact. The STUC advises the Space Telescope Science Institute and the NASA Hubble Project, from the users perspective, on the normal operations of the observatory, and recommends changes in order to maximize scientific productivity. In this letter, we represent the astronomical community and ask you to consider their voice in the upcoming decisions about the Hubble budget.

For three decades, Hubble has been the consistent crown jewel in a varying set of extraordinary research missions in NASA’s astrophysics portfolio. Hubble’s instrument suite is performing extremely well, and the breadth of its capabilities allows Hubble to uniquely address fundamental questions in each of NASA’s strategic astrophysics science goals. Moreover, Hubble has enjoyed a unique and enduring place in the public’s imagination. As with NASA itself, Hubble is not just a technical and scientific achievement, but is recognized world-wide. It is part of the soft power of the nation in the world community.

Hubble is a vital observatory for the future. It offers unique science capabilities that are a fundamental driver in all three of the key scientific challenges identified by the National Academies' Decadal Survey (Astro2020). In comparison to all current telescopes, Hubble is unique in ultraviolet (UV) capabilities, with every instrument operating in the bluer-than-blue regime, at wavelengths below 3000 Å. While other planned UV missions (e.g., UVEX, and international missions ULTRASAT and Xuntian) will explore additional parameter space, only Hubble provides the high spatial and spectral resolution in the UV, together with sensitivity that will not be matched until the next UV flagship that may be decades away.

Addressing Astro2020’s theme “Worlds and Suns in Context,” the UV-optical capabilities of Hubble serve as a vital tool in the characterization of exoplanets, including the detection of systems around white-dwarf stars where UV data from the COS and STIS instruments are the only way to measure the death, or remarkable survival, of planetary systems. Stellar activity has been flagged as one of the major uncertainties in determining if small rocky planets have
atmospheres; again, COS and STIS have proven vital in this effort to better assess the stellar characteristics of planetary host stars. More recently the UV arm of the WFC3 instrument has been used to spectroscopically assess the cloudy nature of exoplanet atmospheres and many studies have already demonstrated that without the UV-optical uniquely offered by Hubble, full characterization of exoplanet spectra with JWST is not possible.

Hubble is an irreplaceable resource for time domain science, connected to Astro2020's "New Messengers and New Physics" theme. Hubble has provided a 30 year history of high-resolution optical imaging, whose legacy value is enhanced by new observations of variables and transients at the same wavelengths. JWST may have comparable resolution in the IR, but many exciting sources in time domain science shine brightest in the UV and optical. Moreover, with new capabilities in gravitational-wave (GW) and neutrino astronomy through facilities like LIGO and IceCube, having Hubble available is crucial for enhancing the science return in Time Domain and Multi-Messenger Astrophysics (TDAMM). For example, Hubble observations of GW 170817 enormously magnified the impact of LIGO, helping to understand the surprising "blue kilonova" component of the emission that would not have been seen by JWST.

In the Astro2020 theme “Cosmic Ecosystems,” Hubble plays a key and unique role in revealing the properties of gas in the Universe, inside and around galaxies - the interstellar and circumgalactic medium. Gas is essential to the life cycle of galaxies; it provides new fuel for the formation of stars and planets. Hubble discovered that our home galaxy, the Milky Way, is not an isolated island, but rather that it is a complex system of gas flows in and out of our galaxy, connecting it to our neighbors, the Magellanic Clouds. Hubble discovered that the gas in the Milky Way contains and transports chemical elements that are essential for the formation of molecules, planets and stars. The unique UV spectroscopic and imaging capabilities of STIS, COS, and ACS, help us to unravel the evolution of chemical elements in galaxies and throughout the universe. These instruments are essential in this field of research, as they are the only ones that can measure the motions, physical conditions, ionizing radiation field, and elemental abundances of this gas and cosmic dust in and around the Milky Way, the Magellanic Clouds, nearby galaxies and in the cosmic web. The high spectral resolution of COS and STIS, and the imaging capabilities of ACS, are essential for unveiling the complexity of interstellar and circumgalactic gas inside and around galaxies.

Hubble continues to have a unique role to play in NASA’s science portfolio as the only facility that provides the high resolution UV/optical imaging and spectroscopy. A non-exhaustive list of outstanding open questions that require these capabilities includes: sampling representative galactic environments (not just the most active environments); measuring the rest-frame UV as a function of redshift to connect the local and high-redshift universe; unraveling the co-evolution of galaxies and black holes; providing high resolution spectroscopy and deep UV-optical-IR photometric follow-up of transient events; unveiling the complexity of gas inside and around the Local Group and nearby galaxies; resolving stars in globular clusters, characterizing binaries (including future gravitational wave events); understanding high-mass stars and their role in reionizing the universe; characterizing faint protoplanetary disks; quantifying activity markers in exoplanet host stars; and characterizing solar system and exoplanet atmospheres. Hubble has
revolutionized our understanding of the deaths of stars, the ubiquity of supermassive black holes, the origin of the elements on the periodic table, the birthplaces of the oldest stars, stellar populations in galaxies of all scales across the Local Group, and set the foundation for planetary atmosphere characterization from hot giants to terrestrial worlds in the habitable zone.

Hubble’s unique science capabilities complement and enhance the science return of other observatories and missions. For example, multiwavelength observations with Hubble, JWST, and ALMA are required to understand the origin, evolution, and composition of dust in the universe; measure the structure of high-redshift quasars via reverberation mapping; determine the temperature of protoplanetary disks; and connect observations of local galaxies with the high-redshift universe. The National Academies’ 2023 Planetary and Astrobiology Decadal Survey (Origins, Worlds, and Life) emphasized key discoveries in solar system science from Hubble, including plume activity on Europa and new moons of Pluto. Unique contributions from Hubble’s long time-baseline and UV observations continue to support solar system spacecraft missions (including Voyager, New Horizons, Dawn, Juno, DART, and Galileo) both by enabling mission planning and by enhancing science return.

Because of its unique UV capabilities, together with high spatial resolution optical imaging, Hubble cannot be replaced by the James Webb Space Telescope (JWST) or any telescope on the ground. Hubble and JWST are complementary facilities that deliver their best when taken together. In fact, about half of the JWST publications last year incorporate or are based on Hubble data. Soon, Euclid and Roman will also complement Hubble, with very large area coverage in the red-optical and near-infrared.

The real successor of Hubble will be the Habitable Worlds Observatory (HWO), the future flagship mission recommended by the Astro 2020 Decadal Survey, which is now in the design phase. It is critical to minimize the gap between Hubble and HWO in order to maintain a baseline of observations needed in various scientific fields, especially those that require long-term observations and follow-up over time. Expertise and commitment are key to the success of any mission, and the loss of UV expertise in the astronomical community would be detrimental to the development of HWO, both for the technical development and the scientific exploitation.

Hubble plays a vital role in training the future leaders in science. Generations of students have graduated under this system, producing unparalleled research with Hubble data and joining the astrophysics work force. This success has broadened participation in Hubble research and demonstrated NASA’s commitment to the core value of Inclusion. Supporting the future development of expertise in unique Hubble science is key for addressing the top-level astrophysical questions highlighted in the Astro 2020 Decadal Survey, as well as bringing us forward to the HWO era.

In conclusion, Hubble continues to offer unique capabilities that address the key questions in NASA’s astrophysics priorities. Its instruments are operating well, and the science return is as high as it has ever been. Moreover, Hubble is the best way to retain expertise and community and decide priorities for the next generation of flagship missions. While we acknowledge the
difficulty of NASA’s budget situation, we challenge NASA to ensure that changes in the Hubble budget will be based on a thorough evaluation of the science impact, and to find a way to maintain this vital resource for science in the long run.

Sincerely,
Hubble Space Telescope User Committee

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