REPORT

of the

HUBBLE SPACE TELESCOPE ULTRAVIOLET LEGACY SCIENCE DEFINITION WORKING GROUP

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EXECUTIVE SUMMARY

Star formation is the basis for understanding cosmic origins from the largest scales to the smallest. High-mass stars are the tracers of star formation on extragalactic and galactic scales, and are the powerhouses of radiative, mechanical, and nucleosynthetic feedback, thus playing an essential role in galaxy evolution across cosmic time. Low-mass stars are the vast majority of stellar mass in the universe and are home to planetary systems, including the only one we know in detail: our own. At ages < 10 Myr, both high-mass and low-mass stars generate complex UV emission processes that are difficult to model, and these are central to a wide range of vital astrophysical problems, ranging from cosmic reionization to the origin of our Earth.

Therefore, in response to the STScI Director's charge to identify a large, legacy UV program focused on star formation and related stellar physics, the HST UV Legacy Science Definition Working Group recommends that the HST UV Initiative be devoted to obtaining a **Hubble UV Legacy Library of Young Stars as Essential Standards (ULLYSES)** to serve as a UV spectroscopic reference sample of high-mass and low-mass, young stars. The recommended library will provide observations that uniformly sample the fundamental astrophysical parameter space for each class of stars, i.e., spectral type, luminosity class, and metallicity for massive stars; and spectral type, age, and disk accretion rate in low-mass stars. Key elements of this program include extending template spectra of massive stars to low-metallicity regimes for studies of the high-redshift universe; and extending those for young, low-mass stars and brown dwarfs to masses below 0.5 M_sun. By combining high-mass and low-mass stars, this program will produce a definitive UV dataset on the first 10 Myr of stellar evolution. The legacy value will be enhanced by enabling additional studies of the ISM, CGM, jets, and exoplanet science.

We recommend that the ULLYSES library be generated in 1000 orbits of HST time, divided equally between high-mass and low-mass stars. For the massive stars, the grid of observations should sample the parameter space of spectral type, luminosity class, and metallicity. We estimate this will require observing about 70 OB stars each, in the lower metallicity, Large and Small Magellanic Clouds, prioritizing the SMC; plus 5 - 10 additional stars that are accessible in even lower metallicity, Local Group galaxies. These observations should correspond to about 200, 250, and 50 orbits, respectively, with COS/G130M+G160M or STIS/E140M, plus STIS/E230M for the Magellanic Clouds targets; and COS/G140L for the few, more distant targets. For the low-mass stars, the grid should sample spectral type, age, and accretion rate, obtaining observations of about 40 K and M-type, T Tauri stars and brown dwarfs. These should correspond to about 400 orbits using COS/G130M+G160M, together with shorter, coeval exposures using STIS/G750L+G430L+G230L. Since these are variable objects, we also recommend time-series monitoring of 4 prototypical targets with COS/G160M+230L, totaling about 100 orbits.

The impact of the ULLYSES library will be greatly enhanced by community engagement during the planning process, both in partnering to develop the final program and target samples, and organizing campaigns for coordinated observations. The latter is especially important for the low-mass component, since the variability of the target objects makes ancillary coeval data especially valuable. It will also be essential to construct a user-friendly archive, with relevant metadata and tools. Including existing archive data in a uniform manner to complete the grids will be also be critical to the library's integrity, and it would be helpful to provide convenient links to external, relevant databases of ancillary and coordinated observations. The sum of these efforts will generate a unique UV legacy data set of great impact and lasting value.