THE IMPORTANCE OF UV/VISIBLE SPACE-BASED TELESCOPIC OBSERVATIONS FOR PLANETARY SCIENCE. J. T Clarke[1], [1]Boston University (Center for Space Physics, 725 Commonwealth Ave, Boston MA 02215; jclarke@bu.edu).

Introduction: First rate science has repeatedly been accomplished with Hubble Space Telescope observations of solar system objects. In addition to unique discovery science, like the images of Jupiter during the impacts of the fragments of Comet Shoemaker/Levy 9, a large number of HST observing programs has been conducted over the years in coordination with various planetary missions of NASA and ESA. Planetary auroral observations were coordinated with Galileo (Jupiter) and Cassini (Jupiter and Saturn), airglow/coronal observations of Mars and Venus were coordinated with the MEX, VEX, and MAVEN missions, and there are many other examples. This presentation will give an overview of the science goals and outcomes of some of these programs to illustrate the importance of combined telescopic and in situ measurements.

Short History of HST Planetary Science: The scientific contributions from HST to solar system science comprise a list far too long to include in this abstract or to mention in the talk. The wide variety of scientific topics can be seen at the press release site (http://hubblesite.org/newscenter/archive/releases/solar-system/). Scientific observations have included every planet but Mercury (too close to the Sun for HST to observe), comets, asteroids, the Kuiper belt, and exoplanets. A few inspiring examples will be shown in the presentation, but the reader is encouraged to click on the link above and scan over the wide range of topics, it is impressive.

Importance of Space-Based UV/Visible Observations for the Future: In the post-HST era there will be IR observations using JWST with a lifetime of 5-10 years, but *there is no currently planned capability for UV/visible high resolution observations*. As long as there are missions to the other planets, coordinated high resolution observations from Earth orbit will greatly enhance the science return, and in fact will be needed to reap the full scientific benefits of planetary missions. This is largely due to the ability of telescopes like HST to obtain the "big picture" from a large distance, while the *in situ* planetary spacecraft measure the local environment. The synergy is extremely important to obtain the full scientific benefits of each mission.

An excellent example from recent missions is the coordination between JUNO charged particle and UV/IR spectral observations of Jupiter's magnetosphere and upper atmosphere near closest approach, coordinated with HISAKI/EXCEED data on the Io plasma torus and overall auroral power, and a large HST program to image the auroral regions at high resolution. The changes with time in the Io plasma torus, in the aurora, and in magnetospheric charged particle motions range from minutes to weeks. With the combination of spacecraft data it has been established that the aurora drive the plasma torus, which is the opposite of what had been expected, and the plasma motions responsible for this control have been identified. Without the HST high resolution auroral imaging it would not have been possible to identify the regions in the magnetosphere where the action was taking place.

HST has become a workhorse for planetary science, including its growing extension to exo-solar systems. One key advantage to HST observations that is often under-appreciated is the stability of response in space. As one example, having a highly stable and repeatable point spread function makes it possible to establish the size of small objects, like dwarf planets in the Kuiper belt, much more accurately than with much large ground-based telescope with adaptive optics and potentially higher angular resolution. The stability of sensitivity similarly makes possible cross calibration of planetary missions. As one example, the UV instrument on MAVEN is being calibrated in comparison with HST data to establish the D/H ratio in the upper atmosphere of Mars with a high accuracy.

Finally, it should be emphasized that HST solar system science has not consisted *solely* of one-off observations that have answered important scientific questions (although there have been those discoveries). HST science has addressed new scientific targets that were unknown when the mission was launched (i.e exoplanets), it has supported space missions that were not planned when HST was launched (i.e. JUNO), and it will be used in the future in ways that no one has imagined today (i.e. we have no idea what we will miss in the future). It is a facility for key science, and represents a capability that will be needed for decades to come. It is very important for the solar system community to find a way to maintain this capability at a reasonable cost level for the long-term future, and we should discuss how to make this happen.