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**HST AND BEYOND—EXPLORATION AND THE SEARCH  
FOR ORIGINS: A VISION FOR ULTRAVIOLET-  
OPTICAL-INFRARED SPACE ASTRONOMY**

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**Bibliographic Information:** Dressler, Alan, ed., *HST and Beyond—Exploration and the Search for Origins: A Vision for Ultraviolet-Optical-Infrared Space Astronomy*, Washington, D.C.: Association of Universities for Research in Astronomy, May 15, 1996 (available at <http://origins.jpl.nasa.gov/library/hst-and-beyond-report.pdf>).  
Committee chair: Alan Dressler.

**PURPOSE**

In 1995, the Space Telescope Science Institute (STScI) asked the HST (Hubble Space Telescope) and Beyond Committee to “study possible missions and programs for ultraviolet-optical-infrared astronomy in space for the first decades of the 21st century. [The committee] should initiate a process which will produce a new consensus vision of the long-term goals of this scientific enterprise.”<sup>1</sup>

**BACKGROUND**

The HST and Beyond study, conducted by a committee of the Association of Universities for Research in Astronomy with support from the National Aeronautics and Space Administration (NASA), suggested the need for a qualitatively new rationale for public funding of space astronomy.

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<sup>1</sup>Dressler (1996), p. vii.

At the request of STScI, the HST & Beyond Committee (also known as the Dressler Committee, after committee chair Alan Dressler of Carnegie Observatories) was formed to conduct this study, with a primary focus on scientific opportunities rather than on technical capabilities. Eighteen committee members from various academic, scientific, and government institutions were chosen for their expertise and interest in ultraviolet-optical-infrared (UVOIR) observations from space, including but not limited to experience with the Hubble Space Telescope.<sup>2</sup> The committee developed a variety of candidate themes that could define the need for and capabilities of future space observatories, and developed those themes in terms of research issues, measurement requirements for facilities, and intellectual ramifications.

## METHODS/APPROACH

The literature that the HST & Beyond Committee used to help formulate its findings and recommendations included Illingworth et al. (1991),<sup>3</sup> Astronomy and Astrophysics Survey Committee (1991)<sup>4</sup> and the Working Papers for that report, and Office of Space Science and Applications (1992).<sup>5</sup> The committee felt that these and other documents broadly represented the thinking of the astronomy community, and supplemented those documents with extensive discussions and further investigations. The documents were read in preparation for a series of meetings, including the 1995 annual meeting of the American Astronomical Society (AAS) at which there was a public discussion of the committee's work. In addition, the HST & Beyond Committee received valuable input through personal presentations from individuals with special expertise in the astronomy community,

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<sup>2</sup>For a complete list of committee members, see Dressler (1996), p. ii.

<sup>3</sup>Illingworth, Garth, et al., "UV-Optical from Space," in *Working Papers: Astronomy and Astrophysics Panel Reports*, Washington, D.C.: National Academy Press, 1991.

<sup>4</sup>Astronomy and Astrophysics Survey Committee, Board on Physics and Astronomy, Commission on Physical Sciences, Mathematics, and Applications, National Research Council, *The Decade of Discovery in Astronomy and Astrophysics*, Washington, D.C.: National Academy Press, 1991.

<sup>5</sup>Office of Space Science and Applications, Solar System Exploration Division, TOPS Science Working Group, *TOPS: Toward Other Planetary Systems: A Report by the Solar System Exploration Division*, Washington, D.C.: National Aeronautics and Space Administration, 1992.

from e-mail messages following a solicitation through the AAS, and from the 1995 annual meeting of the AAS.

The committee identified two major goals for a future observatory, the accomplishment of which they hoped would justify a commitment to develop and maintain the observatory well into the 21st century: (1) the detailed study of the birth and evolution of “normal galaxies” such as the Milky Way and (2) the detection of earth-like planets in other solar systems and the search for evidence of life on those planets.

## **FINDINGS AND RECOMMENDATIONS**

To accomplish the two goals identified by the HST & Beyond Committee, and to simultaneously provide the broad capabilities of ultraviolet-optical-infrared astronomy in space that are necessary to advance the astronomy field on many fronts, the committee recommended the following:

### **Extend Hubble Space Telescope Termination Date**

The committee recommended that the HST should be operated beyond its currently scheduled termination date of 2005. The current and expected emphasis on ultraviolet imaging and spectroscopy and wide-field, high-resolution optical-light imaging makes the HST a critical astronomical tool through the first decade of the 21st century. At the time the committee wrote its report, committee members believed that this premier scientific tool could be operated in a “no repair, no upgrade” mode at approximately 20 percent of its present operation and maintenance cost, which would provide a highly cost-effective return on the investment in the HST beyond 2005. To promote the operation of the HST beyond its planned lifetime, the committee recommended that the telescope be operated much more economically beyond 2005, including

- no servicing or instrument replacement after 2005
- a final boost into a higher, long-lived orbit
- a possible reduction in the supported instrument complement and limited modes of operation.

Following these guidelines, the cost of operating the HST could be significantly reduced.

### **Develop a Space Observatory**

The committee recommended that NASA should develop a space observatory with a 4-meter or larger aperture that is optimized for operation over a wavelength range of 1–5 microns with imaging and spectroscopy.

Extension of the observatory's capabilities shortward to about 0.5 micron and longward to at least 20 microns would greatly increase the observatory's versatility and productivity. Therefore, the committee strongly recommended this course of action, if it could be done without a substantial increase in cost.

An observatory such as this would be the first major astronomical facility-class instrument in space and would follow the Advanced X-Ray Astrophysics Facility and Space Infrared Telescope Facility programs. It will also be an essential tool in an ambitious program of study in all areas of astronomy, especially in the origin and evolution of galaxies. The technology necessary for a cost-effective facility-class mission at these wavelengths—including ultra-lightweight precision mirrors and structures, advanced cooling systems, and smart controls—will be important for a variety of concurrent and follow-on programs, such as the imaging interferometry program discussed next.

The HST & Beyond Committee believes that approximately \$500 million for a 4-meter version of this facility is a realistic and desirable cost goal. As stated in the HST and Beyond report, "As there are presently no U.S. plans for a major space facility optimized for this wavelength region after about 2005, the committee recommends a large infrared-optimized observatory as the highest priority post-HST facility class mission for NASA."<sup>6</sup>

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<sup>6</sup>Dressler (1996).

### **Develop the Capability for Space Interferometry**

The committee also recommended that NASA should develop the capability for space interferometry. This capability would lead to a mission for astrometric observations in visible light at the ten-microarcseconds or better level, and to the eventual construction of an imaging interferometer. The committee recognizes that this technology is a vital next step in pursuit of answers to fundamental astrophysical questions and, specifically, the committee sees infrared interferometry from space as essential to one of the astronomy community's primary goals: the detection and study of earth-like planets around neighboring stars.

Accomplishing these ambitious goals with the resources that are likely to be available in future years will require new space technologies and innovations in the management of large projects, capabilities that are already being developed in NASA. Additionally, international cooperation will be needed in these endeavors. By increasing their direct involvement in the building and operation of these facilities, astronomers can take a positive, active role in achieving these objectives.

Because the lead time for such challenging missions is long, two activities must begin soon. First, the HST & Beyond Committee recommends that NASA set up study teams to investigate the technical issues involved in building an economical, large-aperture, near-infrared-optimized space telescope. This effort will support and parallel the activities already underway within NASA to explore the possibilities for space interferometry. Improved information regarding capabilities, costs, and trade-offs will be crucial to the deliberations of the next decennial survey report in astronomy and astrophysics.

Second, the committee recognized the increasing importance of scientists explaining their motivations, goals, and results to the societies that support their research. The necessity for this is especially acute because as the world draws nearer to answering some of humanity's ancient questions, the competition for available resources to support scientific research will be greater than it has been at any time over the past half-century.

The committee concluded that UVOIR astronomy from space has been remarkably successful in advancing the frontiers of astronomical knowledge and that the promise for future space observatories is equally encouraging.

#### **OTHER ITEM OF INTEREST**

The committee strongly believed that the scientific community represented in the HST & Beyond report needs to better articulate and express its long-term scientific goals to the general public that supports its research.