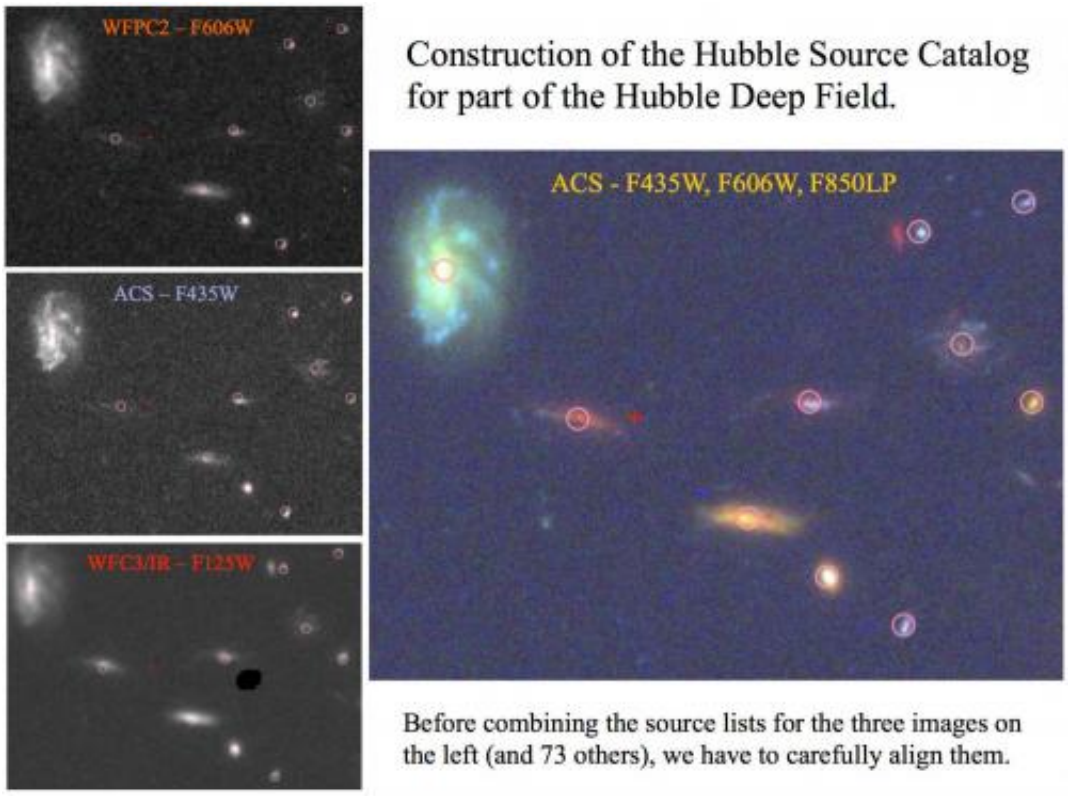
Hubble Source Catalog: One-stop shopping for astronomers

March 14 2015



This graphic shows an example of how the Hubble Source Catalog was constructed for a small part of the Hubble Deep Field. The catalog includes data from 76 separate images for the same region. Only three of these original images are shown on the left: one taken in orange light by the Wide Field Planetary Camera 2 (top); one taken in blue light by the Advanced Camera for Surveys (middle); and one taken in infrared light with the Wide Field Camera 3 (bottom). Note that the "sources," or objects, in each original image are not perfectly aligned with the final position from the Hubble Source Catalog (the pink circles). Specially developed software had to shift all the images slightly to align the sources before making the final version of the catalog. Credit: NASA, B.

Whitmore (STScI), and the Hubble Source Catalog Development Team

Astronomers at the Space Telescope Science Institute and the Johns Hopkins University, both in Baltimore, Maryland, have created a new master catalog of astronomical objects called the Hubble Source Catalog. The catalog provides one-stop shopping for measurements of objects observed with NASA's Hubble Space Telescope.

Hubble has amassed a rich legacy of images and other scientific data over its 25 years of exploring the universe. All of the images are stored in the computer-based Barbara A. Mikulski Archive for Space Telescopes (MAST), which astronomers use for their research. The archive is bursting with more than a million images, which contain roughly 100 million small sources ranging from distant galaxies to compact star clusters to individual stars. For astronomers, however, a major challenge is the difficulty involved with sifting through the archival gold mine to collect the data they want to analyze. The Hubble Source Catalog now allows astronomers to readily perform a computer search for characteristics of these sources.

The Hubble Source Catalog is a database from which astronomers can obtain the Hubble measurements of specific astronomical objects they want to investigate. A query to this database can take just seconds or minutes, while previously it might have required a few months of hard work by searching separate files throughout the archive. This capability promises to open the door to exciting new areas of research with Hubble that otherwise might have been too cumbersome to tackle.

"The Hubble Source Catalog is arguably the Hubble Space Telescope's ultimate legacy," said astronomer Tamás Budavári of the Johns Hopkins University, a member of the Hubble Source Catalog development team.

"Not only is it a one-stop shop, but it's the first place to go. It's the table of contents for and the summary of most Hubble observations. If a zillion investigators pointed Hubble in the same direction at their region of interest in different wavelengths, now we have taken all of those observations and put them together into a compilation of the measurements for all objects within that region."

Building the catalog, however, was a challenging task. "To make this possible, we had to develop new methods to align overlapping images and to determine which sources in different images are actually the same astronomical object," said development team member Steve Lubow of the Space Telescope Science Institute.

Hubble's archive is a diverse collection of data from different instruments, exposure times, and orientations on the sky. This diversity greatly complicates the construction of the catalog.

"Now we can have an even more holistic view of the Hubble universe because you can conduct multi-wavelength and time-domain analyses," Budavári said. "Additionally, due to the improved accuracy of positions in the catalog, we can compare Hubble's observations to those by other observatories, such as the Sloan Digital Sky Survey or the Galaxy Evolution Explorer."

Brad Whitmore, who leads the development team at the Space Telescope Science Institute, cautions, however, that, "In many cases, astronomers will find that they need to go back to the original images and make the measurements that are unique to their science project, such as measuring the very faintest objects in the image."

The catalog brings together observations from the three primary cameras that have served Hubble since 1993: the Wide Field Planetary Camera 2, Advanced Camera for Surveys, and Wide Field Camera 3. The three

cameras combined make observations spanning a wide swath of the spectrum, from ultraviolet to visible and near-infrared light. The catalog lists all of the sources, and includes both a summary and compilation of the measurements for each object. The measurements include information about the brightness of sources, as well as a source's color and shape. Astronomers released the first version of the catalog on Feb. 25.

The new catalog allows astronomers to produce more research using Hubble archival data. "The number of science papers based on Hubble archival data has been larger than the number of papers written by the original investigators for over a decade," Whitmore said. "With this catalog, we hope to accelerate that trend by making it easier to obtain and work with the data, and to allow researchers to address questions that they wouldn't even try to do before because it would be too time-consuming and costly."

Patterned after the Sloan Digital Sky Survey's online catalog, the Hubble Source Catalog is a unique addition to the growing number of online astronomical archives that allow astronomers, amateurs, and the public to explore and study the universe from the comfort of their office, sofa, or favorite coffee shop.

The Hubble Source Catalog, however, wasn't designed only for today's astronomers. It will be a valuable resource for future researchers using the next generation of telescopes, such as NASA's James Webb Space Telescope, an infrared observatory scheduled to launch in 2018.

"We didn't build this catalog for the next year, or two, or three," Whitmore said. "We built this catalog for the next several decades. It will be a great resource long after Hubble has been decommissioned."

The project started with grant funding from NASA's Advanced

Information Systems Research Program and is currently being supported by the Space Telescope Science Institute. The Hubble Space Telescope project and MAST have provided monetary support for the catalog's development.

Users can access the Hubble Source Catalog primarily through the MAST Discovery Portal (mast.stsci.edu), which has been enhanced to support the Hubble Source Catalog project. More details are available at archive.stsci.edu/hst/hsc/ .

Provided by ESA/Hubble Information Centre