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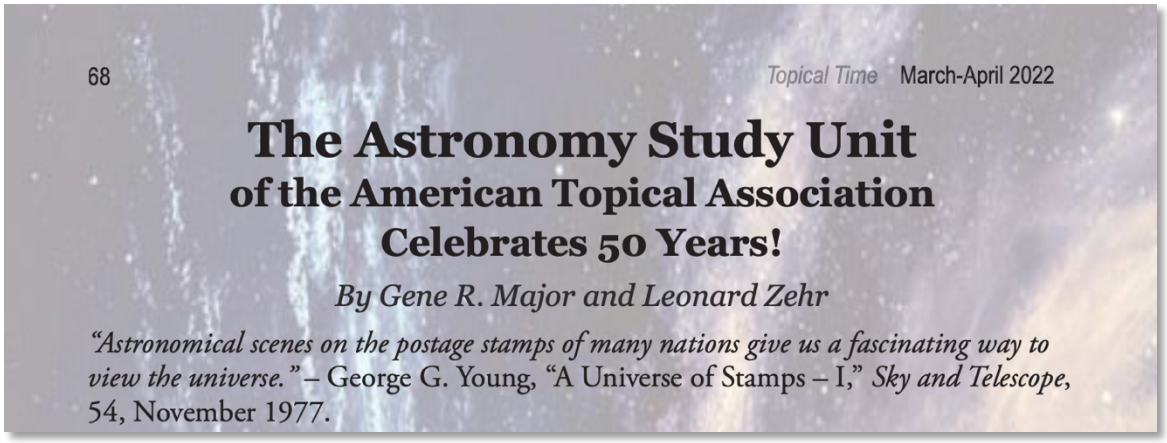
Editor's note:
June 2022 will mark the 50th Anniversary of the Astronomy Study Unit! Our article *The Astronomy Study Unit of the American Topical Association Celebrates 50 Years!* appears in the March/April 2022 issue of *Topical Time* (pp 68-71).


68 Topical Time March-April 2022

The Astronomy Study Unit
of the American Topical Association
Celebrates 50 Years!

By Gene R. Major and Leonard Zehr

"Astronomical scenes on the postage stamps of many nations give us a fascinating way to view the universe." – George G. Young, "A Universe of Stamps – I," *Sky and Telescope*, 54, November 1977.

Check out the top 10 Astrophilately stamps for 2021 posted on the ASU website: https://www.astronomystudyunit.net/astrophilately-top-10-in-2021

In This Issue

The Astronomy Study Unit is pleased to have a guest article from Don Hillger and Garry Toth, creators of the Un-Manned Satellite Philately website. Don is a PhD research meteorologist retired from the National Oceanic and Atmospheric Administration (NOAA) and Garry now retired, worked many years at the Meteorological Service of Canada. They are also authors of many publications on un-manned satellite philately, including the

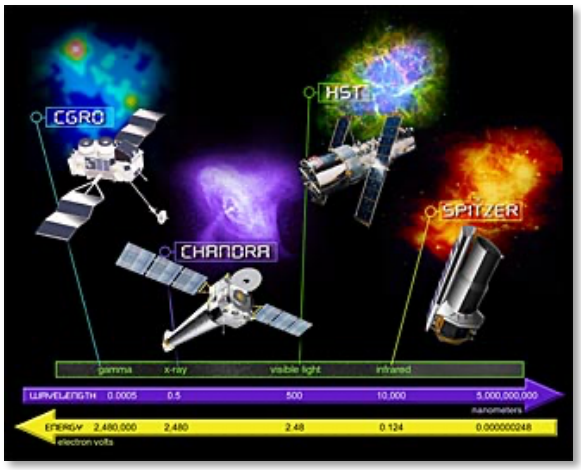
ATA publication *Space Weather and Philately* and the article *Visions of a Blue Planet*, which appeared in the January-February 2022 issue of *Topical Time*.

- **NASA's Great Observatories -** Don Hillger and Garry Toth
- **New Issues**

NASA's Great Observatories

By Don Hillger (SU-5200) and Garry Toth, Un-Manned Satellite Philately
(https://rammb.cira.colostate.edu/dev/hillger/satellites.htm)

This article features the four astronomical missions that NASA refers to as its "Great Observatories." Readers might want to know why these four qualify as Great Observatories when they are far from the only space telescopes that have made important astronomical observations. The reason is that they collectively cover much of the electromagnetic spectrum, with little overlap in their missions. They have worked together at times to study various phenomena multi-spectrally. In the following graphic each satellite is depicted with lines pointing to an electromagnetic spectrum representation at the bottom, in which wavelength increases to the right and spectral energy increases to the left.



NASA four Great Observatories and where they observe the electromagnetic spectrum

NASA's Great Observatories idea was introduced to the public in 1985 via a full-color booklet *The Great Observatories for Space Astrophysics* by

astronomer Martin Harwit and science writer Valerie Neal. This book is still available in paper back at https://www.amazon.com/Great-Observatories-Space-Astrophysics/dp/B001J4ZFC4. The four missions were complementary, and there was some overlap in their observations during their lifetimes, but they were never all operational at the same time. In fact, the 2nd one, Compton, was decommissioned before the 4th one, Spitzer, became operational.

Summary of NASA's four Great Observatories

The following table summarizes NASA's four Great Observatories. They are listed in order of launch. The following sections will present only a small sample of the philatelic material for each of these missions. Readers are referred to the authors' online information for all the postal items that they have found for these missions.

Great Observatory	Electromagnetic spectrum	Launch date	End of mission
Hubble Space Telescope (HST)	Visible light	1990-04-24 (STS-31/Discovery)	Ongoing
Compton Gamma Ray Observatory (CGRO)	Gamma rays	1991-04-05 (STS-37/Atlantis)	2000-06-04 (de-orbited)
Chandra X-ray Observatory (CXO)	X-rays	1999-07-23 (STS-93/Columbia)	Ongoing
Spitzer Space Telescope (SST)	Infrared	2003-08-25 (Delta-2 rocket)	Ongoing

All four Great Observatories embodied new technology and features that advanced astronomical imaging from space. In addition, each was named for an American astrophysicist who made significant contributions to his field of study. Therefore, these missions are often referred to simply by the last names of those astrophysicists. The technology of these missions and the experience gained through them have also contributed to the latest space telescope, the James Webb Space Telescope (JWST), which was launched in late 2021. It promises further discoveries about our universe.

Astronomical observations are best made from above the interference of Earth's atmosphere and clouds. One reason is that the atmosphere is opaque to some parts of the electromagnetic spectrum, requiring space-based

observations to "see" the universe at those wavelengths. Where both types of observations are possible, space-based platforms have historically provided better detail than was generally attainable from ground-based instruments. That advantage has recently decreased, though, due to larger ground-based observatories and advances in adaptive optics.

Hubble Space Telescope / Hubble

The first of the four Great Observatories is the **Hubble Space Telescope (HST)**, or Hubble for short, named after astronomer Edwin Hubble (1889 - 1953). Hubble is famous for his work to understand the expansion of the universe, discovering that objects in space are moving away at speeds proportional to their distance from Earth. Their light is red-shifted because of their motion away from us, with the amount of red-shift related to the distance to the object. This expanding universe is an important component of the Big Bang Theory.

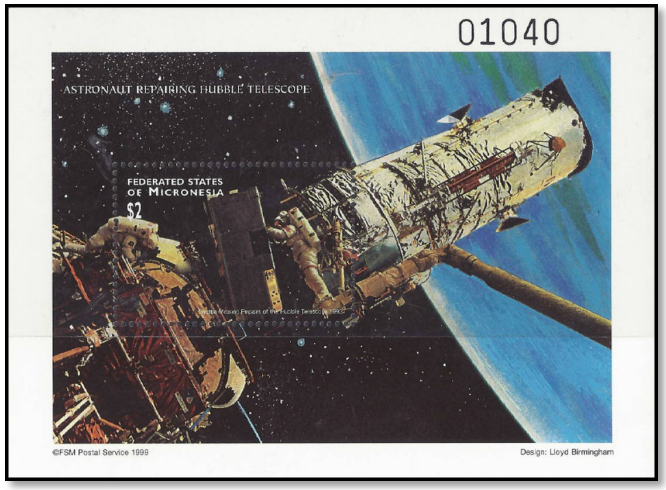
The Hubble Space Telescope was launched and deployed via the Space Shuttle on the STS-31R mission. HST was subsequently serviced on five other Space Shuttle missions, two of which (3A and 3B) NASA considers to be parts of the 3rd Service Mission, as in the table below. The 1st Service Mission was critical to fixing HST when it was discovered to have a design flaw which caused out-of-focus images. This was remedied when some of its components were replaced with corrective optics, restoring the telescope to its intended capabilities. Further Shuttle missions updated or improved HST capabilities, making it an impressive and well-known un-manned space mission in the eyes of the public. Now that the Space Shuttle Program has ended, the HST will continue without any further repairs or improvements until the end of its life.

HST Servicing Mission	Dates	Space Shuttle Mission/Name
launched and deployed	24-29 April 1990	STS-31R/Discovery
SM-1	2-13 Dec 1993	STS-61/Endeavour
SM-2	11-21 Feb 1997	STS-82/Discovery
SM-3A	19-27 Dec 1999	STS-103/Discovery
SM-3B	1-12 March 2002	STS-109/Columbia
SM-4	11-24 May 2009	STS-125/Atlantis

HST continues to be very popular philatelically, with hundreds of postal items as well as numerous postal covers for launch and post-launch events. A surprisingly large number of these postal items are from the 1980s, before the 1990 launch of HST, but HST items were even more prolific after its launch and have continued strong for the last 30 years.

Left: United States *Scott* 1919, *Michel* 1488 (1981). Right: Ireland *Scott* 833, *Michel* 760 (1991)

The United States issued a stamp showing HST in 1981, as part of a set of 8 space stamps. An Irish Europa issue stamp in 1991 includes a large and detailed image of HST, along with the Space Shuttle in the background. Some of the many HST postal items depict its various repairs. One example is a souvenir sheet of one stamp from Micronesia issued in 1999. The repair shown is likely either SM-2 or SM-3A from 1997 and 1999, respectively.



Micronesia *Scott* 346, *Michel* BL49 (1999)

HST observes mainly in visible wavelengths, but also has some capability in the near-visible/ultraviolet (slightly shorter wavelengths) and near-infrared (slightly longer wavelengths). HST orbits at an altitude of 560 km. Its

reflector telescope has a 2.4 m primary mirror. The size of the mirror and the overall size of the telescope was determined by a requirement for HST to fit into the Space Shuttle cargo bay for launch and deployment. As a long-term space observatory, HST has been responsible for thousands of images and has contributed enormously to our understanding of the universe, including stars, galaxies, nebulae, and black holes. Communications to and from HST utilize the Tracking and Data Relay Satellites (TDRS), a NASA series of satellites, the first seven of which were launched during Space Shuttle missions.

Images taken by the HST can be found on postal items. However, those items are not included in the authors' HST website unless they specifically mention the HST. An example is found on a cover (*Scott* 3388a, from 2000) with a set of five colorful HST images of four different nebulae and a galaxy. Although not on the fronts of the stamps, the HST is noted on the back of each stamp. The same cover includes a single stamp honoring Edwin Hubble (*Scott* 4426, from 2008) and the cover has a blue rubber-stamp cachet marking the 125th birthday of Hubble on the date on cancellation.

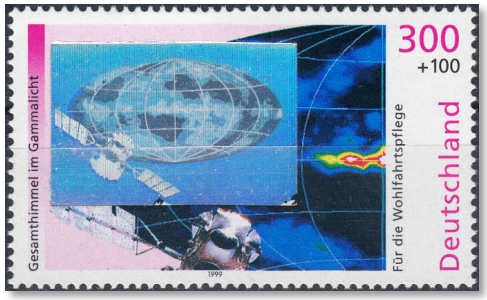
Cover with a strip of five stamps (*Scott* 3388a, showing HST images) and a single stamp (*Scott* 4426, honoring Edwin Hubble)

The authors have compiled a table listing all the postal items that they have found that depict or mention HST. That table can be found at https://rammb.cira.colostate.edu/dev/hillger/hst.htm. That website also

contains hundreds of launch and event covers for all the Space Shuttle missions that were associated with HST.

Compton Gamma Ray Observatory / Compton

The **Compton Gamma Ray Observatory (CGRO)** was launched and deployed by the Space Shuttle on the STS-37 mission in 1991. CGRO was named after Nobel Prize-winning physicist Dr. Arthur H. Compton (1892 – 1962). As a gamma ray detector, it created all-sky maps of gamma emissions, the highest-energy radiation from the cosmos.



Germany *Scott* B859, *Michel* 2081 (1999)

A stamp issued by Germany in 1999 shows CGRO as well as a reproduction of an all-sky map of gamma radiation. A silvery hologram inset is placed on top of a multi-colored version of a portion of the same image. This is one of only a small number of postal items have been found with depictions of CGRO, an indication of its being a far less popular mission than HST.

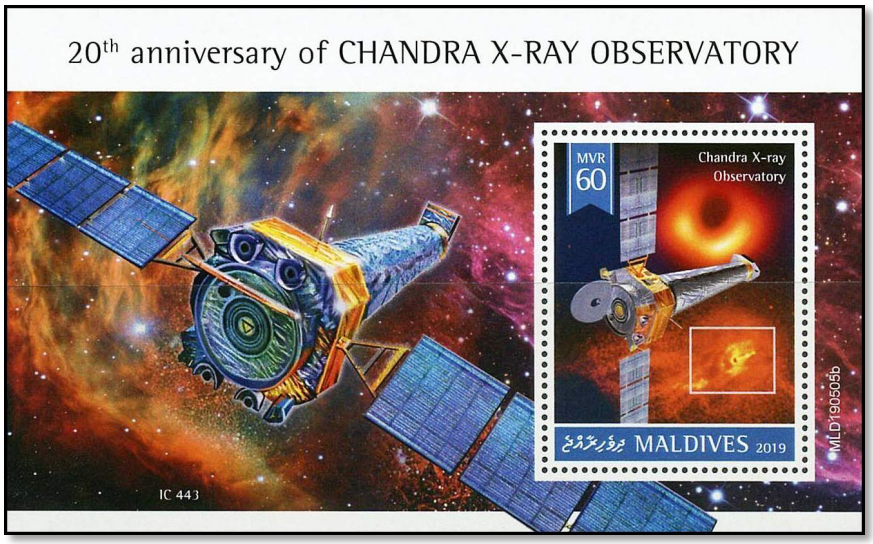
Blue and red CGRO patch on a cover canceled on both the STS-37 launch date and CGRO deployment date.

An example of a CGRO launch and event cover is provided, as one of the few covers that give a detailed depiction of the CGRO spacecraft. Otherwise, most other CGRO-related covers feature the Space Shuttle or the mission patch for STS-37, which contains only a small image of CGRO. CGRO had a 450 km circular orbit. After a gyroscope failed, it was de-orbited in 2000 in order to control its re-entry into an island-free area of the Pacific Ocean.

The authors have compiled a table listing all the postal items and launch and event covers that they have found that depict or mention CGRO. That table can be found at https://rammb.cira.colostate.edu/dev/hillger/cgro.htm.

Chandra X-ray Observatory / Chandra

The **Chandra X-ray Observatory (CXO)** was named after the Nobel Prize-winning physicist S. Chandrasekhar (1910 - 1995). CXO was an X-ray observation satellite. It was launched and deployed by Space Shuttle mission STS-93 in 1999 and boosted into a highly elliptical orbit reaching as far as a third of the way to the Moon. CXO was originally called the **Advanced X-ray Astrophysics Facility (AXAF)**, as noted on a few of the postal items that feature this satellite.



Maldive Islands *Michel* BL1366 (2019)

One of the better depictions of CXO is found on a souvenir sheet of one stamp issued by the Maldive Islands in 2019. The stamp marks the 20th anniversary of the launch of CXO. Many other postal items show CXO as

well. The main telescope opening is at the wide end of the spacecraft, and the focal point is at the narrow end of the cone-like body.

A launch cover for STS-93 has CXO depicted in a "STS-93 Station" pictorial cancel from Houston TX, as well as in a photo of CXO in the cargo bay of Space Shuttle Columbia prior to its deployment.

The authors have compiled a table listing all the postal items and launch and event covers that they have found that depict or mention CXO. That table can be found at https://rammb.cira.colostate.edu/dev/hillger/cxo.htm.

Spitzer Space Telescope / Spitzer

The **Spitzer Space Telescope (SST)** was named after physicist and astronomer Lyman Spitzer Jr. (1914 - 1997). SST was also known as the **Space InfraRed Telescope Facility (SIRTF)**, as noted on a couple of the postal items that feature this satellite. SST observes in the infrared, so must be above the Earth's atmosphere, which is opaque to many infrared wavelengths. SST is the only one of the Great Observatories which was not launched by the Space Shuttle. It was carried by a Delta-2 rocket in 2003. SST greatly improved on some of the studies of stars of lower temperatures and luminosities begun by the InfraRed Astronomical Satellite (IRAS) launched in 1983.

SST was placed into an Earth-trailing heliocentric orbit to stay away from Earth's heat. The first 5 years of SST were called the "cold mission", a time before the cryogenic liquid helium cooling was depleted. Since then, SST has been in its "warm mission" phase, still able to utilize some of its shorter-

wavelength detectors as it continues to operate at the time of writing this article. Follow-on missions to SST will be both the JWST (just launched) and Nancy Grace Roman Space Telescope (NGRST) set for a 2027 launch.

Tanzania *Scott* 2541 *Michel* 4624-4627 (2009)

A miniature sheet of 4 stamps issued by Tanzania in 2009 has several images of SST. SST is depicted on many other postal items as well.

Launch cover with SST noted by its "SIRTF" name both in a "Mission Management Station" pictorial cancel and a mission patch in the JPL Stamp Club cachet

Very few launch or event covers have been found for SST. In particular, one launch cover has SST depicted in both the "Mission Management Station" pictorial cancel and in the JPL Stamp Club mission patch cachet.

The authors have compiled a table listing all the postal items and launch and event covers that they have found that depict or mention SST. That table can be found at https://rammb.cira.colostate.edu/dev/hillger/sst.htm.

Summary
This article is a short examination of NASA's four "Great Observatories". Some details and a small number of postal items and launch or event covers have been presented for each of them. These missions have been important steps in the advance of space telescope technology and in our understanding of the universe. All have contributed indirectly to the latest space telescope, the James Webb Space Telescope (JWST), which at the time of writing has reached its L2 observing position 1.6 million km from Earth. It will undergo telescope alignment and instrument test and verification procedures before taking us on the next exciting step in space-based astronomy.

Readers are encouraged to examine the authors' website showing astronomy missions (https://rammb.cira.colostate.edu/dev/hillger/astronomy.htm), including these four Great Observatories. E-mail correspondence with the authors is welcome: Don Hillger: **don.hillger at colostate.edu**; Garry Toth at **gmt.varia at gmail.com**

If you missed it, check out Katrin Raynor-Evans' American Philatelic Society (APS) Stamp Chat presentation (January 2022) on *Exploring Astronomy & Space Through Philately – A Brief Introduction* (https://www.youtube.com/watch?v=g5VK7wc-AKo&ab_channel=AmericanPhilatelicSociety