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Images on the Web for Astronomy Teaching: Image Repositories

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Abstract

This guide lists and reviews 61 Web sites with catalogs of astronomical images that are useful for both formal and informal education. Some are general sites (including images covering many topics), whereas others are particular to one topic or one instrument. We briefly discuss getting started in using images, and copyright and fair use issues.

One of the best things about teaching astronomy these days is the abundance of superb images, both from telescopes on the ground and our instruments in space. Many of these images were produced with government funding and are not under copyright. Others are from university and nonprofit observatories, which often have liberal policies when it comes to educational uses. However, there is no single organized repository of such images, and instructors and informal educators, especially those new to teaching astronomy, often need to search all over the Web to assemble a set of images that fits with their own curriculum or outreach projects.

This resource guide is an attempt to list, describe, and organize the main astronomy image repositories on the Web. The list of image sources that follows is not meant to be comprehensive; there are far too many small institutional and private archives now. Instead, it introduces some of the major not-for-profit image archives that educators at all levels might find particularly useful. Whenever possible, the link listed will take you to the index page where you can select images by subject.

If you are just starting to teach introductory astronomy, the biggest challenge may well be how to eliminate images rather than how to find them. Here are some ways that you might begin to build up your own list of selected images for your courses:

1. If you are in a larger department, ask more experienced colleagues which images they use for different parts of the course. Ask if you can sit in on some of the lectures in areas of astronomy where your knowledge is more limited.
2. Obtain review copies or borrow colleagues' copies of the major introductory astronomy textbooks and see which images the authors feature in the book and in the associated Web sites (often, the authors have done the hard work of selecting the ones with the greatest educational value). Then you can use our resource guide to find them on the Web. For a list of current textbooks, see David Bruning's compendium: http://aer.noao.edu/cgi-bin/article.pl?id=218.
3. Go to the Web sites recommended in our listing and look around for "greatest hits" areas, PowerPoint overviews, 10th anniversary celebration sections, and so on. In many of these, the mission staff have selected their favorites, and they are often a good starting list.
4. Look at the topical index of favorite images (http://antwrp.gsfc.nasa.gov/apod/lib/aptree.html) that Robert Nemiroff and Jerry Bonnell have selected from their *Astronomy Picture of the Day* site. Alas, this list of favorites has not been updated since 2005, but it is still a nice place to start. You can also use their search feature (http://antwrp.gsfc.nasa.gov/cgi-bin/apod/apod_search), which does return an up-to-date list of all images whose captions mention the key word you entered.

Because we live in a litigious age, a word about copyright issues is necessary. U.S. government images (such as the Hubble Space Telescope photos) are not under copyright and can be freely used by educators for any noncommercial purpose. Most of the Web sites we list (whether government or private) will have a page or section outlining their policies for use of the images. Some observatories copyright their images and use the proceeds from their sale to underwrite their outreach activities. The general sense among attorneys is that showing an image during a class constitutes "fair use" for educational purposes as defined by the copyright law. However, the use of images in programs for which there is paid admission, in printed materials, and on merchandise is more complicated. The appendix lists some sites for beginners that delve into the fair use copyright issues involved.

1. KEY SITES TO START WITH

Astronomy Picture of the Day: http://antwrp.gsfc.nasa.gov/apod/astropix.html
Two space scientists, Robert Nemiroff and Jerry Bonnell, scour the Internet and examine submissions from around the world to select one "sexy" astronomy image to feature and briefly explain each day. Their archives range widely, from traditional astronomical objects taken with the world's largest telescopes, to sky events recorded by amateurs, to famous vehicles from space history. Images are organized by subject and date and are searchable. Some images are copyright free, but many are not.

Hubble Space Telescope Images: http://hubblesite.org/newscenter/archive/browse/images/
Starting at this page, you can select among hundreds of Hubble pictures by subject. Note that most of the images are part of news releases and also have supporting material with them, such as diagrams, animations, and comparisons. Excellent captions and background information are provided. No astronomy course or program is complete without at least a few examples from their spectacular gallery of images. The European Hubble site presents images differently and has some additional material: http://www.spacetelescope.org/images/index.html

National Optical Astronomy Observatory Image Gallery: http://www.noao.edu/image_gallery/
This growing archive shows images taken with the many telescopes that are part of the National Optical Astronomy Observatory. There are many objects pictured that are not available anywhere else. The gallery is nicely organized by topic. An intriguing new section highlights nice images taken in the Advanced Observing Program for nonprofessional guest observers:
http://www.noao.edu/outreach/aop/observers/bestof.html

Planetary Photojournal: http://photojournal.jpl.nasa.gov/index.html
This site features thousands of the best images from planetary exploration, with captions of varied length. You can dial up images by word, feature name, date, or catalog number, and download images in a number of popular formats. The one limitation is that only NASA mission images are included. Note the rich Other Query Methods option on the menu at the bottom of the top page.

Solar System Exploration Gallery (JPL): http://solarsystem.nasa.gov/multimedia/gallery.cfm
Here is another site that organizes and selects material from missions that explore the Solar System. Here you can find images from some non-NASA missions too, such as the Russian Venera Venus landers. It includes interactives, video, audio, historical images, and much more.

Very Large Telescope European Southern Observatory Photo Gallery: http://www.eso.org/esopia/
This archive includes superb color images from the four telescopes that combine to make the Very Large Telescope in Chile. Most images are accompanied by detailed captions and are part of news releases from the European Southern Observatory.

2. OTHER GROUND-BASED OBSERVATORY IMAGE ARCHIVES

Anglo-Australian Observatory Images: http://www.aao.gov.au/images.html
The brilliant astronomical photographer David Malin and his colleagues in Australia offer some of the most beautiful ground-based color images ever taken. They are well organized, but all are under copyright and require permission for use.

Canada-France-Hawaii Telescope Images: http://www.cfht.hawaii.edu/HawaiianStarlight/
This site offers some remarkable color images from a major telescope on top of the Mauna Kea peak in Hawaii, often with unusual color processing.

Isaac Newton Group of Telescopes Image Gallery: http://www.ing.iac.es/PR/images_index.html
This site includes beautiful images from the Herschel, Newton, and Kapteyn telescopes on La Palma. Each of the collections is nicely organized, and the captions, although not lengthy, have useful information. Included is an index of images by Messier number.

National Radio Astronomy Observatory Image Gallery: http://www.nrao.edu/imagegallery/php/level1.php
Organized by topic, the images show many objects and processes that give off radio waves. It provides an interesting contrast to the images from the other sites, which are taken in visible light.

Big Bear Solar Observatory: http://www.bbso.njit.edu/

Gemini Observatory Images: http://www.gemini.edu/index.php?option=com_gallery

Palomar Observatory Images: http://www.astro.caltech.edu/palomarnew/astrophotos.html

Sloan Digital Sky Survey Images: http://www.sdss.org/gallery/

Subaru Telescope (8.2-m on Mauna Kea): http://www.naoj.org/Gallery/pressrelease.html

Two Micron All-Sky Survey (2MASS) Infrared Gallery: http://www.ipac.caltech.edu/2mass/gallery/

3. IMAGES FROM OTHER TELESCOPES IN ORBIT

Chandra X-ray Observatory Images: http://chandra.harvard.edu/photo/category.html
Growing collection of images that show the universe as seen through "X-ray eyes."

European Space Agency Multimedia Gallery: http://www.esa.int/esa-mmg/mmghome.pl
Here you can find images from the many European planetary probes, space telescopes, satellites, and so on, in one place. You can search by keyword (including the name of a mission) or by astronomical topic.

Spitzer Infrared Telescope Image Gallery: http://www.spitzer.caltech.edu/Media/mediaimages/index.shtml
Images showing what the universe looks like in "heat-rays" rather than visible light. Note the various menus that let you pick images by subject, by date, and by whether they are static, zoomable, or animations.

GALEX (Galaxy Evolution Explorer) Ultraviolet Satellite:
http://www.galex.caltech.edu/media/images.html

Our Infrared World Gallery (infrared images from many telescopes):
http://coolcosmos.ipac.caltech.edu/image_galleries/missions_gallery.html

X-ray Images from European Satellites: http://www.mpe.mpg.de/xray/research/gallery.php?lang=en

4. IMAGES FROM PLANETARY AND SOLAR PROBES

Note: For NASA images, for most purposes, the best source to try first is the Planetary Photojournal site in section 1.

Mariner 10: http://ser.sese.asu.edu/M10/IMAGE_ARCHIVE/Mercury_search.html

Messenger: http://messenger.jhuapl.edu/the_mission/gallery.html

Venus Express: http://www.esa.int/esa-mmg/mmg.pl?b=b&type=I&mission=Venus%20Express&start=1

Galileo Mission Images of Earth: http://www2.jpl.nasa.gov/galileo/images/earth.html

Human Space Flight Gallery (search page): http://spaceflight.nasa.gov/gallery/index.html
This page allows you to browse or search through the images of many of the crewed NASA missions, many of which include stunning views of the Earth from space.

Selected NASA Moon Mission Images from NSSDC:
http://nssdc.gsfc.nasa.gov/imgcat/html/group_page/EM.html

Clementine Mission (scroll down to find image galleries and an atlas):
http://www.cmf.nrl.navy.mil/clementine/

Mars Exploration Rovers (Spirit/Opportunity) : http://marsrovers.jpl.nasa.gov/gallery/images.html

Mars Express: http://www.esa.int/SPECIALS/Mars_Express/index.html

Mars Global Surveyor: http://mars.jpl.nasa.gov/mgs/gallery/images.html

Mars Odyssey: http://mars.jpl.nasa.gov/odyssey/gallery/images.html

Mars Pathfinder: http://mars.jpl.nasa.gov/MPF/imp/index.html

Mars Reconnaissance Orbiter (general image pages):
http://www.nasa.gov/mission_pages/MRO/multimedia/index.html

Mars Reconnaissance Orbiter High Resolution Imaging Science Experiment:
http://hirise.lpl.arizona.edu/katalogos.php

NASA Mars Exploration Program Image Gallery (including a Mars Atlas):
http://mars.jpl.nasa.gov/gallery/images.html

Eros Image Database at Arizona State: http://ser.sese.asu.edu/near.html

Galileo Mission Images of Asteroids: http://www2.jpl.nasa.gov/galileo/images/astimages.html

Near Earth Asteroid Rendezvous (Shoemaker) Image Gallery (Eros, Mathilde):
http://near.jhuapl.edu/Images/index.html

Galileo Jupiter System Images: http://www2.jpl.nasa.gov/galileo/images/images.html

New Horizons Images of Jupiter: http://pluto.jhuapl.edu/gallery/sciencePhotos/index.php

Cassini-Huygens Saturn System Images: http://saturn.jpl.nasa.gov/multimedia/images/index.cfm

Voyager Uranus Images: http://voyager.jpl.nasa.gov/image/uranus.html

Voyager Neptune Images: http://voyager.jpl.nasa.gov/image/neptune.html

Comet Holmes Photo Gallery: http://spaceweather.com/comets/gallery_holmes.html

Comet Shoemaker-Levy 9 Collision with Jupiter:
http://nssdc.gsfc.nasa.gov/planetary/sl9/comet_images.html

Stardust Mission to Comet Wild 2: http://stardust.jpl.nasa.gov/photo/top20.html

Transition Region and Coronal Explorer (TRACE): http://trace.lmsal.com/POD/

Solar and Heliospheric Observer (SOHO): http://sohowww.nascom.nasa.gov/gallery/

Yohkoh Solar Observatory: http://www.lmsal.com/SXT/

Solar Terrestrial Relation Observatory (STEREO): http://stereo.gsfc.nasa.gov/gallery/gallery.shtml

5. OTHER IMAGE SITES THAT ARE USEFUL FOR EDUCATION

Great Images in NASA: http://grin.hq.nasa.gov/index.html
This is an extremely limited and dated site, but if you want historical images, including early astronaut pictures, Moon landings, and so on, this is the place to go. A similar site, but with many more images, is the Johnson Space Flight Center image database at http://images.jsc.nasa.gov/

Multiwavelength Astronomy Gallery:
http://coolcosmos.ipac.caltech.edu/cosmic_classroom/multiwavelength_astronomy/multiwavelength_museum/gallery.html
An interesting album from Caltech/JPL, which shows the same astronomical objects in several different bands of the spectrum: visible light, infrared, X-rays, and so on.

NASA Human Spaceflight Image Gallery: http://spaceflight1.nasa.gov/gallery/index.html
This is where to find the great astronaut images from the different NASA missions, including visits by the Shuttle to the International Space Station.

Planetary Data System Imaging Node: http://pdsimg.jpl.nasa.gov/Missions/index.html
This site is for more advanced users, but it includes atlases and unprocessed images from many NASA planetary missions. If you are teaching a more advanced course, this is a site you may want to know about or send your students to.

Quasars and Active Galactic Nuclei: http://www.astr.ua.edu/keel/agn/
Astronomer William Keel at the University of Alabama has assembled a gallery of images and captions showing the wide range of activity in galaxies revealed by modern telescopes.

Wikimedia Commons: http://commons.wikimedia.org/wiki/Main_Page
Although there is considerable controversy among academics about the main *Wikipedia* project (a democratic grass-roots encyclopedia), this part of their Web site contains a huge repository of images that are either no longer under copyright or have been placed there by their owners for common use. A number of useful historical and amateur images for astronomy teaching can be found here.

APPENDIX

Web Resources about Copyright Issues & Using Astronomical Images for Educational Purposes

Fair Use Guidelines for Educational Multimedia:
http://www.utsystem.edu/ogc/Intellectualproperty/ccmcguid.htm

PDF Handy Chart of What Is Permitted and What Is Not:
https://www.cu.edu/ip/copyright/downloads/Quick-Ref-Chart.pdf

University of Texas Crash Course in Copyright:
http://www.utsystem.edu/ogc/Intellectualproperty/cprtindx.htm#top

Princeton University Copyright Basics: http://web.princeton.edu/sites/ogc/copyrightbasics.htm

Stanford University Library Handbook on Copyrights and Fair Use (huge, comprehensive document taken from a NOLO Press Book): http://fairuse.stanford.edu/Copyright_and_Fair_Use_Overview/index.html

Frequently Asked Questions about Creative Commons Licenses (another approach to the copyright issue):
http://wiki.creativecommons.org/FAQ

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