Observatory User Guide

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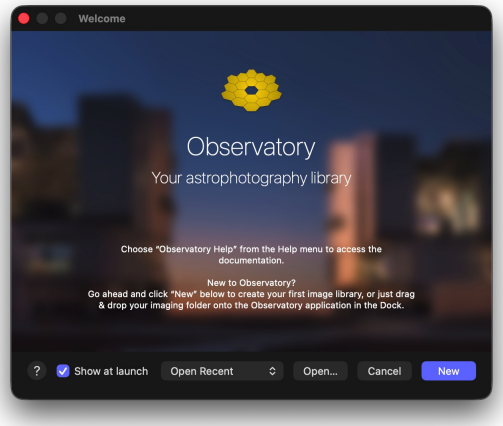
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Welcome to Observatory



Welcome to Observatory!

Observatory is a flexible program for collecting, preprocessing, analyzing and organizing astronomical images. It also enhances macOS by providing

image thumbnails and previews for astronomical images in Finder, and indexing image metadata for Spotlight.

Read on to learn more about the features of Observatory and how this documentation can help you make the most of them.

How This Documentation is Organized

This manual is designed to provide you with a complete tour of Observatory.

It is divided into the following sections that correspond to areas of Observatory's interface, and reference for further customizing your Observatory experience with the array of powerful tools, modes, and settings included with the app.

Interface

- Getting Started

  Here you'll find information about how to use Observatory.

- Using the Browser

  The Browser displays the images of the currently selected album, smart album, session, target, equipment or tag in your library.

- Using the Canvas

  The Canvas shows the image you have currently selected in the Browser in all its glory, or more specifically since you can have multiple images selected at once, the one that has the focus. The Canvas can be shown together with the Browser, without it, or in a separate window.

- Using the Virtual Observatory

  The Virtual Observatory gives you direct access to research images from 10+ professional archives. You can search for images by name and equatorial coordinates, optionally with help of the SIMBAD and NED astronomical databases.

- Integration Statistics

  The Statistics Persona displays session activity, filter and equipment usage, constellation coverage, and integration reports for the current selection in one of the sidebar navigators.

- Using the Toolbar

  Along the top of Observatory's library window you'll find a row of useful buttons in the Toolbar. Fully customizable the Toolbar makes it easy for you to switch between the different view modes, the Virtual Observatory, show the image download progress and a whole lot more.

- Using the Sidebar

  Along the left side of Observatory's window is the Sidebar. It provides access to the Library, Tag and Source Folder navigators.

- Along the right side of Observatory's window are the Inspectors, providing access to most of the tools for adjusting selected images and their meta data. Towards the top you'll find:

  - The Overview Inspector
  - The Attributes Inspector
  - The Adjustments Inspector
  - The Crop, Resize & Rotate Inspector
  - The WCS Inspector
  - The Measure Inspector
  - The Stack Inspector
  - The Album Inspector

  Near the bottom there are:

  - The Preview Inspector
  - The Magnifier Inspector
  - The Histogram Inspector
  - The Channels Inspector
  - The Layers Inspector
  - The Attachments Inspector

Reference

- What's New in Observatory 2

  Read this if you are upgrading from Observatory 1.x.

- Common Tasks

Here you'll find solutions for specific goals, organized by topic.

- Quick Look

  Observatory enhances macOS by automatically generating thumbnails and previews of FITS, XISF and SBIG images, allowing you to see them up-close in Finder without launching an application.

- Spotlight

  Spotlight is a powerful macOS search technology that makes searching for files easy. Observatory enhances it by automatically indexing metadata of all FITS, XISF and SBIG images, regardless if they have been imported into an Observatory library.

- Organizing Images with Observatory

  Learn about how you can use Observatory to organize and search your images.

- Organizing Images in the File System

  Organizing your images starts with the file system. With Observatory you can create many different libraries, each providing a different view on your images, but at the file system level it is recommended to settle on a consistent structure.

- Importing

  The many ways in which images in a variety of formats can be imported.

- Sharing, Printing & Exporting

  Observatory makes it easy to export your images in a variety of formats. This chapter also covers the app's sharing and printing options.

- Plate Solving

  Unlock Observatory's automatic tagging, overlays and advanced features.

- Settings

  This chapter describes the settings panes that you can use to further customize Observatory to suit your needs.

- Menus & Keyboard Shortcuts

  Here you'll find a detailed list of each menu item in Observatory. Where applicable, the descriptions include the menu option's keyboard shortcut so you can work even faster in Observatory.

- Acorn Plugin

  Importing FITS, XISF and SBIG images into the Acorn image editor at full bit depth for postprocessing.

- Glossary

  An alphabetical list of terms you'll encounter throughout the documentation.

- FAQs

  Questions & Answers.

What's New in Observatory 2

Observatory 2 is a major upgrade of Observatory. Its user interface has been completely overhauled, making it more powerful and easier to use. Image overlay and display settings have been enhanced, image calibration has been streamlined, advanced searches can now be performed without creating a Smart Album, and the new Plate Solver automatically adjusts itself to your imaging setup. The orientation of images has changed, to match other software, and internally it now uses Metal Compute instead of OpenCL. USNO-A2.0 and UCAC4 catalog support has been replaced by an internal Gaia catalog up to magnitude 16.

But that's not all. Observatory 2 is capable of way much more than this:

- Session, target & equipment navigators to organize images by observing session, astronomical target and equipment used;
- Statistics Persona: session activity, filter and equipment usage, constellation coverage, and integration reports;
- Nested albums and new Watched Folder features to automatically keep your libraries in sync with the file system;
- An enhanced Quick Look extension with image metadata, FITS headers and scale, orientation & grid overlays;
- Display minor planets, dwarf planets, planets and comets in your images;
- Select objects in your plate solved images to see additional information with the new Object inspector;
- Select a target or tag in the new navigators to display all matching images and highlight the selected object;
- Dual-monitor support;
- Magnitude limits for overlays and automatic tagging;

- Image summary information with the new Overview inspector;
- Blink images and export as a movie;
- Drag the STF, overlay and activity popovers off the toolbar and float as separate panels;
- Faster importing and stacking using the GPU and all CPU performance cores;
- Magnifier inspector;
- Zwicky Transient Facility and Observatory library search in Virtual Observatory;
- Delete Rejected Masters command;
- More image attributes: target, target type, moon phase, angular separation of moon, e-gain, focuser temperature, focuser position, focal ratio, acquisition software used, processing software used, minimum ADU, maximum ADU, HFD and median ADU;
- Preview images with spacebar;
- New Pick stack type for grouping images;
- Stack type and STF type defaults;
- Quickly toggle all overlays, show objects beyond image boundaries, and adjust overlay contrast;
- Optionally combine images in one library when opening individually from Finder;
- Stacks are now cached instead of being generated every time you select a stack;
- Plate solve or apply adjustments to a stack without creating a Managed Master.

If you are new to Observatory and 2.x is your first purchase, then all these features are included already. But if you are upgrading from Observatory 1.x, then these new features require the "Upgrade from Observatory 1" In-App purchase. More information and a limited demo can be found at https://codeobsession.com.

In addition, with an optional In-App purchase the internal Gaia catalog can be expanded all the way to magnitude 20. That's more than 800 million stars in total!

Moving from Observatory 1.x to Observatory 2

The Observatory library format has been enhanced in Observatory 2 and is incompatible with Observatory 1.x. When you open an Observatory 1.x library with Observatory 2 it is automatically migrated. The original file is copied to the `~/Library/Containers/com.codeobsession.Observatory/Data/Library/Application Support/Migration Backup` folder.

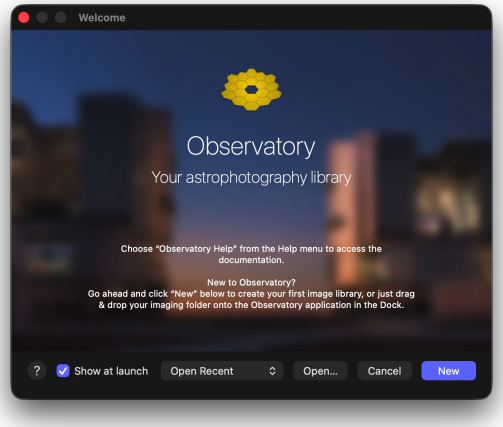
Notable differences between Observatory 2 and Observatory 1.x

Most of the changes in Observatory 2 are easily discoverable for Observatory 1.x users, but a few may be confusing initially:

- Instead of using the Histogram panel to adjust how images are displayed, Observatory now uses a dedicated STF panel that works similar to PixInsight's STF.
- The default Smart Albums have been removed as their functionality is now covered by the Tag Navigator.
- Whereas in Observatory 1.x you had to explicitly add images to one of the system calibration folders in order for them to show up in the calibration adjustment, in Observatory 2 you just need to change their Image Type to one of the three Master calibration types with the **Image ▸ Type** menu items. The Calibration album in the Library Navigators now contains three smart albums instead of three albums.
- In the Browser and Virtual Observatory you can now simply press `spacebar` to see a preview of the selected image.
- There's no need to create a Managed Master from a stack image to plate solve or apply adjustments to it.
- There's a new stack type: Pick. Instead of stacking the images in a stack, with this stack type the pick image will be shown instead. This is useful for grouping a set of related images in an album.
- The Align and Normalized adjustments have moved to the Stack Inspector.
- Stack images are now cached instead of being generated every time you select a stack.
- FITS, XISF and SBIG images are now displayed with their origin at the top-left of the screen instead of the bottom-left.
- In Observatory 1.x, when you selected images in the browser they would always automatically be loaded into memory. Observatory 2 changed this behavior and loads them only when necessary.
- If you plate solve an image with Observatory, the solution is now stored in an extended attribute of the master image file (`com.codeobsession.wcs`). Without modifying the master image file, the Quick Look extension is therefore capable of displaying the scale, orientation & grid overlays for FITS, XISF and SBIG images even if they do not contain an explicit WCS solution.

Getting Started

When you first open Observatory, you'll see its welcome window pop open. It lets you quickly access the documentation, open an existing Observatory library, or create a new library. Creating a new library is what you want to do if this is the first time you use Observatory. Just click the **New** button.

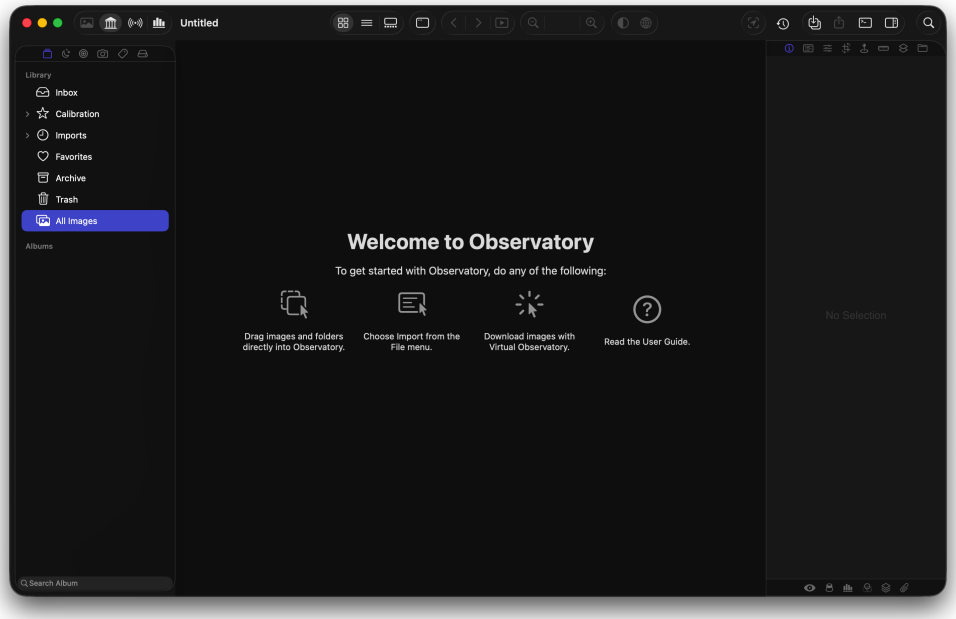


Welcome window

A new window will pop open with your new untitled Observatory library document. This window is where you'll do all of your work. You can create as many library documents as you wish. Observatory is not limited to a single library, and you can have multiple libraries open at the same time.

> **Do not store the Observatory library file on NAS** Images can of course be stored on NAS, but Observatory needs fast random access to the library file itself. For best performance it is recommended to save Observatory library files on the internal SSD or directly attached SSD.

Before diving in, let's take some time for a quick overview of Observatory's user interface:



Empty new library window

1. **Toolbar** – Along the top of Observatory's library window you'll find a row of useful buttons in the Toolbar. Fully customizable the Toolbar makes it easy for you to switch between the different view modes, the Virtual Observatory, integration statistics, show the STF and Overlay panels, image download progress and a whole lot more. See Using the Toolbar for more details.

2. **Sidebar** – Along the left side of Observatory's window is the Sidebar. It provides access to the Library, Session, Target, Equipment, Tag and Source Folder navigators. To learn more about the Sidebar, see Using the Sidebar.

3. Unless created by dropping a file system folder on Observatory's application icon in the Dock, initially an Observatory library does not contain any images. To import a few images, just drop them onto the library window, or click the corresponding button and select them. You can also import complete folders this way. If you wish to search for and import research images from the archives of professional observatories, just click the corresponding button instead. After you have imported one or more images, you can use the Toolbar to switch the window's center contents between:

    - **Browser** – The Browser displays the images of the currently selected album, smart album, session, target, equipment or tag in your library.

To learn more about the browser, see Using the Browser.

- **Canvas** – The Canvas shows the image you have currently selected in the Browser in all its glory, or more specifically since you can have multiple images selected at once, the one that has the focus. The Canvas can be shown together with the Browser, without it, or in a separate window.

- **Virtual Observatory** – The Virtual Observatory gives you direct access to 10+ professional archives and download research images from ESO, Keck, Gemini, Palomar, Hubble, Spitzer, WISE, 2MASS, SDSS and more. You can search for images by name and equatorial coordinates, optionally with help of the SIMBAD and NED astronomical databases. You can learn move about the Virtual Observatory in Using the Virtual Observatory.

- **Statistics** – Shows the observation session history, filter and equipment usage, constellation coverage, and integration reports for selected targets. Like the Browser, it is used together with the navigators, to limit the statistics to the selected album, smart album, session, target, equipment or tag in your library. Select "All Images" in the Library Navigator to see the session activity for the whole library.

4. **Inspectors** – Along the right side of Observatory's window are the Inspectors. It provides access to most of the tools for viewing and adjusting images and their meta data. For more details about the Inspectors and what each of them does, see the Using the Inspectors section in the documentation.

- Create or Open a Library
- Import Images
- View Images
- Create Calibration Masters
- Calibrate
- Stack
- Plate Solve
- Export
- Virtual Observatory
- Save the Library

Create or Open a Library

To get to know Observatory, start with a library for a single target object and a limited number of images, e.g. 5 bias, 5 dark and 5 flat images, all optional, and 5 light images.

Create a new empty library by clicking the **New** button in the welcome window, or choose **File ▸ New Library** in the main menu. Open an existing library by choosing it in the **Open Recent** menu of the welcome window or main menu, by clicking the **Open…** button in the welcome window or choosing **File ▸ Open…** (⌘O) in the main menu.

Alternatively, simply drag the Finder folder containing the target object's images and drop it onto the Observatory application icon. This creates a new library and immediately imports the images from this folder and its subfolders. The source folder you created the library with is also automatically monitored by Observatory for new images that may be added to it later. You can use the same approach later, to create the complete library, by just droping your top-level imaging folder on Observatory's application icon in the Dock.

Import Images

When you import an image into an Observatory library, it stores a reference to the image, and extracts its meta data (dimensions, exposure date/time, exposure duration, etc). Observatory never copies, moves or alters this master image.

If you want to import an image or a folder of images into a library, drop it from Finder onto the library, or choose **File ▸ Import ▸ Images…** (⇧⌘I), select them and click **Import**.

Notice how FITS, XISF and SBIG images are displayed with actual thumbnails and previews in the Import Dialog and in Finder. Observatory includes a Quick Look extension to accomplish this feat, as well as Spotlight importers for helping you find images with Spotlight. Select any image in the Import Dialog or Finder and press `spacebar` to quickly see it up-close.

Put your bias, dark, flat and light images in appropriate albums. You may put them all in a single album, or organize them in multiple albums. Select the images, and choose **Image ▸ Move to New Album**. Make sure to put related images that you intend to stack in the same album. You can have multiple stacks in an album.

Select the bias images and confirm in the Overview Inspector that they all have type "Bias". If not, choose **Image ▸ Type ▸ Bias**. Similarly set the correct image types for all other images.

View Images

After importing images into a new Observatory library, their thumbnails are displayed in the *Browser*. The thumbnail size can be adjusted by the slider in the *Browser Bar* towards the top of the Browser.

For a quick preview of the image, select it and press `spacebar`. To view an image in more detail in the Canvas, double click it. Alternatively, select it and choose **View ▸ as Gallery** (⌘3), or click the corresponding button in the Toolbar. Observatory will then display the Browser together with the full image in the Canvas. Lastly, the Canvas can be opened in its own window, separate from the Browser by Choosing **Window ▸ Open Canvas in New Window**. If you have multiple monitors, you can use this to display the Canvas on a second monitor.

Create Calibration Masters

Select the bias images and choose **Stack ▸ Stack**. This creates a single, stacked image from the selection. Select the stack and use the *Stack Inspector* towards the right of Observatory's library window to change how the images are stacked, e.g. *Mean* (the default) or *Median*. With this bias stack image selected choose **Image ▸ Type ▸ Master Bias**. This makes it available to the *Calibrate Adjustment* you will use later. Do the same for the dark and flat images, changing their types with the **Image ▸ Type ▸ Master Dark** and **Image ▸ Type ▸ Master Flat** menu items.

The stack image of a stack is not like a regular image on disk, but generated dynamically. Although not strictly necessary, for master calibration images that you want to reuse often you may want to create snapshots. Select the bias, dark and flat stacks, and choose **Image ▸ New ▸ Master**.

Calibrate

Select the light images and choose the **Adjustments Inspector** towards the right of the window. Now enable the *Calibrate* adjustment in this inspector. This adjustment will list the master calibration frames you have just created.

The inspector only lists the calibration images relevant to your image selection. It displays only those that have the same dimensions, and also takes exposure time, sensor temperature (if set) and filter name into account. If it doesn't display the expected calibration images, check if this information matches with your light images. You can relax these rules with the corresponding checkbox.

Select the master bias, dark and flat in this inspector to calibrate your light images.

Stack

Select the light images and choose **Stack ▸ Stack**. This creates a stack of the images, after aligning and normalizing them. Double click the stack, or with the stack selected, choose **Stack ▸ Focus on Stack** (^⌘[), or click the button in the *Browser Bar*.

Observatory will now display the stack's comprising images. The center of the Browser Bar has three buttons that allow you to quickly select the stack image (the result of stacking the images), the stack's current pick image, or all images in the stack, respectively.

Aligning images in a stack is always relative to the stack's pick image. Typically, the pick image is the best or most representative image in the stack. Initially the pick is the earliest exposed image in the stack, but you can change it by selecting another image and choosing **Stack ▸ Pick** (^⌘8).

Select all images in the stack by choosing **Stack ▸ Select ▸ All Subs** (^⌘;) or clicking the … button in the Browser Bar. Now click the "play" button in the toolbar to quickly inspect the alignment. It changes into a "pause" button during the blink animation. The blink speed can be adjusted with the < and > buttons. Click the "pause" button when done. These buttons are only enabled if the Canvas is visible.

Now choose **Stack ▸ Unfocus** (^⌘]) or click the **Unfocus** button in the Browser Bar.

Plate Solve

Select the calibrated & aligned stack image, and choose **Image ▸ Match…** (^⌘M), then enter the name of the object in the image, select the retrieve coordinates, and click **Match**.

After a few seconds, the image will be plate solved and a badge icon appears on the image thumbnail. If Observatory is unable to plate solve the image, you may need to apply the **Cosmetic Correction** adjustment to the individual images.

Choose **View ▸ Canvas ▸ Show Overlay Panel** or click the corresponding button in the toolbar to display the Overlay Panel. You use this panel to show or hide the equatorial grid, scale, Messier, NGC/IC and other overlays on the image. You can grab this panel and drag it to turn it into a floating window.

In addition to relating image pixels to sky coordinates, Observatory's plate solver also automatically tags the image with data from its object database. You can then more easily find the images in the Browser by using its search field, or use the **Tag Navigator** in the Sidebar.

Export

Select the calibrated & aligned stack image and choose **File ▸ Export ▸ Image…** (⇧⌘E) to export it in the desired format. Observatory has powerful folder and file naming template support, but for now just select *None* as *Folder Format*, *Name* as *Name Format*, and click the **Export** button.

Virtual Observatory

At any time you can choose **Window ▸ Virtual Observatory Persona** (F3) to search the archives of professional observatories for research images. Enter the target's object name, identifier or coordinates and click **Search**. You can filter the search results, and in the *Preview* inspector see image previews before downloading the FITS images. Move the mouse cursor over the preview and click the Quick Look button to see a larger preview image, or press spacebar. Click **Import** to download the FITS image into the Observatory library.

Alternatively, select the plate solved image and press the option (⌥) key while choosing **Window ▸ Virtual Observatory Persona** (F3). This initiates a search in the archives using the center coordinates of the image.

Save the Library

For checking the quality of your images during or after an observation session there is no need to save the library afterwards, but usually you would save it. Choose **File ▸ Save…** (⌘S) and enter the name of your library (e.g. "Observatory Library"), and its location. Lastly click the **Save** button.

Using the Browser

After you have imported one or more images into a library and have the **Library Persona** (F2) enabled, the center of its window will show the Browser. The browser displays the images of the currently selected album. It may apply some rules to what is exactly shown, e.g. only show calibration images, or only those images that have not been plate solved.

Unless the browser is focused on a stack, you can drag & drop images from the browser to albums in the library navigator to organize your images. In addition, you can drag & drop images and stacks on top of the other in the same album. This combines them in a stack. In both cases, if you press the option (⌥) key while dragging, the image version is copied instead of moved.

There are three types of browsers. Choose one of the **View ▸ as Icons** (⌘1), **View ▸ as List** (⌘2) or **View ▸ as Gallery** (⌘3) menu items to switch between them, or use the buttons in the toolbar.

> To quickly see a preview of the selected image, press the spacebar.

The Browser Bar

The browser displays the Browser Bar with the number of displayed and selected images. The Browser Bar also allows for quick filtering of the displayed images by *Image Type*. The same and more can be accomplished by choosing one of the **View ▸ Image Type** menu items.

If, for example, you select **Show Dark** in the Browser Bar, the browser displays only those images that contain the value "Dark" in their image type. Hence, it will display dark frames, but also master dark frames. The **Bias**, **Flat** and **Light** buttons work similarly.

To show or hide images that have been plate solved, choose **View ▸ Show Type ▸ Matched** or **View ▸ Show Type ▸ Unmatched**. Similarly you can show or hide images that have been rejected.

By default the browser is sorted by exposure date/time in descending order. This can be changed by choosing one of the **View ▸ Sort By** menu items. In the List Browser, you can also change the sorting by clicking the column titles. The sorting is coupled to the current image type view selection.

The Browser Bar also displays the name and type of the currently selected album, or smart album and allows you to traverse up the album hierarchy using its **Unfocus** button (^⌘]).

If your album contains stacks, and you select one, it will show an additional button: **Focus on Stack**. Click it, or press ^⌘[, and the browser will display the images the stack is made of. When focused on a stack, the Browser Bar displays three handy buttons to quickly select the stack's pick image, all accepted images comprising the stack, or the stacked image itself. With the **Unfocus** button (⌘]) you traverse up to the stack's album.

> To quickly focus on a stack, double click it.

- The Icon Browser
- The List Browser
- The Gallery Browser

The Icon Browser

The Icon Browser displays a thumbnail for each of the images in the currently selected album in a vertical scrollable grid. It is shown by choosing **View ▸ as Icons** (⌘1). Below the thumbnail, the image's name is displayed, and below that a subtitle. The contents of the subtitle is configurable using the **View ▸ Subtitle** menu items. The selection is coupled to the above **View ▸ Image Type** selection. For example, unless you change it, Observatory doesn't display the Exposure Duration when the Bias Image Type Filter is enabled, but it does so for all other Image Type Filters. The subtitle may be any combination of

- Rating
- Status
- Image Type
- Exposure Date/Time
- Exposure Duration
- Binning
- Canvas Size
- Filter Name
- Sensor Temperature
- Focal Length
- Aperture Diameter

If you select a color label for an image, it is overlaid at the top-right corner on the thumbnail. It may also be overlaid with several badges:

Badge	Description
	The image version has been plate solved
	It is of a master calibration type
	It has been marked as a favorite
	It is locked
	It contains a note
	It has an attachment
	It contains at least one adjustment
	The master of the image version is a managed master
	Its master has been modified
	Its master is missing
	It has been rejected
	It is a stack, comprising of multiple images
	It is the pick version of a stack
	The image has been processed

Image Icon Badges

The size of the thumbnails in the Icon Browser can be adjusted by moving the slider in the Browser Bar.

The List Browser

Use the **View ▸ Columns** menu items or the contextual menu of the column headers to choose which columns you want the List Browser to display. The selection is coupled to the above **View ▸ Image Type** selection. For example, unless you change it, Observatory doesn't display the Exposure Duration column when the Bias Image Type Filter is enabled, but it does so for all other Image Type Filters.

The Date/Time column is required and cannot be hidden. The weight column is automatically shown if the focus is on a stack. Except for these two, you can reorder the columns by moving their headers, and many, but not all, you can also sort and resize.

The Gallery Browser

The gallery browser is similar to the icon browser, but it displays the thumbnails in a horizontal scrollable strip. The thumbnails are of a fixed size. The image strip browser is always displayed together with the Canvas.

Using the Canvas

The Canvas displays the currently focused image of the browser. It can be shown simultaneously with the browser in the Library Persona by choosing **View ▸ as Gallery** (⌘3), and on its own with the Image Persona. In addition, with the Library Persona it can be shown in a separate window by choosing **Window ▸ Open Canvas in New Window** or clicking the corresponding toolbar button.

It works in cooperation with the selections of the display utility window and the channels panel to display the image.

The current zoom (or magnification) level, as well as buttons to change the zoom can be found in the toolbar. Click the zoom level to switch between actual size (100%) and zoom to fit. You can also choose **View ▸ Zoom In** (⌘+) and **View ▸ Zoom Out** (⌘–) to change the zoom. Choose **View ▸ Actual Size** (⌘1) to quickly zoom to 100%, and **View ▸ Zoom to Fit** (⌘9) to center and zoom the image to fit in the canvas.

If you have the *Zoom in or out* and *Smart zoom* gestures enabled in your trackpad system settings, then you can also pinch with two fingers to zoom in and out, and quickly switch between 100% and 150% by double-tapping the canvas with two fingers.

The image can be moved around (panned) in the canvas using the scrollbars and the panning gesture of your trackpad.

Images that have been plate solved contain all the information to relate image pixels to sky coordinates. If you move the cursor over an image that has been matched, the Probe Tool in the Measure Inspector along the right side of Observatory's window will not only show its pixel position, but also the corresponding right ascension and declination.

The Canvas can overlay information of many astronomical objects onto your image. The Overlay utility window allows you to toggle overlays for the

image scale, orientation and RA/dec grid, as well as Messier and NGC/IC objects, galaxies, planetary nebulae, variable stars, double stars, stars with confirmed exoplanets and regular stars up to V magnitude 16. It will also overlay the positions of the solar system's planets, and asteroids in images from the year 2000 onwards. If you have the Gaia Extension installed, it will display stars up to V magnitude 20.

Symbol	Description
Filled circle	Star
Ellipse or circle	Galaxy (shape and angle may vary)
Circle with crosshair	Globular cluster
Circle (dotted)	Open cluster, asterism
Square	Bright nebula, supernova remnant
Square (dotted)	Dark nebula
Circle with outer crosshair	Planetary nebula
Like star with horizontal solid line	Double, triple or multiple star
Like star with outer circle	Variable star
Like star with an X	Exoplanet host star

Overlay object symbols

Images that have not been plate solved can be matched by choosing **Image ▸ Match...** (^⌘M).

Using the Virtual Observatory

With the Virtual Observatory you can search for and download images from 10+ professional astronomical image archives. Choose **Window ▸ Virtual Observatory Persona** (F3) or click the corresponding button in the toolbar, and the center of the library window will be replaced by the Virtual Observatory, as are the inspectors.

Along the top you'll find the *Archives…* button where you can select which archives to search. Next to it is a text field where you enter the name, identifier or coordinates of the object you are interested in. By default Observatory will do an image search with a radius of 10 arcminutes, which is a little less than the angular diameter of the full moon. You can change this in the *Search Radius* field.

The supported archives are:

- DSS

  The Digitized Sky Survey (DSS) is a digital version of several photographic atlases of the night sky, produced by scanning the plates using microdensitometers. Observatory supports both generations of DSS.

- SDSS

  The Sloan Digital Sky Survey (SDSS) is a multi-filter imaging and spectroscopic redshift survey using a dedicated 2.5 m wide-angle optical telescope. Observatory provides access to the imaging catalog data of Data Release 12 (DR12), which is the final data release of SDSS-III.

- PTF

  Palomar Transient Factory Archive (level 1). A survey using the Palomar Samuel Oschin 1.22 m Schmidt Telescope.

- ZTF

  Zwicky Transient Facility Archive. A survey using the Palomar Samuel Oschin 1.22 m Schmidt Telescope.

- SMSSS

  SkyMapper Southern Sky Survey (DR1.1). Using a 1.3 m telescope at Siding Spring Observatory near Coonabarabran, Australia, the SkyMapper Southern Sky Survey is producing a digital record of the entire southern sky.

  The service is currently restricted to image sizes of 10 arcminutes on a side.

- 2MASS

The Two Micron All-Sky Survey (2MASS) is a survey of the whole sky in three infrared wavebands around 2 micrometers.

- ESO

  The ESO Archive from the European Southern Observatory (ESO) includes images obtained with the VLT (8.2 m), VST (2.6 m), VISTA (4.1 m), NTT (3.6 m) and the ESO 3.6 m telescopes. To download these images, you'll first need to enter your ESO user portal account name and password in the Settings. Creating it is free, and can be done at https://www.eso.org/UserPortal/. On that page, select *I would like to create a new account*, and follow the instructions.

- GOA

  Gemini Observatory Archive. The Gemini Observatory consists of two 8.19 m telescopes, the Gemini North in Hawaii and the Gemini South in Chile.

- KOA

  The W. M. Keck Observatory is a two-telescope astronomical observatory near the summit of Mauna Kea in the U.S. state of Hawaii. Both telescopes feature 10 m primary mirrors. Through the Keck Observatory Archive (KOA), Observatory provides access to the images obtained with the NIRC2 instrument.

- HST

  The Hubble Space Telescope (HST) is a space telescope that was launched into low Earth orbit in 1990, and remains in operation. This button gives access to the HST Mikulski Archive for Space Telescopes.

- HLA

  The Hubble Legacy Archive of the Hubble Space Telescope.

- WISE

  Wide-field Infrared Survey Explorer (WISE AllWISE Atlas). WISE is a 0.4 m NASA infrared-wavelength space telescope.

- SHA

  Spitzer Heritage Archive (level 2). The Spitzer Space Telescope is a 0.85 m NASA infrared-wavelength space telescope.

- Library

  The Observatory library itself.

To search for an object, enter its name, identifier or coordinates in the text box. Observatory recognizes Messier, NGC/IC, Tycho-2 and LEDA identifiers, as well as hundreds of common names. Entries like "Whirlpool Galaxy", "M 51", "202.4696+47.1953" and "13 30+47 12" (without quotes) will all be resolved.

As soon as you enter anything, the resolved items with their celestial coordinates will be displayed immediately below the text field. If the object you want to obtain images for is in the list, select it and click the **Search** button. Observatory will then search for all images in the selected archives, and display the results.

> Although Observatory contains data for millions of objects, you may find that it cannot always resolve the object you are looking for. For this reason, the SIMBAD and NED web services are integrated with the Virtual Observatory. After entering the target name or identifier, just click the corresponding buttons to have these services resolve your entry and add them to the list.

The results are initially sorted by exposure date, but you can change this by clicking one of the column headers. By clicking a second time, you change the sort order.

Your search may return thousands of results. One way to reduce the number of results is by deselecting the archives you are not interested in. You can reduce or extend search results this way even after you have performed the search. By reducing the search radius, the number of results will also be reduced.

Another way to reduce the number of search results is by filtering them using the Virtual Observatory Results Filter near the bottom of the window. It allows you to reduce the number of results by target, instrument, filter name, description or identifier. You can specify which field you want to match, or you can have it match any of these fields by using "All". For example, if you only want to include images obtained with the Hubble ACS instrument, you might enter "ACS" here.

If you select one or more results, the inspector on the right hand side will display more details of the selection. For many items preview images are available, which is indicated by a circle. Press `spacebar` or use the **Preview Inspector** to see the preview.

Items you have already in your library are indicated with an arrow in the results table. Double click to open this image in the Canvas. Sometimes you will also see items in red. This indicates that the data is still under the proprietary period.

To download images, select them and click the **Import** button. If you have selected the *Add to album* checkbox, they will be imported straight into the

album that you have currently selected in the sidebar, if any, instead of the “Inbox”.

The images will be downloaded and imported in the background, and you can continue to search for other images or use Observatory in any way you wish. If you quit Observatory then any ongoing downloads will be cancelled though.

You can view the progress of downloads by opening the **Activity Panel** in the toolbar. In that panel you can also cancel individual downloads, as well as clean up the list such that only downloads that are in progress are displayed.

The downloaded images are stored as **Managed Master** images in your library. If you wish to have access to them from outside Observatory, then you’ll need to export them by choosing **File ▸ Export ▸ Managed Master…**. This exports the original downloaded files.

> If you press and hold the ⌥ key while selecting the **Window ▸ Virtual Observatory Persona** menu item and the currently selected image has been plate solved, Virtual Observatory will then use its center equatorial coordinates to initiate a search right away. This is handy way to search for images in the archives that cover the same area as your selected image.

⇪

Integration Statistics

The Statistics Persona displays session activity, filter and equipment usage, constellation coverage, and integration reports. By using the navigators in the sidebar, these statistics can be generated for albums, imaging sessions, targets, and equipment used. You can drill down into sessions, equipment and targets by selecting them in the navigators or statistics sections. Select “All Images” in the Library Navigator to see these summaries for the whole library. Calibration frames and processed images are ignored for these statistics.

The inspector displays a representative image for your selection. Images marked as favorite take precedence for this, followed by processed images.

The statistics are based on the metadata associated with each image. Use the Attributes Inspector of the Library Persona to modify this metadata as stored in the library.

⇪

Using the Toolbar

Along the top of Observatory’s window is the fully customizable **Toolbar**. To the left, you’ll find the standard macOS window controls for closing or minimizing the window or entering Full Screen mode. Next to it, you’ll see an Observatory library document icon and its filename. If you hold down the **Command** key (⌘) and click that icon or filename, you’ll get a tiny menu that shows you where the file is stored on your Mac. This is sometimes handy for when you’re working on duplicated files and you can’t remember where you saved the last revision. Another use of the document icon is that you can drag it to the Desktop or a Finder window to move or copy the file.

To the right of the filename is a small chevron. Clicking it opens a small popup window, in which you can change the name of the file, add tags to help make the file easier to find using Spotlight, move the file to another location on your Mac, or lock/unlock it.

Most of the items in the toolbar have corresponding items in the main menu and are described in more detail in other parts of the documentation. The default toolbar consists of the following items, from left to right:

- Image, Library, Virtual Observatory and Statistics Persona selection, to only display the currently focused image and inspectors, the complete library, switch to the Virtual Observatory mode, or show session activity and integration reports.
- Import images into the library.
- Icon, List or Gallery View selection for the center of the window.
- Navigation buttons for when you select multiple image in the browser. Only the focused image is displayed in the canvas. You can use the *Go Back* and *Go Forward* buttons to focus on another image in the selection, or press the ⌘[and ⌘] keys. Here you can also blink between these images by pressing the *Play/Pause Animation* button. During blinking, the *Go Back* and *Go Forward* buttons function as *Slower* and *Faster* blink speed controls.
- Display the Plate Solver for an image. There is also a button available for the blind plate solver, but it is hidden by default.
- Open the canvas in a separate window. If you have two monitors, this allows you to have the sidebar, browser and inspectors on one monitor, and the image canvas on the second.
- Canvas zoom in, zoom out and current zoom value. Click the zoom value to switch between Actual Size (100%) and Zoom to Fit mode.
- STF, Overlay and Activity buttons for showing their corresponding panels. Initially these are shown as a popover in the toolbar, which disappears when clicking outside it, but they can be detached from the toolbar by clicking the background of the panel and dragging it away from the toolbar.
- Share.
- Show Console window.
- Show or hide the inspectors.
- Search field to quickly filter images by tag, name, filter name, object and status. Initially if you enter a search term it will filter by any of these attributes, but you can also explicitly select one in this search field. The search context is the currently selected album, but this can be changed to *Everything* in the Search Bar that appears. In this Search Bar you can also add more criteria, and save the search as a Smart Album.

Customizing the Toolbar

To hide the toolbar, choose **View ▸ Hide Toolbar** or press ⌥⌘T. Repeat this to show it again.

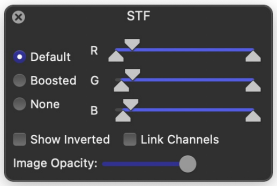
To customize the toolbar, choose **View ▸ Customize Toolbar** or **Control-click** on the toolbar and select **Customize Toolbar**. When you do, a sheet slides down from under the toolbar, revealing a slew of function-related buttons that you can drag up to the toolbar. When you've finished making changes to the toolbar, click **Done**.

If you don't like the changes you've made, or if you ever want to reset the toolbar to its default set, all you need to do is drag the bottom row up to the toolbar and then click **Done** to save the changes. The changes you've made to the toolbar are saved along with Observatory's settings, so that you'll see the same toolbar options with every library document you create.

STF Panel

Astronomical images typically have most of their data in a very small portion of the available dynamic range. For this reason, the image displayed in the Canvas is rendered after applying a screen transfer function (STF) to the image, without modifying the image itself. This histogram transformation can be adjusted with the black point, midtones balance and white point parameters in the STF Panel. This can be done for each image channel, or all channels at once.

To display the STF Panel, click its toolbar button or choose the **View ▸ Canvas ▸ Show STF Panel** (⌘D) menu item. Initially it is shown as a popover in the toolbar, which disappears when clicking outside it, but it can be detached from the toolbar by clicking its background and dragging it away from the toolbar.

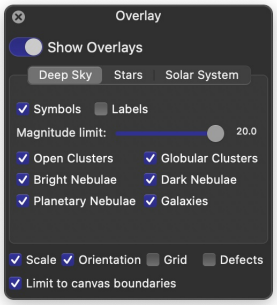


STF

Overlay Panel

Plate solved images can be overlaid in the canvas with the image scale, orientation, equatorial coordinate grid and positions of deep sky objects, stars and solar system objects. With the Overlay Panel, magnitude limits can be set for these overlays and if the overlays should be displayed beyond the image boundaries. For many objects additional information can be displayed in the canvas, as well as their apparent dimension and position angle.

To display the Overlay Panel, click its toolbar button or choose the **View ▸ Canvas ▸ Show Overlay Panel** (⌥⌘D) menu item. Initially it is shown as a popover in the toolbar, which disappears when clicking outside it, but it can be detached from the toolbar by clicking its background and dragging it away from the toolbar.



Overlay

Using the Sidebar

If the Library Persona, Virtual Observatory or Statistics Persona is active, the left edge of Observatory's window will show the **Sidebar**. It contains the Library Navigator, and when the Library or Statistics Persona is active also the Session, Target, Equipment, Tag and Source Folder Navigators. Near the bottom of most navigators you'll find a Search field that makes it easy for you to sift through your albums, sessions, targets, tags and source folders and find the information you're looking for.

Choose **Window ▸ Library Persona** (F2) or the corresponding toolbar button to switch to the Library Persona. Similarly choose **Window ▸ Virtual**

Observatory Persona (F3) for the Virtual Observatory Persona or **Window ▸ Statistics Persona** (F4) for the Statistics Persona.

If you mouse over the right edge of the Sidebar, you'll notice that the mouse pointer changes to a resizing handle. Click and drag the resizing handle to resize the Sidebar.

- The Library Navigator
- The Session Navigator
- The Target Navigator
- The Equipment Navigator
- The Tag Navigator
- The Source Folder Navigator

The Library Navigator

The Library Navigator displays the image albums and smart albums in your library in a scrollable pane.

- An **Album** is a type of container in the Observatory library document that may contain images and stacks of images. Albums can be nested.

  If you select an Album in the Library Navigator while the Browser is visible, you will see it display all images of that album and its children. The Browser may apply some rules to what is exactly shown, e.g. only those images that have not been manually rejected, or only certain calibration images.

- A **Smart Album** is a dynamic album used to organize images by gathering them based on search criteria. You can create your own Smart Albums, e.g. to show all images of Planetary Nebulae that were taken through narrowband filters and exposed for at least 20 minutes. Smart albums cannot be nested. To learn more about Smart Albums, see Using Smart Albums.

In this Library Navigator, albums with children have a disclosure triangle on the left edge. To view the children, click the disclosure triangle to flip open the list. Option-click a disclosure triangle to open or close all of the items within.

The Library Navigator is organized in two parts:

- The collapsible **Library** group of the Library Navigator contains predefined Albums, Smart Albums and other special system generated containers:

  - **Inbox**

    The Inbox contains all images that have not yet been organized in albums. Organize your images using **Image ▸ Move to Album** and **Image ▸ Move to New Album**.

  - **Calibration**

    The Calibration album contains three Smart Albums that show images of type "MasterBias", "MasterDark" and "MasterFlat". Images of these types are used by the Calibrate Adjustment.

    You make master calibration images available to the Calibrate Adjustment by selecting the images and choosing one of **Image ▸ Type ▸ Master Bias**, **Image ▸ Type ▸ Master Dark** or **Image ▸ Type ▸ Master Flat**.

    Make sure that their exposure date, sensor temperature, exposure duration and filter name have been set correctly. This information is used for listing them in the popup menus of the Calibrate Adjustment. For example, if you add a Calibrate Adjustment to an image that was taken with a sensor temperature of -25°C, the popup menus will only list calibration images that were taken at a temperature between at -25.5°C and -24.5°C.

  - **Imports**

    The Imports album contains Smart Albums for displaying all Today's imports, Yesterday's imports, all imports of the current week, as well as one for all imports of the current month.

  - **Favorites**

    If you mark one of your own albums as a favorite by choosing **Album ▸ Add To Favorites**, it will be added to this item in the Library Navigator. All the album's images will implicitly be marked as favorite, including those you will add later. If you wish to mark a single image as favorite, you should choose **Image ▸ Add To Favorites** instead.

  - **Archive**

    When you archive one of your albums by choosing **Album ▸ Move to Archive**, it will disappear from the Albums section of the Library Navigator, it stops being discoverable with the Library Navigator search field and makes it invisible to Smart Albums. All archived albums can be found under the Archive item.

    Archived albums are not implicitly locked, and can be used like any other albums. They cannot be marked as Favorite though. To unarchive an album, select it and choose **Album ▸ Put Back**.

  - **Trash**

    When you choose the **Album ▸ Move to Trash** or **Image ▸ Move to Trash** menu items, the albums and images are not permanently

removed from the library right away. You can still restore them by choosing **Album ▸ Put Back** or **Image ▸ Put Back**. They are only permanently removed if you choose **File ▸ Empty Trash...**.

- **All Images** represents all images in your library. If you select it while the Browser is visible, you will see it display all images in your library. The Browser may apply some rules to what is exactly shown, but it will do so for the images of all your albums combined, except those that are archived or in the trash.

- The collapsible **Albums** group in the Library Navigator contains all the albums and smart albums that you create yourself.

  You create a new album by choosing **Album ▸ New Album**. Alternatively, you can select a few images, and choose **Image ▸ Add to New Album** (press ⌥ to see this menu item). Albums you create can be moved around, into other albums, or merged with them. To create a Smart Album, choose **Album ▸ New Smart Album**.

  The Library Navigator's contextual menu, displayed by holding the `Control` key while clicking, provides quick access to these and other handy menu commands.

You can accentuate an album in the Library Navigator by assigning a color label to it with the **Album Inspector**. There you can also add Tags, assign a Rating or Status to it. In addition, you can add notes and attachments to your own albums. When you do not want any further modifications to an album, lock it by clicking the lock button in the Album Inspector.

Searching Within the Library Navigator

If you have many albums in your library, you might need some help finding the one you are looking for.

At the bottom of the Library Navigator, you'll see a search field with a little magnifying glass icon in it. You can search here by album Name, Tag or Status. Or you can search for any of them, which is the default.

To clear the search field, press Escape or click the little Clear search button at its right edge. When you've finished searching, the Library Navigator reverts back to its former state of showing you everything.

The Session Navigator

Observatory automatically organizes your images by observation session with the Session Navigator. When you select a session when the Library Persona is active, the Browser will show all images that were taking during this session. With the Statistics Persona, it will limit the the analytics to the unprocessed light images of this session.

The Target Navigator

The Target Navigator shows all astronomical targets in your library. In the Library Persona, when you select a target, the Browser will show all images that have this target set. With the Statistics Persona, it will show the target's sessions, filters used, exposure times etc. You can edit the target's name directly in the Target Navigator, or by selecting images and changing it in the Image Attributes Inspector.

Observatory will highlight the target in the Canvas for the currently focused image if it has been plate solved. More details about an object is shown in the WCS Inspector.

The Equipment Navigator

The Equipment Navigator organizes your library by equipment used. It uses the telescope name, focal length, aperture diameter, camera name, and binning values. Use the Image Attributes Inspector to update these values.

The Tag Navigator

The Tag Navigator in the sidebar is shown when the Library or Statistics Persona is active. When you select a tag, the Browser shows all images that contain this tag. In addition, Observatory will highlight the corresponding object in the Canvas for the currently focused image. More details about an object is shown in the WCS Inspector.

Tags are automatically created for plate solved images and grouped by object type. You can also manually organize, add, edit or delete tags with its contextual menu. You assign tags to selected images in the Overview Inspector.

To ensure Observatory only creates tags for objects that are actually captured in your images, it is recommended to control the magnitude limit for automatically created tags in the General Setting. Overide this limit for selected images with the **Image ▸ Reset...** dialog.

The Source Folder Navigator

The Source Folder Navigator in the sidebar is shown when the Library Persona is active. A source folder represents a folder in the file system, outside of the Observatory library. Because the macOS Sandbox restricts access to the file system, it is up to you to explicitly give Observatory permission to access the folders in which your images reside, by choosing **File ▸ Import ▸ Images...** (⇧⌘I) or **File ▸ Import ▸ Add Source Folder...**. The Source Folder Navigator keeps tracks of these folders. Neither these folders, nor their contents, is ever modified by Observatory, except with the **File ▸ Delete Rejected Masters...** command.

If you choose **File ▸ Import ▸ Add Source Folder...**, the selected source folders, and optionally all their subfolders will be added to the Source Folder Navigator. No images will be imported. Only the source folders are made available to Observatory.

You can make Observatory unaware of a previously added Source Folder by choosing **File ▸ Import ▸ Remove Source Folder...**. Be aware that the images in your library that originate from that Source Folder will also be removed, without moving them to Trash first. Your master images in the file system will not be affected of course.

The Source Folder Navigator action popup menu provides quick access to these and other handy menu commands.

Watch Source Folder

Observatory by default does not monitor source folders or their subfolders for new images. This has to be explicitly turned on for a source folder. The one exception is for libraries created by dropping a folder from Finder onto the Observatory application icon. That source folder and its subfolders *is* automatically watched. This feature is useful for inspecting images during an imaging session, where the image acquisition software saves newly captured images in a folder.

To have Observatory automatically detect new images added to a source folder choose **File ▸ Import ▸ Watch Source Folder**. By default new images will then automatically be imported and appear in *Inbox*, but a different album can be selected. Here you can also select if you want images to be automatically stacked, and if you want Observatory to automatically create albums for new source subfolders.



Using Smart Albums

A Smart Album is a dynamic album to organize images by gathering them based on search criteria. Combined with Observatory's ability to extract and supplement metadata of your images, it is a powerful feature that makes searching for images easy. You can create Smart Albums using the following attributes of your images:

- **Airmass** – The relative airmass at the image center.
- **Album name** – The name of the album the image is assigned to.
- **Altitude [°]** – The center altitude of the image in degrees.
- **Aperture diameter [mm]** – Aperture diameter of the telescope in mm.
- **Azimuth [°]** – The center azimuth of the image in degrees.
- **Binning height** – Vertical binning value.
- **Binning width** – Horizontal binning value.
- **Camera name** – The name of the camera used.
- **Canvas height** – The image height in pixels.
- **Canvas width** – The image width in pixels.
- **Constellation IAU abbreviation** – Three-letter constellation abbreviation.
- **Constellation name** – Constellation name.
- **Declination [°]** – The center declination of the image in degrees.
- **Exposure date** – Exposure date (UTC).
- **Exposure duration [s]** – The exposure duration in seconds.
- **Filter name** – The filter used for the observation.
- **Focal length [mm]** – Focal length in mm.
- **Gain** – Camera gain.
- **Image type** – The image type, e.g. "light" or "dark".
- **ISO speed** – Camera ISO speed setting.
- **Latitude [°]** – Observatory latitude in degrees.
- **Longitude [°]** – Observatory longitude in degrees.
- **Name** – The object name or target name.
- **Observatory name** – The name of the location where the image was obtained.
- **Observer name** – The name of the observer.
- **Offset** – Bias offset.
- **Rating** – The rating assigned to the image (0–5).
- **Right ascension [°]** – The center right ascension of the image in degrees.
- **Status** – The value of the status field.
- **Telescope name** – The name of the telescope used.
- **Detector temperature [°C]** – Detector temperature in °C.
- **Weight** – Assigned image weight (0 for rejected images).
- **Tag** – Tag assigned to the image.

To create a Smart Album, choose **Album ▸ New Smart Album** or begin with a search in the toolbar. The search bar appears immediately below the toolbar. Start by selecting one of the criteria in the first menu of the second row, and enter its expected value in the last field. You can change the operator of your criterion, e.g. *is not* instead of *is*, or *is greater than*.

Often a search requires more than one set of criteria to reduce the number of results to just those you are interested in. Smart Albums let you specify as many as you want. Say you want to search for all light exposures taken through an OIII filter. To do this, you would select *Filter name*, *is* and enter "OIII" in the first row. Now click on the + button next to it to add another search criterion, for *Image type*, *is* and entering "light". Observatory will display all images matching these criteria in the Browser.

You can reorder the criteria, and you can also use Boolean search terms, to exclude criteria or to create an OR search. You can do this for all criteria using

the top row, but you can also nest Boolean search terms. Once you have one condition set up, add a Boolean term to your next condition by `Option`-clicking the + button. The + will turn into an ellipsis (…), and you'll get a new pull-down menu with options for*Any* (`OR`), *All* (`AND`), or *None* (`NOT`).

Save the Smart Album by clicking the **Save** button. To edit it later, just double-click it in the sidebar. Smart Albums can also be duplicated, by choosing **Album ▸ Duplicate**, which allows you to quickly create a variation of an existing search.

Related Topics

- Using the Sidebar



Using the Inspectors

Along the right side of Observatory's window are the Inspectors. It provides access to most of the tools for inspecting and adjusting selected images and their meta data.

- The Overview Inspector
- The Attributes Inspector
- The Adjustments Inspector
- The Crop, Resize & Rotate Inspector
- The WCS Inspector
- The Measure Inspector
- The Stack Inspector
- The Album Inspector

Along the bottom of the window we have

- The Preview Inspector
- The Magnifier Inspector
- The Histogram Inspector
- The Channels Inspector
- The Layers Inspector
- The Attachments Inspector



The Overview Inspector

When you choose one or more images in the Browser, the image Overview Inspector along the right side of Observatory's window will display important metadata of the selection. This metadata is retrieved, normalized and stored in the Observatory library upon importing the images.

Towards the top, you'll see a thumbnail of the image and its name. If you just imported the image, this may be the file name, but you can modify it here (which can also be done directly in the Icon Browser.). Next to it is a *lock* icon. It allows you to lock the image version, to protect it against changes. If you marked your image as a favorite, or archived it, then you will see an indicator here too.

The inspector is organized in three sections.

Observation

Displays important metadata of the selected image or images.

Organize

- **Label**

  You can assign a color label to your image by clicking on one of these seven colored circles. The meaning of the different colors is up to you. For example, you could

  - Use different color labels for different locations.
  - Group images by telescope, aperture diameter or focal length by assigning color labels.
  - Assign a color label to images you have published online.
  - Use a color label to indicate the progress towards processing the image.

  To remove the color label, click it for a second time.

- **Rating**

  You can assign a 1–5 star rating to your image by clicking towards the right of this label. Drag the stars towards the left to remove the rating.

- **Status**

This attribute may contain an arbitrary textual or numeric value of your choice. You can filter images by this status attribute.

- **Tags**

  Tags, or keywords, are a good way of organizing your images. You can add your own, but Observatory also adds them automatically when importing or when plate solving was successful.

Note

When you import an image that contains comments or a processing history, Observatory will copy them as a note associated with the image. But it also allows you to add your own notes to each of your images. With this inspector you can view and edit it. If you have selected it, you can even press ⌘F to search inside the note.

Albeit handy, there isn't much room in the inspector. Choose **Image ▸ Edit Note...** (⌘') to open a much bigger, resizable Dialog for editing the note. There you can also press ⌘F to search inside the note, or click the icon near the bottom left of the Dialog.

The Attributes Inspector

When you choose one or more images in the Browser, the Attributes Inspector along the right side of Observatory's window will display the metadata of the selection. This metadata is retrieved, normalized and stored in the Observatory library upon importing the images. You can edit this metadata here without altering your master images.

You are not limited to editing the metadata for one image at a time. You can select many images, and the inspector will indicate which metadata is common or different among them, and allows you to alter it for all selected images at once.

If you made an accidental change, just choose **Edit ▸ Undo** (⌘Z).

The inspector is organized in three sections.

Observation

- **Target**

  Primary astronomical target in the image.

- **Target type**

  Type of target, e.g. Reflection Nebula.

- **Date/time**

  The date and time the exposure was started (UTC). It is displayed in *Year-Month-Day Hour:Minutes:Seconds* format.

- **Exposure**

  The exposure duration in seconds. You may optionally include a unit when entering a value. For example, entering "10min", "10m", "600s" and "600" are equivalent. For calibration purposes it is important to have a correct value set for this attribute.

- **ISO speed**

  Camera ISO speed setting.

- **Offset**

  Bias offset.

- **Gain**

  Camera gain.

- **Filter**

  The name of the filter that was used when the image was taken. For calibration purposes it is important to have a correct value set for this attribute, if any.

- **Sensor temperature**

  The sensor temperature during the exposure in °C. You may optionally include a unit when entering a value. For example, entering "253.15K", "-4F", "-20C" and "-20" are equivalent. For calibration purposes it is important to have a correct value set for this attribute, if any.

- **Source**

  The image source attribute is set by Observatory for images obtained using Virtual Observatory. You cannot adjust the value in the inspector.

Possible values are:

- Digitized Sky Survey
- Sloan Digital Sky Survey
- ESO Archive
- Hubble Data Archive
- Hubble Legacy Archive
- Two Micron All Sky Survey
- Keck Observatory Archive
- Wide-field Infrared Survey Explorer Archive
- Spitzer Heritage Archive
- Palomar Transient Factory Archive
- Zwicky Transient Facility Archive
- Gemini Observatory Archive
- SkyMapper Southern Sky Survey

- **Id**

  The image identifier. For manually imported images, this is the original file name. For images obtained using Virtual Observatory, this is a unique identifier for the image in the source archive. You cannot adjust the value in the inspector.

Instrument

- **Telescope**

  The name or description of the telescope that was used for acquiring the image.

- **Focal ratio**

  The effective focal ratio of the telescopein millimeters.

- **Focal length**

  The effective focal length of the telescope or camera in millimeters. You may optionally include a unit when entering a value. For example, entering “2.5m”, “2500mm” and “2500” are equivalent.

- **Aperture diameter**

  The effective aperture diameter of the telescope or camera in millimeters. You may optionally include a unit when entering a value.

- **Aperture area**

  The effective aperture area of the telescope or camera in square millimeters. This is the area of the objective minus any obstruction.

- **Camera**

  The name or description of the camera that was used for acquiring the image.

- **Rotator angle**

  The position angle in degrees of the field rotator, if any.

- **Guider**

  A description of the guider or guiding method that was used while acquiring the image.

- **Binning**

  Binning is the process of combining charge from adjacent pixels in a sensor during readout. It improves the signal-to-noise ratio, at the expense of reducing spatial resolution. If the image was acquired with binning enabled, this attribute contains the X and Y binning values. Otherwise these are set to 1.

- **Pixel size**

  The pixel size in micrometers. When binning is used, this is the effective pixel size (*sensor pixel size* × *binning value*).

- **Electronic gain**

  The number of electrons per ADU of the camera.

- **Focuser temperature**

  The temperature as reported by the focuser temperature sensor.

- **Focuser position**

The position as reported by the focuser.

- **Acquisition software**

  Software used to expose the image.

- **Processing software**

  Software used to process the image.

Location

- **Observer**

  The name of the observer.

- **Observatory**

  The name of the observatory.

- **Latitude**

  The latitude of the observatory.

- **Longitude**

  The longitude of the observatory.

The Adjustments Inspector

Adjustments are nondestructive image editing tools that adjust your image without permanently changing its pixels. You can edit and discard your adjustments or restore your original image at any time. You can use them with regular image versions, stacks, as well as with the images comprising the stack.

Bring up the Adjustments Inspector by either clicking the corresponding button along the right side of Observatory's window, or by choosing **View ▸ Inspectors ▸ Adjustments**.

When you first do this for an image, you'll see that it has no adjustments. After all, when you have imported an image, its first image version is the same as the master image. You enable an adjustment by clicking its toggle and adjusting its parameters, if any. You are not limited to adding adjustments to images individually. You can select multiple images and apply the same adjustments to each.

Calibrate

With the Calibrate adjustment you can apply bias, dark and flat field correction using the master calibration images in your library, i.e. images with type Master Bias, Master Bias or Master Flat. The layer dimensions, exposure duration, ISO speed, offset, gain, filter name, sensor temperature (±0.5 °C) and rotator angle (±0.1°) are taken into account when listing the applicable master calibration images. Archived calibration images are ignored.

This adjustment has the following options. You do not need to select a value for each option.

- **Master bias** – Lists the master bias frames that match the image's dimensions and sensor temperature. Select one to apply, or *None* to not use bias calibration.
- **Master dark** – Lists the master dark frames that match the image's dimensions, sensor temperature and exposure duration. A matching exposure duration is not required if a **Master bias** is selected. Select one to apply, or *None* to not use dark calibration.
- **Master flat** – Lists the master flat frames that match the image's dimensions, sensor temperature, filter and rotator angle. Select one to apply, or *None* to not use flat calibration.
- **Master dark flat** – Lists the master dark frames that match the flat's dimensions, sensor temperature and exposure duration. A matching exposure duration is not required if a **Master bias** is selected. Select one to apply, or *None*.

If you are not seeing the calibration images you had expected, make sure that they have the correct image type and the relevant metadata matches for your image and its calibration images. Select them all and look for "*Multiple Values*" in the inspector. Select **Relax rules** to not apply these strict rules, and just list the calibration frames that have matching dimensions.

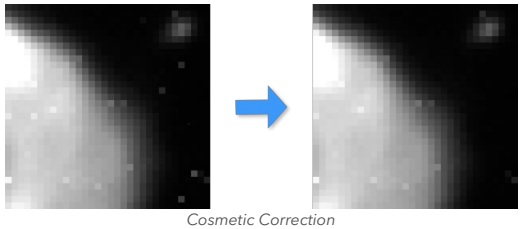
> **Using an image for image calibration**
>
> Select the image, for example a master dark frame, and choose **Image ▸ Type ▸ Master Dark**.
>
> If you created a master calibration image by stacking multiple images in Observatory, then it is recommended to create a snapshot of the stack's current state by creating a Managed Master of it. Although a stack can be used directly as calibration image, this is slower as Observatory may need to create the stack first. Select the stack, then choose **Image ▸ New ▸ Master** and adjust its type if needed.

Cosmetic Correction

Identifies hot and cold pixels by comparing each pixel in the image to its neighbors and correcting any which vary more than the specified number of deviation units.

If the image is grayscale and was obtained with an OSC sensor, or you enable the Debayer adjustment, Cosmetic Correction automatically takes the bayer pattern into account when selecting the neighbor pixels.

- **Hot sigma** – Identifies hot pixels.
- **Cold sigma** – Identifies cold pixels.
- **Action** – *Average* or *Identify*. Choose *Average* to modify the hot or cold pixel by replacing its value with the average value of its neighbor pixels. Choose *Identify* to have Observatory mark the hot or cold pixel and handle it as such, typically by skipping it in computations.



Cosmetic Correction

Binning

Reduces the size of the image in both directions by binning the pixels.

If the image is grayscale and was obtained with an OSC sensor, or you enable the Debayer adjustment, Binning automatically takes the bayer pattern into account.

- **Binning** – The X and Y binning values.

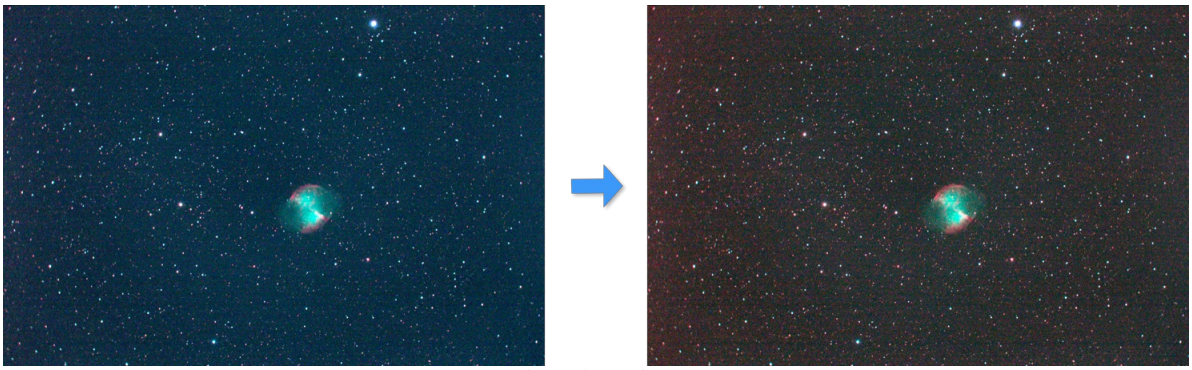
Debayer

Converts a Bayer-encoded grayscale image to an RGB image. Use the Background Neutralization adjustment to equalize the background level of the red and blue channels with that of the green channel.

- **Pattern** – The bayer pattern of the image sensor. Choose*Auto* to extract this information from the image header, if available.

Background Neutralization

Equalizes the red, green and blue components of an RGB image to yield a neutral gray rendition of the sky background.

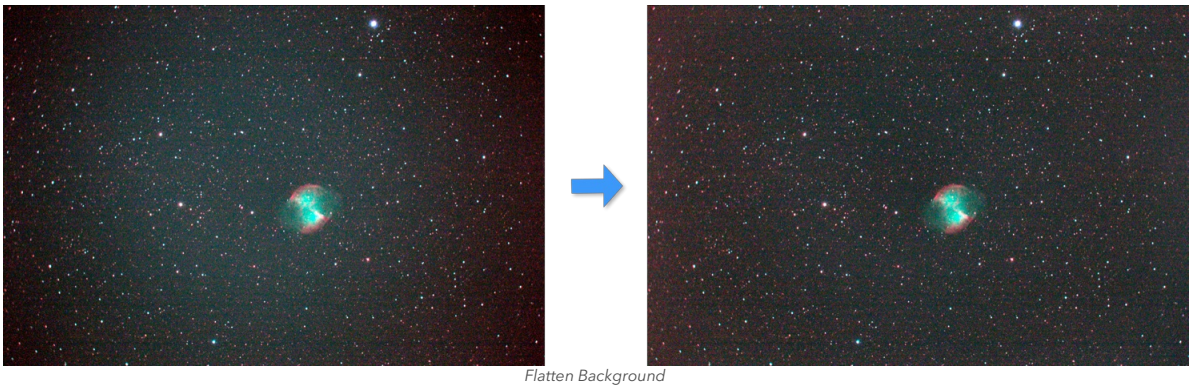


Background Neutralization

Flatten Background

Reduces or eliminates gradients in an image caused by instrumental vignetting or light pollution. It estimates the background level in various regions of the image and fits either a plane or a higher-degree polynomial surface to the measured background. The resulting surface is removed from the image, thus reducing the variations.

- **Correction** – *Subtraction* or *Division*. Choose *Subtraction* to correct for additive effects, such as gradients caused by light pollution or by the Moon. Choose *Division* to correct for multiplicative effects, such as vignetting or differential atmospheric absorption.
- **Type** – *Linear*, *Quadratic* or *Cubic*. Choose *Linear* to fit a plane surface, or any of the other options to fit a higher-degree two-dimensional polynomial surface.
- **Global rejection** – Tolerance of background sample rejection to avoid inclusion of large-scale structures, in sigma units. You can use larger values on star fields. Use a small value for images with a large foreground object or extended nebular regions.
- **Local rejection** – Tolerance of local sample rejections.



Flatten Background

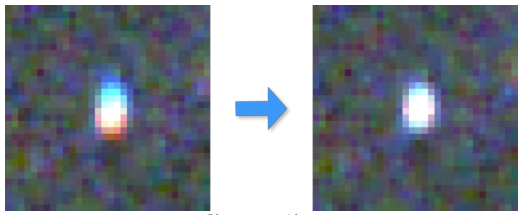
Pixel Aspect Ratio

Adjusts the pixel aspect ratio.

- **Interpolation** – *Nearest Neighbor* or *Bilinear*.
- **Pixel Aspect Ratio**

Chromatic Align

Aligns the red and blue channels with the green channel of an RGB image to counter the effects ofAtmospheric Dispersion.



Chromatic Align

Grayscale

Converts a RGB image into a grayscale image by combining its three channels into one.

RGB

Converts a grayscale image into a RGB image by duplicating its single channel.

Color Balance

Adjusts the color balance of an image. There are three white balance coefficients that allow you to compensate for transmittance differences between the filters used to acquire the three color channels. Each channel in the image will be multipled by the corresponding coefficient. A value of 100 % means that the corresponding channel won't be affected. Lower values weaken the corresponding color in the image. Higher values strengthen the color. The Reset button resets all three coefficients to 100 %.

The Color Balance adjustment only works on color images.

The Crop, Resize & Rotate Inspector

To nondestructively crop, resize or rotate an image, bring up the Crop, Resize & Rotate Inspector by either clicking the corresponding button along the right side of Observatory's window, or by choosing **View ▸ Inspectors ▸ Crop & Resize**.

Crop

Crops the image around its center with the given width and height in pixels.

Resize

Resizes the layer in both directions using a scaling factor.

- **Interpolation** – *Nearest Neighbor* or *Bilinear*.
- **Scale** – The scaling factor.

Mirror

Reverses the layer's left and right.

Flip

Flips the layer upside down.

Rotate

Rotates the layer at an arbitrary angle.

- **Interpolation** – *Nearest Neighbor* or *Bilinear*.
- **Angle** – Angle in degrees.

The WCS Inspector

When you choose an image in the Browser that has been plate solved, the WCS Inspector along the right side of Observatory's window will display additional information of the image, and details for the selected object within. The WCS inspector is displayed automatically if you double click an object in the canvas.

WCS

The values in the WCS inspector cannot be changed directly. Instead, they are retrieved from the image when importing, or updated when plate solving was successful.

- **Constellation**

  The constellation the center of the image falls in, as determined from the center right ascension and declination.

- **Center right ascension**

  The right ascension of the center of the image.

- **Center declination**

  The declination of the center of the image.

- **Pixel scale**

  The pixel scale in arcseconds per pixel near the center of the image.

- **Position angle**

  The position angle in degrees near the center of the image.

- **Field of view**

  The area of the sky the image covers in arcminutes.

- **Center azimuth**

  The azimuth of the center of the image at the time of the exposure.

- **Center altitude**

  The altitude of the center of the image at the time of the exposure.

- **Air mass**

  The air mass of the center of the image at the time of the exposure.

- **Angular moon separation**

  The angular distance of the center of the image to the moon at the time of the exposure.

Object

Displays details for the selected object in the canvas.

- **Identifier**

  Catalog identifiers.

- **Type**

Catalog object type.

- **Constellation**

  Object constellation.

- **RA**

  The right ascension of the object.

- **Dec**

  The declination of the object.

- **Azimuth**

  The azimuth of the object.

- **Altitude**

  The altitude of the object.

- **Air mass**

  The air mass of the object.

- **Vmag**

  V magnitude.

- **Bmag**

  B magnitude.

- **Rmag**

  R magnitude.

- **Imag**

  I magnitude.

- **Size**

  Major and minor diameter in arc seconds.

- **Position angle**

  Position angle in degrees.

- **Vmag min.**

  Minimum V magnitude for a variable star.

- **Vmag max.**

  Maximum V magnitude for a variable star.

- **Period**

  Variable star period in days.

- **Separation**

  Separation in arc seconds for a double star.

- **Vmag1**

  V magnitude of component A of a double star.

- **Vmag2**

  V magnitude of component B of a double star.

- **CDS details**

  Link to object details at the Strasbourg Astronomical Data Center.

- **SIMBAD details**

  Link to object details in the SIMBAD Astronomical Database.

- **NED details**

  Link to object details in the NASA/IPAC Extragalactic Database.

- **MPC details**

  Link to object details at the Minor Planet Center.

- **Stellarium Web**

  Link to object details in the Stellarium Web Online Star Map.

- **Sky Chart**

  Search the object in the Sky Chart.

The Measure Inspector

With an image focused in the Canvas, the Measure Inspector along the right side of Observatory's window provides more information from the image pixels themselves. Bring up the Measure Inspector by either clicking the corresponding button along the right side of Observatory's window, or by choosing **View ▸ Inspectors ▸ Measure**.

The inspector is organized in four sections. Click the button on the right of a section to expand it.

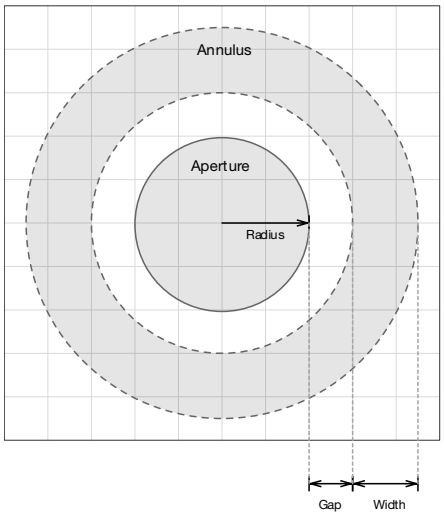
Probe

When you move the cursor over the image, this tool will display the cursor's position, the pixel value of its visible channels and median value of the pixels in the annulus around the this position. Observatory will calculate the centroid position of a star within the aperture around the cursor position and its HFD and FWHM values. In addition, if your image has been plate solved, it displays the right ascension and declination at the cursor position.

Below this, the minimum, maximum, mean and median pixel values of the image are displayed, as well as the median HFD of the stars within. You can also select a rectangular area in the image, resize it and drag it around, and it will display this information for this area instead. Click outside the selection to reset it.

Probe Settings

The plate solvers, probe, photometry & astrometry tools and various adjustments use the aperture radius, annulus gap and annulus width of the Probe Settings to determine the position and local background of stars in the image. These values can be set manually, or automatically by selecting a few individual stars followed by clicking the eyedropper button. For selecting multiple stars, press and hold the ⌘ key. Observatory selects the centroid of the stars. Press and hold the `Shift` key to select any point. You can deselect a star by selecting it again, or drag the selection around.



Aperture and Annulus

The pixels in the annulus area around the cursor position are used to compute the local background value. This value is subtracted from the value for each pixel in the aperture area. The resulting values are then used to compute the centroid position. If successful, the FWHM of the gaussian profile is computed. The gap is a "dead zone" in which all pixels are ignored. It prevents stars near the target from being measured.

Photometry

This tool allows you to perform basic aperture photometry and Gaussian PSF fitting on your image. Select the star you want to measure and the comparison star while holding the ⌘ key, then click the eyedropper button. The first will then be marked with the *V* label, the second with the *C* label.

For an RGB image it will use the maximum pixel value of the visible channels. To measure a specific channel, enable only this channel with the Channels panel.

Displayed in the tool are:

- **V** – The selected position of the to be measured star, V.
- **C** – The selected position of the comparison star, C.
- **Centroid** – The computed centroid position of V.
- **Gaussian center** – The computed center position of the best fitting gaussian profile for V.
- **FWHM** – The minimum and maximum FWHM of the two-dimensional gaussian profile of V.
- **Flattening** – The ellipticity of the gaussian profile. Usually it is not completely round (0), because of seeing and tracking issues.
- **FWHM angle** – The planar angle of the elliptical gaussian profile.
- **Gaussian peak** – The peak of the best fitting gaussian profile.
- **V pixels** – The number of pixels used for the aperture and annulus of V.
- **C pixels** – The number of pixels used for the aperture and annulus of C.
- **V background** – The annulus background value and sigma of V.
- **C background** – The annulus background value and sigma of C.
- **V flux** – The sum of valid aperture pixel values minus the background of V.
- **C flux** – The sum of valid aperture pixel values minus the background of C.
- **C mag** – The known magnitude of C and its estimated error. If the image has been plate solved, Observatory will automatically provide the magnitude and its estimated error from the Tycho-2 or Gaia DR2 catalog. If multiple stars match for one of these catalogs, it will pick the brightest. It uses the V, or R, or B magnitude, whichever is available, in that order.
- **e gain** – Electronic gain in e-/ADU.
- **V mag** – Computed magnitude of V and its estimated error.

The measurements are also reported in the Observatory Console (**Window ▸ Show Console**).

Astrometry

Use this tool if you wish to measure positions of stars in your image, their mutual distance and position angle. Only when the image has been plate solved Observatory will be able to display all this information.

For an RGB image it will use the maximum pixel value of the visible channels. To measure a specific channel, enable only this channel with the Channels panel.

Select the stars you want to measure while holding the ⌘ key, then click the eyedropper button. The first will then be marked with the *A* label, the second with the *B* label.

The tool displays:

- **A** – The selected position of star A.
- **B** – The selected position of star B.
- **RA** – The right ascension of A and B.
- **Dec** – The declination of A and B.
- **Separation** – The separation in pixels of A and B.
- **Planar angle** – The angle between A and B in degrees.
- **Angular separation** – The angular separation in degrees, arc minutes and arc seconds of A and B.
- **Position angle** – The position angle in degrees.

The Stack Inspector

![][stack-img-inspector]

Image stacking is a digital image processing technique which combines multiple images into one to obtain a single high quality image. For example, a master dark frame created from a set of dark frames. Or an image created from multiple calibrated and aligned images.

If you have a set of images in an album that you wish to stack, select them, and choose **Stack ▸ Stack**. This will create a single stacked image from all those source images. Usually the images you want to stack will be of the same type, dimensions, have the same exposure duration, are taken at nearly equal sensor temperatures, etc.

When you stack images in the browser, they are replaced by a single image. You can recognize it from the stack badge:

Stack Browser Badge

What happened is that Observatory created a new image by averaging the corresponding pixels of your original images. If you switch to the Stack

Inspector along the right side of Observatory's window, you'll see that the stack type is "Mean". For flat images the Normalize adjustment will also be enabled, and for light images the Align adjustment will be as well.

When you select a stack, and choose **Image ▸ Focus on Stack** (^⌘[), or click the **Focus on Stack** button in the Browser Bar, the Browser will display the images that you used to create the stack. One of these images will automatically be selected as the stack's Pick image. The pick image is usually the most representative or best image of the stack, e.g. the sharpest one. It is referenced by the Align and Normalize adjustments of other images in the same stack. Every stack has a pick. When a stack is created, or when you unstack a pick image, the earliest exposure in the stack is set as its pick image. You can change it by selecting an image and choosing **Stack ▸ Pick** (^⌘8).

You can add adjustments to the stack image and the images comprising a stack. The stack image is automatically updated whenever you make changes to the stack. For best results, you typically apply the adjustments to the images comprising a stack.

The resulting stack image is cached by Observatory. When creating master calibration frames or large stacks it is recommended to select it and choosing **Image ▸ New ▸ Master**. This will freeze the current state of the stack image into a new managed master.

You can choose between the following stack types:

- **Pick**

  Observatory will not actually stack any of the images, but display the Pick image of the stack instead and group them as a set of images. This is the default unless you change it in the General Settings.

- **Sum**

  Each corresponding pixel of every source image is added. Invalid or missing pixels are skipped.

- **Average**

  The pixels of the source images are averaged. Invalid or missing pixels are skipped.

- **Median**

  The median of the source pixels is used for the target image. Invalid or missing pixels are skipped.

Align

Aligns the image with the stack's pick. For RGB images the green channel is used for the image registration. The adjustment is ignored for the pick itself.

- **Type** – *Translate*, *Rotate and translate*, *Scale, rotate and translate* or *Affine*. Typically you would choose the *Translate* transformation.

Normalize

Adjusts the pixel values of a image such that its background or overall brightness matches that of the stack's pick. The adjustment is ignored for the pick itself.

- **Normalize** – *Background* or *Linear*. If *Background* is chosen, then for each of the layer's channels the pixel values are adjusted such that the channel's median is equal to that of the corresponding pick's channel. If *Linear* is chosen, the pixels are furthermore adjusted such that the standard deviations match as well.

Avoid using this adjustment when creating master bias or dark frames. Instead, if you have outliers in bias or dark stacks, remove those images from the stack or reject them by choosing **Stack ▸ Reject**.

The Album Inspector

When you choose an album or smart album in the Library Navigator of the Sidebar, the Album Inspector along the right side of Observatory's window will display its metadata.

Towards the top, you'll see an icon to help you quickly identify the album type. Next to it is its editable name and a lock icon. It allows you to lock the album, to protect it and its contents against changes. If you marked the album as a favorite, or archived it, then you will see an indicator here too.

Unless the album is locked, you can edit all information presented in this inspector. If you made an accidental change, just choose **Edit ▸ Undo** (⌘Z).

The inspector is organized in two sections.

Organize

- **Label**

  You can assign a color label to your album by clicking on one of these seven colored circles. The meaning of the different colors is up to you. To remove the color label, click it for a second time.

- **Rating**

You can assign a 1–5 star rating to your album by clicking towards the right of this label. Drag the stars towards the left to remove the rating.

- **Status**

  This attribute may contain an arbitrary textual or numeric value of your choice. The search field in the Library Navigator lets you filter albums by this status attribute.

- **Tags**

  Tags, or keywords, are a good way to organize your albums. The search field in the Library Navigator lets you filter albums by tags.

Note

You can add notes to each of your albums. With this inspector you can view and edit it. If you have selected it, you can even press ⌘F to search inside the note.

Albeit handy, there isn't much room in the inspector. Choose **Album ▸ Edit Note...** (⌥⌘') to open a much bigger, resizable Dialog for editing the note. There you can also press ⌘F to search inside the note, or click the icon near the bottom left of the Dialog.



The Preview Inspector

Near the bottom of the **Inspectors** along the right edge of Observatory's window, is the **Preview** inspector. Click its button or choose **View ▸ Inspectors ▸ Preview** to open or close it.

If you select an image in the Browser, the Preview panel will contain a small preview of that image. This is especially useful if you are using the List Browser. Likewise, if you are using the Virtual Observatory, and select a search result that is marked with a ● symbol, revealing the Preview inspector will have it automatically download a preview image and display it.

> If you want to have a closer look at a preview image, just move the cursor over it and click the **Quick Look** button that appears, or press the `spacebar`. This is especially useful for Virtual Observatory previews, since they are not restricted in size.
>
> You can use the Quick Look window to open the preview image in other applications, for example the Preview application. If you wish to keep it or modify it, please Duplicate it first, because the original preview image may be removed while you use Observatory.



The Magnifier Inspector

Near the bottom of the **Inspectors** along the right edge of Observatory's window, is the **Magnifier** inspector. Click its button or choose **View ▸ Inspectors ▸ Magnifier** to open or close it.



The Histogram Inspector

Near the bottom of the **Inspectors** along the right edge of Observatory's window, is the **Histogram** inspector. Click its button or choose **View ▸ Inspectors ▸ Histogram** to open or close it.

The histogram is a graph which shows how many pixels are in the image in different brightness ranges. The darkest pixel represented is at the left side, and the brightest pixel is at the right side. The highest point on the graph corresponds to the most common brightness level in the image. The vertical scale is logarithmic.

The histogram represents the actual image, not its presentation in the Canvas. The latter has the STF histogram transformation applied to it. The histogram shows only the visible channels. Its background color is a handy indicator of the currently visible channels. If you move the mouse cursor over the histogram, additional information is shown.



The Channels Inspector

Near the bottom of the **Inspectors** along the right edge of Observatory's window, is the **Channels** inspector. Click its button or choose **View ▸ Inspectors ▸ Channels** to open or close it.

It lists all channels in the image. A thumbnail of the channel's contents appears to the left of the channel name. It is automatically updated as you change the image version. An RGB image has a channel for each color (red, green, and blue), while a grayscale image has only a single channel.

You can use the Channels inspector to view any combination of channels in the Canvas. Click the eye icon next to the channel to show or hide that channel. Observatory requires you to have at least one visible channel.

The histogram shows only the visible channels. Its background color is a handy indicator of the currently visible channels.

The Layers Inspector

Near the bottom of the **Inspectors** along the right edge of Observatory's window, is the **Layers** inspector. Click its button or choose **View ▸ Inspectors ▸ Layers** to open or close it.

Layers are like sheets of stacked tracing paper. You can see through transparent areas of a layer to the layers below. You can change the opacity of a layer to make content partially transparent. Layers are composited together to form a single image which shows up in the Canvas.

The Layers panel in Observatory lists all layers in an image. You can use the Layers panel to show and hide layers, select and rename them, and lock or unlock them. The Layers panel also is used to select the **Active Layer**. Information in the **Measure Inspector** always act on the Active Layer.

The Attachments Inspector

During an observation session you often take notes in a text document, or you might have collected research papers for some of the objects in an image or album. With Observatory you can attach these files to images and albums, so you can quickly look into or open them while working in Observatory.

To attach a file to an album, select the album and choose **Album ▸ Attach File…**. You are presented with a Dialog where you can select the file or files to attach. Usually you would link the attachments, but you can also decide to embed them in the library by selecting **Embed the file in the library** instead of the default **Create a link to the file**. Click the **Select** button to attach the file or files.

Note that when embedding attachments, Observatory will make sure that if you attach the same file to multiple albums or image versions, it will only embed it once.

The attachments appear in the **Attachments** inspector along the right edge of Observatory's window.

You can attach files to albums and smart albums. These kinds of attachments are indicated in the inspector with the appropriate icon for the album type. If you see a curly arrow next to it, you know it is a linked attachment, and not an embedded one.

Similarly you can attach files to individual image versions. Select the images in the Browser and choose **Image ▸ Attach File…**.

An alternative to using the main menu for attaching files is clicking the + button in the Attachments panel. Here you can also remove attachments, by selecting them and clicking the – button.

The Attachments inspector displays a thumbnail of the attachment, and you can look at it up-close by selecting the attachment and clicking the *eye*-button or pressing the spacebar. This will open a standard Quick Look window.

More options can be found in the contextual menu when selecting an attachment:

- **Open**

  Open the attachment with its default application.

- **Open With**

  Open the attachment with one of the listed applications.

- **Quick Look Attachment**

  The same as clicking the *eye*-button or pressing the spacebar.

- **Show in Finder**

  Opens a Finder window with the attachment file selected.

> The Import Dialog contains an **Attach other files** option, which is enabled by default, that will have Observatory attach (link) any file that is not an image to the generated albums.

Common Tasks

Here you'll find solutions for specific goals, organized by topic.

Preparing for an imaging session

- Creating a library of prospective targets

Working with images during an imaging session

- Inspect, process or stack images during an imaging session

Processing images

- Creating master bias, dark or flat frames
- Image calibration
- Removing hot and cold pixels
- Reducing or eliminating gradients
- Stacking images
- Synchronizing a library with a modified master image
- Stopping tasks

Analyzing images

- Blinking images
- Photometry
- Astrometry

Organizing images

- Organizing images with Observatory
- Organizing images in the file system
- Sharing a library between computers
- Exporting to PDF in landscape mode



Astrometry

With its astrometry tool, Observatory can compute the separation in pixels and planar angle of stars. If an image has been plate solved, it will also compute their spherical equatorial coordinates, angular separation and position angle.

To measure the angular separation and position angle of stars:

1. Select the plate solved image.
2. Show the Canvas.
3. Select the astrometry tool in the Measure Inspector.
4. Click on the first star in the image you wish to measure. It will be marked with the *1* label in the image.
5. Hold the ⌘ key and click on the second star in the image. It will be marked with the *2* label in the image.
6. Click the eyedropper button in the astrometry tool. The stars will now be marked with the *A* and *B* labels in the image.

The astrometry tool now displays the spherical equatorial coordinates of the stars, their separation in pixels and in degrees, arc minutes and arc seconds, as well as the planar and position angles in degrees.

Related Topics

- Using the Canvas
- The Measure Inspector
- Plate Solving
- The Channels Inspector

Blinking images

When rapidly switching between viewing two or more registered images taken of the same area of the sky at different times, "blinking" back and forth

between them, moving objects such as asteroids and comets will stand out. They will appear to be jumping back and forth between different positions, while all the distant stars remained stationary. Images taken at longer intervals similarly can be used to detect stars with large proper motion, variable stars, supernovas, or to distinguish binary stars from optical doubles.

To blink images:

1. Select the images.
2. Choose **Stack ▸ Stack**.
3. Select the stack and click the **Focus on Stack** button.
4. Select all images in the stack by clicking the… button in the browser bar.
5. Show the Canvas.
6. Click on the play button in the toolbar to start the blink animation.
7. Adjust the blink speed with the ⌘[and ⌘] keys.
8. Click the pause button when done.

You may need to change the Stack Type and Align adjustment in the Stack Inspector to align the images.

Related Topics

- Stacking images
- Using the Browser
- Using the Canvas

Image calibration

Image calibration is the process of applying dark, bias, and/or flat field frames to an image. Bias frames help compensate for camera read-out noise, dark frames compensate for the thermal properties of the camera sensor (hot and cold pixels) and flat frames compensate for imperfections in the light path (instrumental vignetting and dust donuts).

To calibrate an image:

1. Select the image (or multiple images).
2. Select the Adjustments Inspector.
3. Enable the Calibrate adjustment and choose the dark, bias, and/or flat field master calibration frames you wish to apply to the image.

If a master calibration frame is not listed in the Calibrate adjustment, check that

1. You have assigned it the corresponding image type.
2. Its dimensions, ISO speed, offset, gain and sensor temperature (±0.5 °C) match that of your image.
3. A dark frame is only listed if its exposure duration matches that of the image, unless a bias frame is selected.
4. A flat frame is only listed if its filter name and rotator angle (±0.1°) matches that of the image.

Related Topics

- The Attributes Inspector
- The Adjustments Inspector
- Creating master bias, dark or flat frames

Removing hot and cold pixels

Calibrating an image with a master dark frame is the preferred way to compensate for hot and cold pixels. If a master dark frame is not available, or it did not compensate for all hot and cold pixels, you may want to remove them with the Cosmetic Correction adjustment. It identifies defective pixels by comparing each pixel in the image to its neighbors and correcting any which vary more than the specified number of deviation units.

To remove hot and cold pixels:

1. Select the image (or multiple images).
2. Select the Adjustments Inspector.
3. Enable the Cosmetic Correction adjustment and specify how many times (in deviation units) the value of a pixel must differ from the surrounding neighbors to be considered a hot or cold pixel.

An indicator of the hot pixel lower limit can be found by temporarily switching the*action* parameter to *Identify*, setting the value to its minimum and increasing it until no star cores are being affected anymore. Then switch back *action* to *Average*.

Related Topics

- The Adjustments Inspector
- Image calibration

Reducing or eliminating gradients

Calibrating an image with a master flat field is the preferred way to compensate for instrumental vignetting and dust donuts. If a master flat field is not available, or your image contains gradients because of light pollution, you may want to reduce or eliminate them with the Flatten Background adjustment. It estimates the background level in various regions of the image and fits either a plane or a higher-degree polynomial surface to the measured background. The resulting surface is removed from the image, thus reducing the variations.

To reduce or eliminate gradients:

1. Select the image (or multiple images).
2. Select the Adjustments Inspector.
3. Enable the Flatten Background adjustment. For an image with a large foreground object or extended nebular region use a small value for the background sample rejection tolerance, in sigma units. You can use larger values on star fields.
4. Select the surface type that best matches the gradient.

Related Topics

- The Adjustments Inspector
- Image calibration

Creating master bias, dark or flat frames

Image calibration is the process of applying dark, bias, and/or flat field frames to an image. It mostly eliminates the effects of instrumental vignetting and hot and cold pixels. The process requires master calibration frames, which are a created by stacking individual calibration frames.

To create a master bias, dark or flat frame:

1. Select the bias, dark or flat frames.
2. Choose **Stack ▸ Stack**. This menu item is only enabled if the selected images all are part of the same album or Inbox.
3. Select the newly created stack in the browser and adjust the image type with**Image ▸ Type ▸ Master Bias**, **Image ▸ Type ▸ Master Dark** or **Image ▸ Type ▸ Master Flat**. Optionally change how the images are stacked with the stack inspector.

The master calibration frame now can be used to calibrate images. To improve calibration performance you may want to create a managed master of the master calibration frame by selecting it and choosing **Image ▸ New ▸ Master**.

Related Topics

- The Stack Inspector
- The Attributes Inspector

- Image calibration

Exporting to PDF in landscape mode

When exporting images with overlays using **File ▸ Export as PDF**, they are always saved in portrait mode.

To export images to PDF in landscape mode:

1. Select the images.
2. Choose **File ▸ Page Setup** and select *Landscape* as Orientation. Click the OK button.
3. Choose **File ▸ Print**, and at the bottom left select *Save as PDF*.
4. Enter the file name, choose the destination folder, and optionally change the title, author, subject and keywords before clicking the Save button.

Related Topics

- Sharing, Printing & Exporting

Photometry

Observatory supports basic aperture photometry to measure magnitudes in your images.

To perform aperture photometry:

1. Select the image.
2. Show the Canvas.
3. Select the photometry tool in the Measure Inspector.
4. Click on the first star in the image you wish to measure. It will be marked with the *1* label in the image.
5. Hold the ⌘ key and click on the second star in the image. It will be marked with the *2* label in the image.
6. Click the eyedropper button in the astrometry tool. The stars will now be marked with the *V* and *C* labels in the image.
7. Enter the magnitude and its estimated error of the comparison star in the *C mag* field of the inspector and adjust the electronic gain value in the *e gain* field if it is incorrect.

The photometry tool now displays the computed magnitude, its estimated error, and other measurements for both stars.

If the image has been plate solved, Observatory will automatically provide the magnitude and its estimated error from the Tycho-2 or Gaia DR2 catalog. If multiple stars match for one of these catalogs, it will pick the brightest. It uses the V, or R, or B magnitude, whichever is available, in that order. Use the Probe Settings in the Measure Inspector to adjust the photometry aperture, annulus and gap radii.

Related Topics

- Using the Canvas
- The Measure Inspector
- Plate Solving
- The Channels Inspector

Synchronizing a library with a modified master image

Master images typically are not modified after they have been created by image acquisition software. But sometimes it may be necessary to update the FITS header of a master image. It may already have been imported into an Observatory library, hence Observatory automatically detects modifications to master images. This is indicated in the browser with a badge icon.

Modified master image badge

Because the master image's metadata may not match what is stored in the library anymore, you should synchronize them.

To synchronize a library with a modified master image:

1. Select the image with the “modified master” badge icon.
2. Choose **Image ▸ Reset...**.
3. Select “Replace” in the Metadata dropdown and set the “Sync Master” checkbox.
4. Click “OK”.

This will reload the metadata from the master and reset all attributes for its versions.

Related Topics

- Using the Browser

Sharing a library between computers

Although Observatory libraries aren’t designed to automatically synchronize changes between computers, sharing a library between computers is possible by following a simple rule:

> Always close the library before opening it on a different computer.

Move the library and images to an external drive. Then as you open the library on the other computer, you may need to use **File ▸ Import ▸ Locate Source Folder...** to have it locate your images. This is because Observatory is sandboxed. This operation is recursive, so it is best to have a single top-level folder for your image folders.

> Storing images on an external drive does not severely impact performance. Storing a library on an external drive does.

Stacking images

Image stacking is the process of combining images of the same object to improve the signal to noise ratio. Unless you are creating a master calibration frame, typically you will need to align (register) the images before combining them.

To align and stack images:

1. Select the images.
2. Choose **Stack ▸ Stack**. This menu item is only enabled if the selected images all are part of the same album or *Inbox*.

The default type of stack created can be set in the General Settings. Images of type Flat and Light are automatically normalized. Images of type Light are automatically aligned as well. With the Stack Inspector these settings can be adjusted for each stack.

For best results, the images you align and stack should all be calibrated and processed with the Calibrate and other adjustments. The reference image used for alignment is the *Pick* image of the stack. This is initially the first exposure in the stack, but it can be changed with the **Stack ▸ Pick** menu item. You can take a snapshot of the stack by choosing **Image ▸ New ▸ Master**.

The *Pick* Stack Type is a special stack that isn’t really a stack, but a means of grouping images.

Related Topics

- The Stack Inspector
- The Adjustments Inspector
- Creating master bias, dark or flat frames
- Image calibration
- Using the Browser

Stopping tasks

If the *Stop Tasks* toolbar button is enabled, Observatory is loading, processing or stacking images. These tasks may be running because you selected one

or more images or are adjusting them. Observatory itself can also initiate automatic library maintenance tasks, for example to generate a thumbnail of an image or stack.

User initiated tasks always have a higher priority than library maintenance task, and they will gracefully pause them. If a library maintenance task is active while you initiate a new task, that maintenance task will first be completed though. If it is a lengthy one, and you don't want to wait for it to complete, then use this button to stop it gracefully.

To stop loading, processing or stacking images:

1. Press ⌘. or click the *Stop Tasks* toolbar button.

This will deselect the currently selected images, and stop the automatic library maintenance tasks. In addition, it will temporarily block Observatory from initiating any new library maintenance tasks.

The *Stop Tasks* toolbar button is not shown by default in the toolbar. To show it use **View ▸ Customize Toolbar...** and drag the button into the toolbar.

Related Topics

- Using the Toolbar

Creating a library of prospective targets

To prepare for an imaging session, it may be helpful to download a few images of prospective targets and their immediate surroundings. This will help you frame the target properly and avoid missing other interesting objects nearby. Use images obtained with Virtual Observatory that have image scales comparable to your equipment.

To create a library for prospective targets:

1. Click **New** in the *Welcome* window, or choose **File ▸ New Library**.
2. Click the **Virtual Observatory** button in the center of the window, its toolbar button or choose **Window ▸ Virtual Observatory Persona**.
3. Deselect all but the DSS, SDSS, PTF, ZTF, SMSSS, 2MASS and WISE catalogs. Their images all have a scale of approximately 1–10 arc seconds per pixel, albeit some at vastly different wavelengths.
4. Enter the target's name or identifier and click the **Search** button or press ⏎.
5. Expand the Preview Inspector to view a small thumbnail of any image with a preview indicator (●).
6. For a large preview, press `spacebar` or mouse-over the Preview panel and click the preview button.
7. To download and import one or more images into the library, select them and click the **Import** button.

Switch to the Browser and Canvas to see the downloaded images in your library and display object catalog overlays.

Related Topics

- Using the Virtual Observatory
- Using the Browser
- Using the Canvas
- The Overlay Panel

Inspect, process or stack images during an imaging session

Sometimes you may want to quickly inspect, process or even stack images during an imaging session.

To inspect, process or stack images during an imaging session:

1. Drop the folder the image acquisition software is saving the images in onto the Observatory application icon.
2. This creates a temporary library with Observatory watching the folder for new images.
3. While imaging, Observatory now automatically imports the newly acquired images into the Inbox.
4. Here you can quickly visually inspect them, see their metadata, blink them, or you can calibrate, align, stack & plate solve the images, all without affecting the master images.

Afterwards, you can just close the Observatory window, without even saving the newly created library, and move your master images to a more permanent location.

Related Topics

- The Source Folder Navigator

Plugins

Observatory contains plugins for FITS, XISF and SBIG images that automatically generate thumbnails for Finder, allow you to preview them up-close in Finder without opening any application, and will index their metadata for easy searching in Finder. Observatory also lets you use our plugin for Acorn, so you can open these images at full bit depth directly in this powerful image editor for post-processing.

- Quick Look
- Spotlight
- Acorn Plugin

Quick Look

Quick Look lets you view a file's contents by selecting it in Finder and then pressing the `spacebar`. There's no need to wait for the file to open in an application. Although macOS supports many types of images, the formats typically used for astronomy are not. Observatory therefore provides a Quick Look extension for the following image formats:

- **FITS** – Flexible Image Transport System (FITS) is a digital file format useful for storage, transmission and processing of scientific and other images. FITS is the most commonly used digital file format in astronomy. FITS images usually have a `.fits`, `.fts` or `.fit` extension.
- **XISF** – Extensible Image Serialization Format (XISF) is a free file format for storage, management and interchange of digital images and associated data. XISF has been conceived and implemented as the native file format of PixInsight, an image processing software platform designed specifically for astronomical imaging, and developed by the company Pleiades Astrophoto S.L. These images usually have a `.XISF` extension.
- **SBIG** – The SBIG format is the default format for saving images when using the SBIG CCDOPS image acquisition software. These images usually have a `.ST7`, `.ST8`, `.ST9` or `.SBIG` extension.

If you have PixInsight installed then there's an **Open with PixInsight** button towards the top of the window, which when clicked will open the image in PixInsight.

The extension also generate image thumbnails for the Finder windows. In addition they are used in its Gallery view and for Finder's *Get Info* window. They even appear in the Dialog for opening files (instead of generic icons), in any application. In these Dialogs you can also view a file's contents up-close by pressing `spacebar`.

The extension displays image metadata below the preview. Plate solved images will show the image scale, orientation and grid. These features can be toggled with the action menu at the bottom left. FITS headers can be displayed for FITS images.

Spotlight

Spotlight is a powerful macOS search technology that makes searching for files easy. Using Spotlight, you can search for things using attributes such as the width and height of an image in pixels, or its exposure time. Information like this (called metadata) is embedded in a file by the application that created it. Spotlight's power comes from being able to extract, store, update, and organize the metadata of files to allow fast, comprehensive searches.

Spotlight uses Quick Look technology to display thumbnails and full-size previews of the documents returned in a search. As is the case with Quick Look, although macOS supports many types of images, the formats typically used for astronomy are not. Observatory therefore also provides Spotlight importers for the following image formats:

- **FITS** – Flexible Image Transport System (FITS) is a digital file format useful for storage, transmission and processing of scientific and other images. FITS is the most commonly used digital file format in astronomy. FITS images usually have a `.fits`, `.fts` or `.fit` extension.
- **XISF** – Extensible Image Serialization Format (XISF) is a free file format for storage, management and interchange of digital images and associated

data. XISF has been conceived and implemented as the native file format of PixInsight, an image processing software platform designed specifically for astronomical imaging, and developed by the company Pleiades Astrophoto S.L. These images usually have a `.XISF` extension.

- **SBIG** – The SBIG format is the default format for saving images when using the SBIG CCDOPS image acquisition software. These images usually have a `.ST7`, `.ST8`, `.ST9` or `.SBIG` extension.

These Spotlight importers ensure that you can search for astronomical images using the following attributes in Finder:

- **Title** – The object name or target name, e.g. `OBJECT` FITS keyword.
- **Device model** – A combination of the telescope, instrument and detector used for the observation, separated by semi-colons, e.g. `TELESCOP`, `INSTRUME` and `DETECTOR` FITS keywords.
- **Location** – The name of the location where the image was obtained, e.g. `ORIGIN` FITS keyword.
- **Authors** – The names of the observers, e.g. `OBSERVER` FITS keyword.
- **Kind** – The file type, e.g. *Flexible Image Transport System*.
- **Identifier** – The archive or root file identifier, e.g. `ARCFILE` FITS keyword.
- **Filter name** – The filter used for the observation, e.g. `FILTER` FITS keyword.
- **Image type** – The image type, e.g. `IMAGETYP` FITS keyword.
- **Detector temperature** – Detector temperature in °C, e.g. `CCD-TEMP` FITS keyword.
- **Right ascension** – The center right ascension of the image, e.g. `RA` FITS keyword.
- **Declination** – The center declination of the image, e.g. `DEC` FITS keyword.
- **Equinox** – Equinox, e.g. `EQUINOX` FITS keyword.
- **Epoch** – Epoch, e.g. `EPOCH` FITS keyword.
- **Content created** – Exposure date & time, e.g. `DATE-OBS` and `TIME-OBS` FITS keywords.
- **Dimensions** – Only for display purposes, the image width and height in pixels.
- **Axis** – The number of axis of the image file. Only indexed if not exactly 2.
- **Pixel width** – The width in pixels.
- **Pixel height** – The height in pixels.
- **Pixel count** – The total number of pixels in the image (width * height).
- **Exposure time** – The exposure duration in seconds, e.g. `EXPTIME` FITS keyword.
- **Bits per sample** – The number of bits per sample, e.g. `BITPIX` FITS keyword.
- **Focal length** – Focal length in mm, e.g. `FOCALLEN` FITS keyword.
- **ISO speed** – Camera ISO speed setting, e.g. `ISOSPEED` FITS keyword.
- **Offset** – Bias offset, e.g. `OFFSET` FITS keyword.
- **Gain** – Camera gain, e.g. `GAIN` FITS keyword.
- **Content Creator** - Application used to create the image, e.g. `SWCREATE` FITS keyword.

The attribute names were chosen to match those of image formats natively supported by macOS, when applicable, so there's no need need for separate searches for, say, DNG files and FITS files.

Some of this extracted metadata is displayed in the *More Info* section of Finder's *Get Info* window, which is displayed if you select an image and choose **File ▸ Get Info** (`⌘I`). The preview is generated by the Quick Look extension.

Searching with Spotlight

To invoke Spotlight, you would usually press `⌘spacebar` or click the magnifying glass icon at the right of your menubar. Much more advanced searches can be performed by searching in Finder. Open a Finder window and click in the search field at the top, or press `⌘F` to open a new search window or convert an open Finder window into a search window.

If Finder displays your search results in Icon view, you'll probably want to switch to List view to get a better look at your results. You can then select the column headers to sort the results. If you want more column headers to be visible, press `⌘J` and check other columns from the *View Options* window, or use the contextual menu of the column header (`Control`-click).

macOS Finder has an undocumented but very useful feature: If you move the folder containing your astronomical images into the *Pictures* folder, the contextual menu of the List view's column header will also contain a *Dimensions* item. Select it, and a *Dimensions* column will be added to the folder's Finder window. The information displayed is obtained from the Spotlight index, and because Observatory contains Spotlight importers for FITS, SBIG and XISF images, Finder will now display the width and height in pixels for these files.

Another useful feature is that when you switch to Icon view and press ⌘J, by selecting *Show item info* in the *View Options* window, the image dimensions will be displayed below the image thumbnails.

The Finder window's search bar contains several options for tailoring your results. When you start typing search terms, Finder pops up a menu asking if you want to restrict your search terms to file names only. And you can click on **This Mac** to change the target of your search from the folder you were in when you started searching, to your entire Mac.

Adding criteria

To narrow down your results, start by selecting one of the criteria in the first menu. The default items in the menu are not very good choices for searching FITS, SBIG and XISF images, so click *Other…* here. Observatory's Spotlight importer adds many attributes to the list. Click on the **In Menu** check box next to an item if you want it to appear in the search bar menus for easy access in the future.

Useful additions to the menu might be:

- **Device model** – If your images were obtained with multiple telescopes or cameras.
- **Filter name** – If your images were obtained with different filters.
- **Detector temperature**
- **Right ascension**
- **Declination**
- **Exposure time**
- **Focal length**

Combining multiple queries

Often a search requires more than one set of criteria to reduce the number results to just those you are interested in. Finder window searches let you specify as many parameters as you want. Say you want to search for all light exposures of 1800 seconds taken through an OIII filter. To do this, you could select *Filter name* in the the first menu and have it match "OIII". Click on the + button in the search bar to add another search parameter, set it to *Image type* and enter "light". Then add another with the + button, select *Exposure time* and enter "1800". Spotlight will display all images matching these criteria.

You can also change the operators of your criteria, e.g. *is greater than* instead of *equals*. This way, by combining criteria, you can even search for all images within a range of *Right Ascension* and *Declination* values.

You can use quotes to specify that a search should look at the exact phrase you type. You can also use Boolean search terms, to exclude criteria or to create an OR search. Once you have one condition set up, you can add a Boolean term to your next condition by `Option`-clicking the + button. The + will turn into an ellipsis (…), and you'll get a new pull-down menu with options for *Any* (`OR`), *All* (`AND`), or *None* (`NOT`).

Saving searches for later

To save your search as a Smart Folder, click on the **Save** button in the search bar and enter a name for the Smart Folder. Enable the **Add To Sidebar** option if you want add the Smart Folder to the sidebar of your Finder window. Whenever you open this Smart Folder, Spotlight will run the search again and update the results with all files that fit the criteria.

You can change the search by opening the Smart Folder, clicking the action button, and selecting *Show Search Criteria*.

Rebuilding the Spotlight index

To rebuild the Spotlight index, choose ▸ **System Settings**, then click Spotlight. Click the Privacy tab and drag the folder or disk that you want to index again to the list of locations that Spotlight is prevented from searching. Or click the + button and select the folder or disk to add. From the same list of locations, select the folder or disk that you just added. Then click the – button to remove it from the list. Quit System Settings. Spotlight will reindex the contents of the folder or disk. This can take some time, depending on the amount of information being indexed.

Spotlight indexing should be enabled for the drive your images reside on. To check the Spotlight indexing status of a drive, open `Terminal` (in `/Applications/Utilities`), and enter

```
`mdutil -s` *\<path to volume\>*
```

For example,

```
`mdutil -s "/Volumes/Macintosh HD"`
```

It should return *Indexing enabled*. If you have your images on an external drive or NAS, then it may report *Indexing and searching disabled*. You can enable it with the same command (enter `mdutil` for the available options).

Acorn Plugin

Acorn by Flying Meat Inc. is a powerful image editor for macOS that supports nondestructive levels, curves and filters, layer masks, batch editing and many tools that work on pixels, text and shapes. It supports images with 8, 16 and 32 bits per channel. And you don't need a subscription. It is a cost-effective solution for post-processing astronomical images.

Code Obsession's Acorn Plugin adds FITS, XISF and SBIG image support to Acorn. After installing the plugin, you can open any such image as easy as a JPEG or TIFF. It is a great addition to Observatory's Quick Look and Spotlight plugins for the same image formats.

Preprocess and stack your images in Observatory, export as 32 bits FITS, open in Acorn and start post-processing. Add layers, annotations, watermarks. The options are endless.

What You Need

1. Observatory.
2. Acorn 5.6.5 or later. You can buy it direct or from the Mac App Store. The direct version has a 14 day trial period.
3. Our Acorn Plugin.

How to Install or Update

1. Download the Acorn Plugin.
2. Unzip the file in your *Downloads* folder, if not done automatically. This results in an `ObservatoryACIO.acplugin` file in your *Downloads* folder.
3. Open the Terminal application, and enter the command

   ```
   xattr -r -d com.apple.quarantine `~/Downloads/ObservatoryACIO.acplugin`
   ```

4. Start the Acorn application.
5. Choose **Help ▸ Open Acorn's App Support Folder**.
6. Drag the `ObservatoryACIO.acplugin` file into the `Plug-Ins` subfolder of Acorn's Application Support folder.
7. Quit the Acorn application (**Acorn ▸ Quit Acorn**).
8. Start the Acorn application once again.

How to Use

With this plugin installed, you can open FITS, XISF and SBIG images in Acorn, drag & drop them onto its application icon, and use the **Image ▸ Open Master With ▸ Acorn** option in Observatory. To avoid accidentally overwriting the files, the plugin does not allow you to save them in these formats.

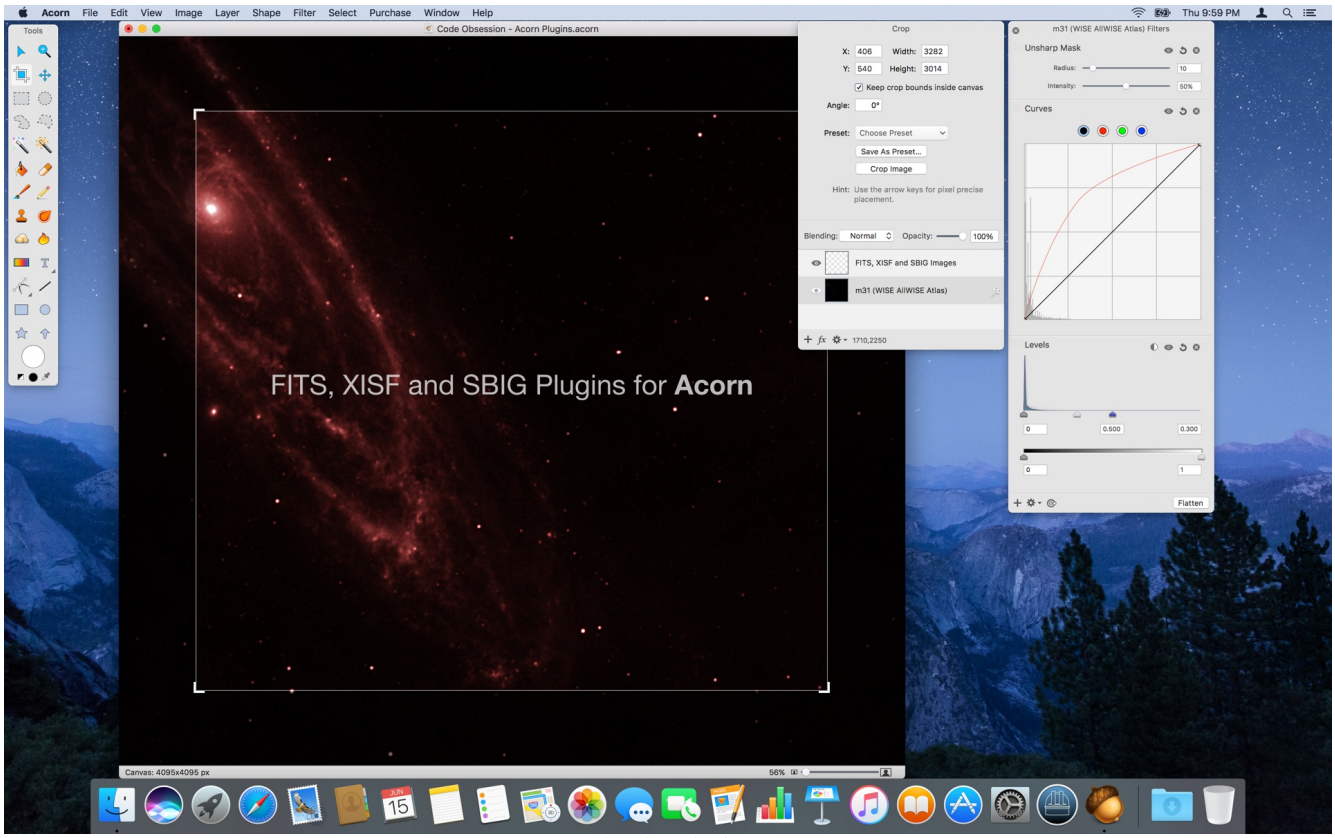
The plugin automatically switches Acorn's image editing workflow to True Color (8 bits per channel), Deep Color (16 bpc) or Really Deep Color (32 bpc), ensuring no dynamic range loss will occur. You can also manually change it with Acorn's **Image ▸ Image Depth** menu.

Because of the dynamic range of astronomical images, one of the first things you will usually do is adding nondestructive levels (**Image ▸ Levels...**) and curves (**Image ▸ Curves...**). You might want to use multiple of these to get the desired results.

Save the edited image in Acorn's default `.acorn` format. When you're happy with your image, just export it into a more common format, like JPEG.

Unlike Observatory, the Acorn Plugin has no automatic update mechanism. Keep an eye on its Release Notes or the Blog. Observatory will notify you about updates, and you can also use an RSS reader to follow the blog.

If you have questions about the plugin, please contact us. For questions about Acorn, please contact Flying Meat Inc.



Acorn Plugin by Code Obsession

Organizing Images with Observatory

Observatory's ability to extract metadata of your images, supplement it, and allowing you to nondestructively modify it for multiple images at once are powerful features that make searching your images easy.

Its Spotlight plugin allows you to search your FITS, XISF and SBIG images directly from Finder, without creating an Observatory library. But it only indexes the metadata that is stored in the images. By creating an Observatory library, amending the metadata and plate solving images, you can run much more powerful searches.

Observatory is not limited to a single library, and you'll probably create many of them as Observatory becomes part of your workflow. Here are a few suggestions for commonly used libraries.

A library of unprocessed images

With a large number of images, it becomes futile to organize them manually using albums in an Observatory library. It is more important to organize the images correctly in the file system than it is to organize them meticulously in an Observatory library. So start by using Observatory's Quick Look and Spotlight Finder integration to organize the images in the file system. There's no need to do this as thorough as is described in Organizing Images in the File System, but at a minimum it is advised to organize them in folders by imaging session date, with subfolders for each imaged object.

Then create a single library by importing all these images from their root folder. The library will then have a similar structure as your folder structure in the file system. Keep it up to date by regularly importing the folders of your latest imaging sessions, or let Observatory do this for you automatically with its Watched Folder feature.

As you import new images, quickly inspect and update their metadata if needed. You can also take this opportunity to mark some of them as rejected. Make sure that especially the core metadata, such as image type, exposure date/time, duration, filter used, sensor temperature, ISO speed, offset and gain are correct. Usually they will be, but depending on your equipment it may be necessary to update some fields. Observatory supports bulk editing of metadata, so this can be done quickly. It is also advised to enter a short name for the telescope and camera used, aperture diameter, and if you image at multiple locations also the name of the location.

The main goal is to create the ability to find images later. Some manual organization inside each Observatory imaging session folder may be beneficial, but is not required. For example, if you create flats for each set of lights of a given object, and these are in separate folders in your file system, you could just merge the two corresponding Observatory albums by dropping one on top of the other.

With this enhanced mirror of your file system, you can do things like

- Select the album of an imaging session to see all images. In Finder when you open a folder, you will only see the images immediately in that folder, but with Observatory you see all images in an album and its children.

- Click the button in the browser bar to see only light frames of the imaging session.
- Combined with the Search field in the toolbar you can quickly display only those that were taken with a specific filter.
- See all images for the selected target or obtained with the selected equipment with the corresponding navigator.
- Select a target, and see all sessions you had for this target, the number of exposures, filter usage, etc with the Statistics Persona.

Observatory's image organization and search power really takes off with the search bar and its Smart Albums. Instead of meticulously trying to organize the images in albums, add search criteria with the search bar and create Smart Albums. These can be as generic as "*Narrowband images*", or "*Henry Coe State Park*", or specific like "*Asteroid BVRI (ST8XE)*". Smart Album results can be further narrowed down with the browser bar filters and can be used with the Statistics Persona as well. To learn more about Smart Albums, see Using Smart Albums.

For searches to be most effective, the tags field should be set. You can manually add tags, but plate solving your light frames is much more effective. It's not necessary to plate solve all of your lights, but doing so for at least your final processed one is recommended. Copy the automatically generated tags to the other images of the same set. You can now use the Tag Navigator to find objects.

Stack the calibration frames in this library. Use a file naming convention as is described in Organizing Images in the File System. If you keep your calibration frames in albums separate from your light frames, move these calibration albums to the library's archive so they don't show up in Smart Album searches anymore.

A library for preprocessing images

Although all image preprocessing can be done in your main library, you may also use it only for searching images and the creation of master calibration frames. If you decide to do all preprocessing in the main library, then at least make it easy to differentiate between unprocessed and preprocessed images in your library. Use separate albums, and the status field for this.

For a dedicated preprocessing library, import all master calibration frames, ensure their core metadata is correct, and assign the correct master calibration type to them. Import the images you wish to preprocess in a new album. Calibrate, align and stack them, and export the resulting image. Then move them to the library's archive.

A library of fully processed images

Collect all your fully processed images in one library. Inspect and update all their metadata, and add notes about the imaging session and processing steps for each image. Plate solve each image. This library is intended for searching your processed images, overlaying astronomical objects for each of your images, printing and sharing them.

A temporary imaging session library

To inspect, process or stack images during an imaging session, create a temporary library with a watched folder. Discard it after completing the imaging session.

Related Topics

- Organizing Images in the File System
- Using Smart Albums
- Using the Browser
- Common Tasks

Organizing Images in the File System

Organizing your images starts with the file system. With Observatory you can create many different libraries, each providing a different view on your images, but at the file system level it is recommended to settle on a consistent structure. There are many different ways, and what is described below is only meant as a guideline.

Folder Structure

At the highest level, organize by year. Create folders in *YYYY* format. Below that, for each imaging session, create folders in *YYYYMMDD* format. Don't use *MM/DD/YYYY*, or month names, but just *YYYYMMDD* names. This ensures that they are always correctly sorted in Finder. Use the date for the timezone in which the images are acquired. For example, a folder structure like:

- 2018
  - 20180319
  - 20180320
  - …
- 2019
  - 20190104
  - 20190106
  - …
- 2020
  - 20200109

        - 20200121
        - …
- …

In each *YYYYMMDD* folder, create a text file named *YYYYMMDD*`.txt`, or *YYYYMMDD*`.md` if you prefer markdown. For example, `20200121.txt` in the `20200121` folder. Do this with *TextEdit*, or any other text editor you prefer. Don't use a *Word* or *Pages* document, but just use plain UTF-8 text instead. In this file you will keep your notes for the imaging session.

During an imaging session, just dump your images in this folder, and make quick notes in the text document. Focus on the imaging, not on the file system structure, but do keep notes during the imaging session.

Afterwards, organize your images in each *YYYYMMDD* folder, for example

- `20200109`
    - `reject`
        - *rejected frames*
    - `master`
        - `light`
            - `M 27`
                - *M 27 light frames*
            - `NGC 891`
                - *NGC 891 light frames*
            - …
        - `flat`
            - *flat frames*
    - `guiding`
        - *guider logs*
    - `final`
        - *fully processed images*
    - `20200109.md`
        - *session notes*

Always make sure to have a backup of at least your original master frames, including the calibration frames.

Naming the Files

Organize the files the next day. Your acquisition software likely has file naming templates to do this automatically, but if not, use Finder's batch renaming feature, renaming multiple files at once using the contextual menu or **File ▸ Rename**, to encoding information in your image file names, like

YYYYMMDD`.`*[objectid]*`.`*[aperture]*`mm.`*[cameraid]*`.`*[filtername]*`.`*[imagetype]*`.`*[exposures]*`x`*[duration]*`s`*[xbinning]*`x`*[ybinning][temperature]_[index number]*`.fits`

where

- *objectid* is a short identifier for the target object. Omit for bias and dark frames. Add it for flats when you take them without changing the telescope orientation. Avoid long names and do not use spaces. Just use `m42` for the Orion Nebula for example. If necessary, just add a note to the *YYYYMMDD*`.txt` file. Use lowercase.
- *aperture* Optional aperture in mm of the telescope. Omit for bias and dark frames.
- *cameraid* Optional short identifier of the camera, for example `st7`. Use lowercase.
- *filtername* Name of filter used for obtaining the image, typically one of `r`, `g`, `b`, `U`, `B`, `V`, `R`, `I`, `Ha`, `OIII`, `SII`. Omit if none.
- *imagetype* is one of `bias`, `dark` or `flat`. Omit `light` for light exposures. Later on, we'll also introduce `masterbias`, `masterdark` and `masterflat`. Use lowercase.
- *exposures* Number of exposures, if more than one. Use for stacked images only.
- *duration* Exposure duration in seconds. May also be expressed in microseconds, in which case the suffix should be `ms` instead of `s`. Omit for bias exposures.
- *xbinning* X binning. Usually `1`.
- *ybinning* Y binning. Usually `1`.
- *temperature* sensor temperature setpoint in °C. Always include the sign. Use `+` when zero or positive.
- *index* Index number of the image in fixed length format like *NNN*. It does not necessarily have to begin with `001`. The number of digits is not important, as long as all images during one imaging session have a unique incremental index number. You may also choose a larger number, like 7 digits, to ensure that no image ever has the same index number.
- For calibrated, aligned (registered) images, add `_c_r` between the index number and the file extension.

Use Obervatory's Quick Look, Spotlight and the enhanced Finder "Get Info" features for helping you get to this file system organization.

Some examples:

- `20021227.dark.st7.120s1x1-15_001.fits`

  One of a set of dark frames acquired on December 27, 2002, using an SBIG ST-7XE camera, exposed for 2 minutes without binning at a camera setpoint temperature of -15°C.

- `20040702.bias.st7.1x1-15_001.fits`

  A single bias frame, acquired on July 2, 2004, with the same camera and temperature.

- `20041203.ngc1502.80mm.st7.V.60s1x1-15_102.fits`

  One of a set of exposures of the open cluster NGC 1502, using a photometric V filter with a 80mm telescope, exposed for 1 minute with the camera cooled to -15°C on December 3, 2004.

Intermediate Files

Observatory doesn't generate intermediate files, but most astronomical image processing software does. If you use such software, use special symbols to differentiate the different type of processing applied to images, in the correct order, separated by the underscore character.

Symbol	Meaning
`c`	Calibrated image.
`r`	Registered (aligned) image.
`i`	Integrated (stacked) image.

Some examples:

- `20040702.masterbias.st7.200x1x1-15_i.fits`

  A master bias frame, a combination of 200 bias frames obtained on July 2, 2004 with a SBIG ST-7XE camera at a setpoint temperature of -15°C.

- `20041029.m76.254mm.st7.Ha.4x1800s1x1-15_c_r_i.fits`

  A combination of 4 calibrated and registered images of planetary nebula M76 acquired on October 29, 2004 using the same camera and setpoint temperature, but with an Hα filter on a 10" telescope. Each individual image was exposed for 30 minutes.

Never store intermediate files with your master frames.

Related Topics

- Quick Look
- Spotlight

Importing

The easiest way to create a new library is by dragging the folder containing your images from Finder and dropping it on the Observatory application icon. You can save this library, or use this mechanism to quickly inspect the contents of a folder, and then discard the library afterwards. For example, you could create a temporary library to inspect the images of your most recent observation session this way.

To create a new empty library, click the **New** button in the welcome window, or choose **File ▸ New Library**.

Import images into a library by dropping them onto the library window, or for an empty library click the drop area and select them. You can also import complete folders this way. Alternatively you can choose **File ▸ Import ▸ Images...** (⇧⌘I) in the main menu, or in the action menu of the Source Folder Navigator choose **Import Images...**.

Unless you import by dropping them on the library window, you are presented an Import dialog with the following options:

- **Add to album**

  This option is only enabled if you have selected an album in the Sidebar before importing. If checked, the images will be imported into that album. If not checked, they will be added to the *Inbox*, or if you have the next option checked, they may be added to automatically generated albums.

- **When choosing folders, import all images of their subfolders**

  If checked, the importing will be recursively traverse the folders.

- **Watch source folders**

  If checked, automatically import new images from source folders, and create albums for new subfolders.

- **Auto-Stack**

  If checked, the images will be auto-stacked after importing.

  Creates one or more stacks of the selected images. The selected images all have to belong to the same album. Observatory automatically groups

them in stacks, using the following criteria:

- Equal color mode (grayscale or RGB)
- Equal number of layers
- Equal image type
- Equal canvas size
- Equal filter name
- Equal exposure duration
- Equal ISO speed
- Equal offset
- Equal gain
- Equal binning values
- Nearly the same sensor temperature (±0.5 °C)
- Nearly the same right ascension and declination, if available (±0.1°)
- Nearly the same rotator angle (±0.1°)

- **Attach other files**

  If checked, any file that is not an image will be attached (linked) to their corresponding generated album.

After selecting the images or folders, click the **Import** button to import them. If you select folders, they are added as Source Folders as well.

⇧

Sharing, Printing & Exporting

- Share
- Print
- Export as PDF
- Export

Share

With Observatory you can quickly share one or more images with others. Just select them in the Browser and click the *Share* button in the Toolbar of the library or choose an item in the **File ▸ Share** menu.

Depending on your selections in the **▸ System Settings ▸ Extensions ▸ Sharing** settings, you will be presented with the ability to email the images, add them as a note to the Notes application, create a message in Messages, etc.

Included in the message is the image, and usually also its name, basic metadata and the notes. What exactly is included depends on the service you are targeting. You can edit the information before sending it. The image is converted to JPEG with the current view settings.

Print

By selecting images in the Browser and choosing **File ▸ Print…** (⌘P) you can print images, their name, basic metadata and the notes. Each selected version is printed on a separate page. If the image is plate solved, the image may be printed with the overlays.

Export as PDF

You can quickly create a PDF file from the images and some of their metadata you have selected in the Browser by choosing **File ▸ Export as PDF…**. It is a shortcut for printing to a PDF file. Each image, its name, basic metadata and the notes is added to a separate page in the PDF. As is the case with printing, if the image is plate solved, it optionally includes the overlays.

Export

Observatory has powerful image export capabilities that allow you to convert your images to different file formats, resizing them, apply file naming templates, all while storing them in folders that use naming templates.

You define these file format, file naming and folder naming template using the Export Settings.

Export Format

The Export Format determines the output file format, as well its dimensions. These dimensions may be the same as those of the source image, a percentage of its size, or resized to fit within a given rectangular size. You can define your own formats, or use one of the defaults:

Name	Description
Original Size (FITS)	Output as 32 bit floating point FITS file
Original Size (FITS 16)	Output as signed 16 bit integer FITS file

Name	Description
Original Size (TIFF)	Output as TIFF file
Original Size (JPEG)	Output as JPEG file
Original Size (PNG)	Output as PNG file
Large Size (JPEG)	Output as JPEG file (fit within 1280 × 1280)
Large Size (PNG)	Output as PNG file (fit within 1280 × 1280)
Medium Size (JPEG)	Output as JPEG file (fit within 640 × 640)
Medium Size (PNG)	Output as PNG file (fit within 640 × 640)
Small Size (JPEG)	Output as JPEG file (fit within 320 × 320)
Small Size (PNG)	Output as PNG file (fit within 320 × 320)

Default Export Formats

Folder Naming Templates

When you export images, you select an output folder where the images will be exported to. The images can be exported simply as files immediately in this output folder, or in a deeper subfolder structure which reflects certain aspects of each image or its album. The Folder Naming Template determines this subfolder structure.

Name	Description
None	Do not create subfolders
Observation Date	Create *YYYYMMDD* subfolders, based on image exposure date
Album	Create subfolders with lowercase name of image's album
Name	Create subfolders with lowercase image version's name
Album / Observation Date	Create nested subfolders based on album name and exposure date
Name / Observation Date	Create nested subfolders based on version name and exposure date

Default Folder Naming Templates

File Naming Templates

When you export images, you can simply use the version name as output name, but also let various attributes of the image determine its file name. The File Naming Template defines this naming pattern.

Name	Description
Master Bias	Lowercase name for master bias
Master Dark	Lowercase name for master dark
Master Flat	Lowercase name for master flat
Processed	Lowercase name for processed image
Name	Lowercase version name

Default File Naming Templates

Exporting Images

To export images, select them in the Browser and choose**File ▸ Export ▸ Image...** (⇧⌘E). This will export the selected versions. If you wish to export their master versions instead, choose **File ▸ Export ▸ Master Image...**. In both cases you are presented with a Dialog where you select the export destination folder. In addition, the following options are shown:

- **Export Format**

The export format to be used for the export. This determines the file type and dimensions.

- **Folder Format**

  The folder format to be used for the export. This determines the naming of the subfolders in the export destination folder, if any.

- **Folder Custom Name**

  A custom name that may be referenced in the folder format template.

- **Name Format**

  The file format to be used for the export. This determines the file naming.

- **Custom Name**

  A custom name that may be referenced in the file format template.

After selecting the destination folder and the various options, click the**Export** button to start the export.

Exporting Managed Masters

If you have used Virtual Observatory to obtain images from professional observatories, these will be stored as Managed Masters in the library. They are indicated with a special badge in the browser:

Managed Master Browser Badge

To export these original, unmodified images, choose**File ▸ Export ▸ Managed Master...**.

Note that the same badge is also used for Managed Masters that were created using**Image ▸ New ▸ Master**. These kinds of masters you can only export through one of the methods described in the section *Exporting Images*.

⇪

Plate Solving

If you import images or download them through Virtual Observatory, those that have been plate solved, .i.e., contain all information to relate image pixels to sky coordinates, will be shown with a special badge in the browser.

Matched Image Browser Badge

Observatory refers to these images as having been *matched*. Observatory performs extra steps for these images:

- It automatically generates tags so you can more easily find the images.

  For example, if you import a plate solved image of*M 1*, Observatory will automatically tag it with`M 1`, the `Supernova Remnant` tag to indicate that this is a supernova remnant, as well as additional tags for other objects in the image.

  You can search for images containing these tags in the Browser by selecting them in the Tag Navigator, by typing the tag name in the search field, as well as by creating Smart Albums in the Sidebar. In this case, if you select **Nebula ▸ Supernova Remnants** in the Tag Navigator, your *M 1* image will appear in the Browser. If you then select image, Observatory will even highlight *M 1* in the image.

- It computes additional information, for example the constellation the center of the image falls in.

Other benefits of matched images in Observatory are:

- The canvas displays overlays: image scale, orientation, RA/Dec grid, but also objects of various catalogs.
- The Probe Inspector displays the right ascension and declination coordinates at the cursor position.
- The astrometry tool displays right ascension and declination coordinates, angular separation of stars and their position angle.
- The photometry tool will automatically provide the magnitude of the selected comparison star from the BSC, Tycho-2 and Gaia catalogs.

Using the Plate Solver

If one or more of your images are not plate solved, you can ask Observatory to do this for you by selecting the images, and choosing**Image ▸ Match...** (^⌘M).

If Observatory can find coordinates in the image metadata, it will shown them in the sheet that appears. Images often contain valid coordinates, but not all image orientation and scale information, and this may suffice for Observatory to fully plate solve the image. Do this by clicking the **Match** button.

If you started with multiple images, multiple coordinates may be returned. If you want the plate solver to use one of those retrieved coordinates, select it and click the **Match** button.

Object Lookup

Your image may not contain any coordinates of course. The master FITS or XISF file may not contain this information, or you are using a different file format (e.g. SBIG or RAW). In such case, or when the coordinates are incorrect, you need to provide a hint to Observatory.

Just type the name of the object in the image, its catalog identifier or its coordinates in the text field towards the top of the sheet. Observatory will attempt to resolve your entry, and display the coordinates and description. Observatory is able to resolve many common names and catalog object identifiers. If it is unable resolve it, click the **SIMBAD** and **NED** buttons to have these services resolve it. For these two services an internet connection is required.

If your image contains the exposure date/time, then the object name will also be checked against our solar system's planets and first 500,000 asteroids, and Observatory displays their coordinates.

Additional Settings

Click on the triangle at the bottom left of the sheet for additional settings.

- **Pixel scale**

  The estimated pixel scale in arc seconds per pixel. It only needs to be an estimate, but if it is not accurate within a factor of two, this significantly reduces the chances on success.

- **Use brightest *N* stars**

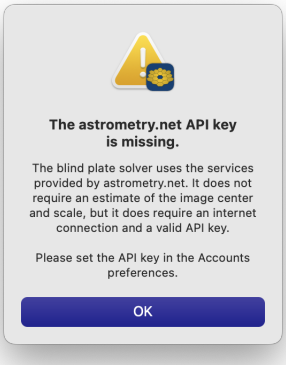
  Limits the number of bright stars in the extracted set.

The star detector also uses the current centroid settings. You can change those with the Probe Settings in the Measure Inspector. For RGB images, the green channel is always used for matching, regardless the selection in the Channels panel.

Using the Blind Plate Solver

Sometimes you may not be able to provide an estimate of the image center. Or the image contains optical distortions to a degree that Observatory cannot find a solution. For these and other cases Observatory lets you conveniently use the blind plate solver services of astrometry.net. The blind plate solver does not require an estimate of the image center and scale, but it does require an internet connection.

Select the images and choose **Image ▸ Blind Match...** (^⇧⌘M). The first time you do this you may see the following alert:



Astrometric Match: Missing API key

The blind plate solver require a valid API key. You can enter this API key in the Accounts Settings. Login to https://nova.astrometry.net with your web browser, open the Dashboard Profile page, and copy the API key shown on that page into the appropriate field of the Accounts Settings.

After you have set the API key, the **Image ▸ Blind Match...** command opens a sheet with options. When you click the **Match** button, Observatory will contact the service and upload the information needed by the blind plate solver for each of your images. You have two options:

1. Let Observatory use its star detector to determine the positions of many stars in your images, and upload these positions only. The star detector uses the current centroid settings. For RGB images the star detector only uses the green channel.
2. Or, upload the images themselves. If you press the option (⌥) key while selecting the command, Observatory uploads the master file instead of the image version.

The first option uses significantly less bandwidth and is therefore preferred.

Observatory will wait up to 5 minutes for the solution of each image. Usually the service returns a solution before that, but you can change this timeout here.

If it fails to find a solution, try calibrating your image, or use the Cosmetic Correction adjustment. Having Observatory upload the image sometimes increases the chances as well.

If you have many similar images for which you do not know the estimated image center and scale, instead of selecting them all and choosing **Image ▸ Blind Match...**, a more appropriate approach is to only do this for one image, and use the result as input for the **Image ▸ Match...** command for the other images.

Settings

To open Observatory's settings window, choose **Observatory ▸ Settings**, or use the keyboard shortcut (⌘,). There are four preference panes that you can use to further customize Observatory to suit your needs.

- General Settings
- Accounts Settings
- Catalogs Settings
- Export Settings
- Expert Settings

General Settings

The General tab of the Settings window includes settings for common interactions you'll have with Observatory. It contains the following settings:

- **Appearance**

  Adjusts the appearance of Observatory. Pick System to follow the system setting, or choose either Dark or Light to override it.

- **Compute device**

  Observatory is using the Graphics Processing Unit (GPU) for many intensive computations. If your hardware has multiple GPUs, they are listed here.

  The GPU that is currently connected to your display is indicated with a 🖥 icon. Low power devices are indicated with 🔋, and removable devices with ⏏. You should generally not select the GPU that is connected to the display, as this may impact the overall system performance.

- **Sky chart**

  If you have SkySafari 6.1 or later installed on your system, select it here to enable the **Image ▸ Show Sky Chart** command for matched images. This command displays the sky chart in SkySafari centered on the coordinates of the selected image. It also adds the **Search in Sky Chart** link for selected objects in the Object Inspector. This allows you to quickly view the selected object and its information in SkySafari.

  Note that SkySafari ignores the command if you have explicitly centered an object using "Center Selected Object" or the corresponding toolbar button. Click on another object in its sky chart or pan the chart before choosing **Show Sky Chart** in this case.

  Observatory will adjust the sky chart field of view to approximately match that of the image, but it is unable to control its orientation or flip it. Use SkySafari's *Coordinates* and *Scope Display* panels to manually do this. SkySafari typically launches with your current time, and if the object you are viewing in Observatory is not currently visible, selecting **Show Sky Chart** may display the blue sky or an area below the horizon. To avoid this, in its *Horizon* panel, disable "Show Daylight" and set "Show Horizon & Sky as Transparent With Line".

- **Sidebar icon size**

  Adjusts the size of the icons and text in the sidebar. The default is the size you have configured in the General tab of your System Settings. You can override it here.

- **Stack type**

  Sets the default stack type when stacking images with the **Stack ▸ Stack** menu item. The default is mean. You can override this for any stack with the Stack Inspector. The options are:

  - Pick

    Instead of stacking the selected images, this will let Observatory show the stack's pick image instead. This is useful if you just want to group related images in the browser and display a representative image.

  - Sum

    Stacks the selected images by adding each corresponding pixel value.

  - Mean

    Averages each corresponding pixel of the selected images.

  - Median

Uses the median value of each corresponding pixel of the selected images instead.

- **STF type**

  Sets the STF used for the browser thumbnails, exporting, sharing, and as the default for the canvas.

- **Session offset**

  Local session date offset in hours. Default is -8, so observations at 6pm local time and 7.59am the next morning are all considered to be part of the same session.

- **Tag magnitude limit**

  Plate solved images are automatically tagged by Observatory. Use this slider to set the V magnitude threshold for tagging. Objects fainter than the selected magnitude will not be automatically tagged in the images. Objects with an unknown magnitude are treated as if they are of magnitude 18 for this. For individual images, this setting can be overridden using the **Image ▸ Reset...** menu item. It is recommended to not set this beyond the magnitude limit of your equipment, e.g. 17 or 18.

- **CPU core allocation**

  Sets the number of CPU performance cores Observatory will use during importing and certain image processing tasks. Select *Automatic* to let it choose the recommended setting for your hardware.

- **Reopen library windows when launching**

  When launching, Observatory automatically reopens the libraries that were previously open. You can disable this behavior with this setting.

- **Preserve library versions**

  Observatory uses document versioning to let you restore a library to a previous state. With this setting you can disable library document versioning.

- **Open images in single new library**

  If you open image files with Observatory, they are combined in a single new library. Disable this option if you wish to have Observatory open each image in its own window, a single-image library, instead.

- **Play sound effects**

  Observatory plays a sound effect after successfully plate solving an image or when selecting an object in an image. You can disable it here.

- **Share Observatory Analytics**

  If you'd like to help us improve future versions of Observatory for you and others, you can choose to send us anonymous information about your system and Observatory usage. The kind of information sent is

  - Basic information about your system: macOS version, CPU, RAM and display
  - Performance: time taken to read images, apply adjustments, create stacks and plate solve
  - Memory pressure warnings
  - Information about how Observatory is used

  No personal information, images, folder or file names, image coordinates or anything that identifies you or the projects you are working on is ever collected.

  If you prefer not to submit your diagnostics and usage data, no problem – simply disable this option.

- **Reset Warnings**

  If you selected "Do not show this message again" in one or more dialogs, clicking **Reset Warnings** makes the messages appear again.



Accounts Settings

The Accounts tab of the Settings window includes settings for Virtual Observatory and the blind plate solver used by the **Image ▸ Blind Match...** command.

The blind plate solver uses the services provided by astrometry.net. Unlike Observatory's own plate solver, it does not require an estimate of the image center and scale, but it does require an internet connection and a valid API key. You can set this API key here. Login to https://nova.astrometry.net with your web browser, open the Dashboard Profile page, and copy the API key shown on that page here. It is securely stored in your computer's keychain and only transmitted to `astrometry.net` over a secure connection. It is never transmitted to us or anyone else.

The Virtual Observatory is used to search for and download images from several professional astronomical image archives. To download images from the ESO archive a user account is required. Creating it is free, and can be done at https://www.eso.org/UserPortal/. On that page, select *I would like to create a new account*, and follow the instructions.

After you have created the account, enter your ESO User Portal username and password here. The account information is securely stored in your computer's keychain and only transmitted to `eso.org` over a secure connection. It is never transmitted to us or anyone else.

Catalogs Settings

Observatory contains information of 60 million stars up to V magnitude 16, combining data from the BSC, Tycho-2, GCVS, WDS and Gaia DR2 catalogs. With the **Gaia Extension** In-App purchase this can be extended with an additional 750 million stars up to magnitude 20 from the Gaia DR2 catalog. This data can be displayed, and is used by the plate solver, photometry tool and the object inspector. Since it could take up to 15 GB additional disk space, the upper limit is adjustable with the slider in the Catalogs Settings.

When increasing the limit, additional data will be downloaded, and when finished Observatory needs to be relaunched to have it take effect. When decreasing the limit, the data will be removed from your computer when you quit Observatory.

It is recommended to set this to the magnitude limit of your equipment. Use the **Stars** tab of the Overlays panel to adjust the displayed magnitude limit for stars.

Reset Plate Solver

Observatory's Plate Solver adjusts itself after each successfully plate solved image, learning about the best settings for your equipment. You can restore the default criteria for plate solving by clicking this button. All training for plate solving will be lost.

Export Settings

The Export tab of the Settings controls how images are exported.

When you export images, you are presented with a number of presets for the output image format, the naming of the exported files as well as the generated folder structure. You configure these presets here. You can modify the default ones, or add and remove presets according to your needs.

Expert Settings

There are a number of behaviors in Observatory for which there are no UI controls in the Settings window; this is typically because the settings are so obscure that placing them in the Settings window would just make it complicated.

> Adjusting the settings described here involves using the Unix command line in the Terminal. Most changes will not have any immediate visible effect, but will instead take effect after quitting and restarting Observatory.

Photometry

- To use a magnitude error calculation as described in *"Flux-Uncertainty from Aperture Photometry"* by F. Masci, 1.0, 2008-10-14, which takes the number of pixels in the aperture and annulus into account:

  ```
  defaults write com.codeobsession.Observatory photometryVMagnitudeErrorMethod -int 1
  ```

  Reset to the default method:

  ```
  defaults delete com.codeobsession.Observatory photometryVMagnitudeErrorMethod
  ```

- Observatory uses subpixels for aperture photometry. To disable this, and have it only use pixels that fall completely within the aperture or annulus:

  ```
  defaults write com.codeobsession.Observatory disablePhotometrySubpixels -bool YES
  ```

  Reset to the default:

  ```
  defaults delete com.codeobsession.Observatory disablePhotometrySubpixels
  ```

- For measurements near the border of an image, or when it contains identified bad pixels, Observatory will adjust for the number of pixels in the V and C apertures when calculating the magnitude for V from the measured flux, unless this difference is < 1. To have Observatory always ignore the aperture pixel count for this calculation:

  ```
  defaults write com.codeobsession.Observatory ignoreAperturePixelCount -bool YES
  ```

  Reset to the default:

  ```
  defaults delete com.codeobsession.Observatory ignoreAperturePixelCount
  ```

Menus & Keyboard Shortcuts

Here is an exhaustive list of every single menu item, along with any corresponding keyboard shortcut, available in Observatory.

- Observatory Menu
- File Menu
- Edit Menu
- View Menu
- Album Menu
- Stack Menu
- Image Menu
- Window Menu
- Help Menu

If you find a menu option that doesn't have a keyboard shortcut but you really want one, you can always define new ones in the **Shortcuts** tab of ▸ **System Settings** ▸ **Keyboard**.

The Observatory Menu

The Observatory menu holds commands related specifically to the administration of the Observatory application itself. View and modify your settings here.

- **About Observatory**

  Find out some details about your copy of Observatory. This is good for checking exactly which version you're using.

- **Settings…** (⌘,)

  Open the Observatory settings window, where you can customize how the application works for you.

- **In-App Purchase…**

  Extend the capabilities of Observatory with the listed In-App purchases. If you previously purchased Observatory 1, you can unlock all new features of Observatory 2 here. In addition, if you have installed Observatory on multiple devices, you can use the *Restore Purchases* button to synchronize the purchases between the devices.

- **Services**

  Access system-wide macOS services offered by other applications.

- **Hide Observatory** (⌘H)

  Temporarily hide all of Observatory's windows.

- **Hide Others** (⌥⌘H)

  Temporarily hide windows of all other applications so you can concentrate on Observatory.

- **Show All**

  Show all windows of all applications.

- **Quit Observatory** (⌘Q)

  Stop using Observatory and put it away for now. Your libraries are automatically saved if you have the **Reopen library windows when launching** setting enabled in the General Settings.

  > If you press the ⌥ (option) key this menu item will change into **Quit and Close All Windows** (⌥⌘Q).

The File Menu

The File menu contains commands related to Observatory on a library level. Create or open a library, import images into it or export images from it.

- **New Library**

  Create a new empty Observatory library document.

- **Open...** (⌘O)

  Open an existing library document.

- **Open Recent**

  Observatory keeps track of recently opened library documents and includes their names in this menu so you can reopen a library and continue your work.

- **Close** (⌘W)

  Close the frontmost library window. Even if you close the last remaining Observatory window, you can always just open a new one.

  > If you press the ⌥ (option) key this menu item will change into **Close All** (⌥⌘W), allowing you to quickly close all library windows.

- **Save** (⌘S)

  Save the contents of the current library document.

  > Do not store the Observatory library file on NAS.

- **Duplicate** (⇧⌘S)

  Create a duplicate copy of the current library document. The exact contents of the current window are copied into a new window, which has the filename in the titlebar highlighted so you can enter a different name for the file. The file will be saved in the same location as its parent.

  > If you press the ⌥ (option) key this menu item will change into **Save As (⌥⇧⌘S)...**, to save the library under a new name or at a different location.

- **Rename...**

  Choose this option to highlight the filename in the document's titlebar so you can enter a new name for the file.

- **Move To...**

  Choose this option to open a sheet and select another location on your Mac to store the file.

- **Revert To**

  Opens Time Machine so you can sift through earlier saves of the current library document and restore it from an older save.

- **Import**

  This submenu contains commands related to importing images into the library and managing Source Folders. The Source Folder Navigator's action and contextual menus provide shortcuts to these commands.

  - **Images...** (⇧⌘I)

    Import images into the library.

  - **Add Source Folder...**

    Because of macOS imposed sandbox restrictions, if you want Observatory to monitor (watch) a folder on disk for changes, Observatory first needs to be given access to it. Choose this command to give Observatory access to a folder and add it to the Source Folder Navigator.

  - **Remove Source Folder...**

    Remove the selected source folder from the Source Folder Navigator and all its image versions from the library. This will not remove the folder or its images from the file system.

  - **Watch Source Folder...**

    Turn on or off, or configure automatic image importing for the selected source folder. With this turned on, Observatory will detect new images added to the source folder and automatically import them. The new images appear in *Inbox* by default. By further configuring the options here, they can be imported into any album, stacked, and new albums can automatically be created for new subfolders.

    Observatory by default does not monitor manually added source folders or their subfolders. This has to be explicitly turned on for a source

folder. The one exception is for libraries created by dropping a folder from Finder onto the Observatory application icon. That source folder *is* automatically watched. This feature is useful for inspecting images during an imaging session, where the image acquisition software saves newly captured images in a folder, and for keeping the library in sync with the file system.

- **Show Source Folder in Finder**

  Open a Finder window for the selected folder.

- **Locate Source Folder…**

  The references to Source Folders are stored such that renaming or moving them on the same disk will usually not break the link. If you move it to another disk, the link will be broken though. The master images will then not be accessible to Observatory. To make them accessible again, choose this command and select the new location of the Source Folder.

- **Export**

  Export your images in a variety of formats. You can use one of the default file formats, file naming templates and folder naming templates, or define your own using the Export Settings.

  - **Image…** (⇧⌘E)

    Export the image versions currently selected in the Browser.

  - **Master Image…**

    Export the master version of the images currently selected in the Browser.

  - **Managed Master…**

    Export the managed master image of your selection. Images you import from your file system are referenced by Observatory, not copied into the library document. Images you download using Virtual Observatory are stored in the library itself though, and this menu item gives you the ability to copy this original file into your file system.

- **Export as Movie…**

  Export the selected images as a movie. You can select the number of frames per second the movie will be played back.

- **Export as PDF…**

  Create a PDF file from the images you have selected in the Browser. Each image, its version name, basic metadata and the notes is added to a separate page in the PDF. If the image is Matched, it optionally includes the overlays.

- **Share**

  Share the selected images using Mail, Messages, AirDrop or anything else you have configured with **System Settings ▸ Extensions ▸ Sharing**. You can also access this feature from the toolbar.

- **Empty Trash…**

  Permanently remove all images and albums that were moved into the trash.

  > If you press the option (⌥) key, the menu item will change into **Compact Library…**. It removes unreferenced internal data and all generated previews and thumbnails from the library. They will be regenerated when needed.

- **Delete Rejected Masters…**

  Permanently delete the master images that are marked as rejected. This command not only removes the images from the library, but it also moves the affected master images to the file system's Trash. To permanently delete the master images you need to empty the Trash in Finder.

  > Warning: This command deletes master images from your file system.

- **Stop Tasks…** (⌘.)

  Gracefully stop image loading, processing and stacking, and deselect all currently selected images. Observatory sometimes automatically initiates such tasks in the background as well, and this menu item also stops these. In addition, it will temporarily stop Observatory from initiating new background tasks.

- **Page Setup…** (⇧⌘P)

Open the standard macOS Page Setup window, where you can change some settings for printing (or exporting to a PDF file). These settings are saved even if you quit Observatory.

- **Print…** (⌘P)

  Open the standard macOS Print window, with a variety of options for printing (or creating a PDF file).

The Edit Menu

- **Undo** (⌘Z)

  Reverse the most recent change you made.

- **Redo** (⇧⌘Z)

  Reenact the last change you undid.

- **Cut** (⌘X)

  Remove the selected text or items, putting them on the clipboard so you can paste them somewhere.

- **Copy** (⌘C)

  Put a copy of the selected text or items on the clipboard, so you can paste them somewhere.

- **Paste** (⌘P)

  Take whatever's on the clipboard and insert it at the current selection.

- **Paste and Match Style** (⌥⇧⌘V)

  Ignore any styles on the text you're pasting and just use the style already there at the place you're pasting into. Of course, this only makes a difference in notes, since that's the only place where you can have special styles anyway.

- **Delete**

  Remove the selected text.

- **Select All** (⌘A)

  If you are editing text, select it all, or if you are working with the Browser, select all items in the Browser.

- **Insert Time Stamp**

  Automatically type the current date or time, as defined by the Short Date, Long Date, and Time formats set up in System Settings' Language & Region pane. This can be handy when editing image, stack or album notes.

  - **Short Date**
  - **Short Date and Time**
  - **Time**
  - **Long Date**
  - **Long Date and Time**

- **Find**

  This submenu contains the standard Find commands included in many macOS applications. In Observatory they are handy when editing image, stack or album notes.

  - **Find…** (⌘F)
  - **Find and Replace…** (⌥⌘F)
  - **Find Next** (⌘G)
  - **Find Previous** (⇧⌘G)
  - **Use Selection for Find** (⌘E)
  - **Jump to Selection** (⌘J)

- **Format**

This submenu contains standard macOS commands that apply to text in image, stack or album notes.

- **Font**

  This submenu contains commands to change the typeface and style of your text.

- **Text**

  This submenu contains alignment options for text.

- **Spelling and Grammar**

  This submenu contains the standard Spelling commands for the macOS spell checking system.

- **Substitutions**

  Use this submenu to enable or disable automatic text and punctuation substitutions.

- **Transformations**

  This submenu contains commands that apply to selected text to convert it to completely upper case, lowercase, or capitalize each selected word, respectively.

- **Speech**

  This submenu contains the Start Speaking and Stop Speaking commands, which you can use to make the macOS text-to-speech system say the selected text out loud.

- **Start Dictation**

  With dictation enabled in ▸ **System Settings** ▸ **Keyboard** ▸ **Dictation**, select an editable text field and use this command to enter text via the spoken word.

- **Emoji & Symbols**

  Open the macOS Character Palette, where you can find characters not easily accessible from the keyboard



The View Menu

- **as Icons** (⌘1)

  Images are shown as icons arranged in a grid. To change the icon size, drag the “Icon size” slider.

- **as List** (⌘2)

  Images are arranged in a list, and other columns show additional information. To sort the list in a different order, click a column header. To change which columns are shown, Control-click any column header, then choose columns to show or hide.

- **as Gallery** (⌘3)

  Images are arranged in a row along the bottom of the library window. As you browse, the selected image is shown above the row, with its details in the inspectors.

- **Actual Size** (⌘0)

  Scale your image in the canvas to 100 percent (normal size).

- **Zoom to Fit** (⌘9)

  Scale your image in the canvas to make it completely visible in the window, regardless of its size.

  > You can use the zoom gesture to magnify and demagnify the view of your image. You can also quickly toggle between zoom levels by using the smart zoom gesture. The smart zoom gesture is a two-finger double tap on trackpads.

- **Zoom In** (⌘+)

  Magnify the view of your image in the canvas. You can scale your image up to 2000 percent.

- **Zoom Out** (⌘–)

  Demagnify the view of your image in the canvas. You can scale your image down to 1 percent.

- **Image Type**

  Images displayed in the browser can be filtered by image type. Choose here, or using the corresponding Image Type Filter in the browser bar if and how you want to reduce the number of displayed images.

  - **All**

    Display all images, regardless of their type.

  - **Bias**

    Display only bias calibration images, which are those with an image type that contains “Bias”.

  - **Dark**

    Display only dark calibration images, which are those with an image type that contains “Dark”.

  - **Flat**

    Display only flat calibration images, which are those with an image type that contains “Flat”.

  - **Light**

    Display only those images that have an image type that contains “Light”.

  - **Other**

    Display only those images that have an image type that neither contains “Bias”, “Dark”, “Flat” or “Light”.

  - **Unmatched**

    Display only those images that have not been plate solved.

  - **Matched**

    Display only those images that have been plate solved.

  - **Accepted**

    Display only those images that are not rejected.

  - **Rejected**

    Display only those images that have been rejected, i.e. a zero weight.

- **Columns**

  Choose here which columns you want the List Browser to display. The selection is coupled to the above **View ▸ Image Type** selection. For example, unless you change it, Observatory doesn’t display the Duration column when the Bias Image Type Filter is enabled, but it does so for all other Image Type Filters.

- **Subtitle**

  Choose here which information you want the Browser to display below the image icon name. The selection is coupled to the above **View ▸ Image Type** selection. For example, unless you change it, Observatory doesn’t display the Duration when the Bias Image Type Filter is enabled, but it does so for all other Image Type Filters.

- **Sort By**

  Choose here or in the browser bar, how you want the Browser to sort the displayed images. In the List Browser, you can change the sorting also by clicking the column titles. The selection is coupled to the above **View ▸ Image Type** selection. Images are sorted by exposure date/time in descending order by default.

- **Sidebar**

  This submenu contains commands related to the Sidebar along the left edge of Observatory’s library window.

  - **Library Navigator**

    Show the Library Navigator.

  - **Session Navigator**

    Show the Session Navigator.

  - **Target Navigator**

Show the Target Navigator.

- **Equipment Navigator**

  Show the Equipment Navigator.

- **Tag Navigator**

  Show the Tag Navigator.

- **Source Folders Navigator**

  Show the Source Folder Navigator.

- **Canvas**

  This submenu contains commands related to the Canvas in the center of Observatory's library window.

  - **Inverted**

    Display the image in the canvas with inverted colors.

  - **Show STF Panel** (⌘D)

    Show the detachable canvas STF panel.

  - **Show Overlay Panel** (⌥⌘D)

    Show the detachable canvas overlay panel.

  - **Show/Hide Canvas Header**

    Show or hide the canvas header.

  - **Go Back** (⌘[)

    Show the previous image of your browser selection in the canvas, wrapping around. Only enabled if you have more than one image selected in the browser.

    > The menu's title changes into "Slower" in animation mode. Choosing it will cut the animation's speed in half. The minimum animation speed is one frame every 16 seconds.

  - **Go Forward** (⌘])

    Show the next image of your browser selection in the canvas, wrapping around. Only enabled if you have more than one image selected in the browser.

    > The menu's title changes into "Faster" in animation mode. Choosing it will double the animation's speed. The maximum animation speed is 16 FPS.

  - **Play/Pause Animation** (⌘\)

    Loop through the images selected in the browser and display each in the canvas ("blinking"). The animation speed can be adjusted with the ⌘[and ⌘] keys.

- **Inspectors**

  This submenu contains commands related to the Inspectors along the right edge of Observatory's library window.

- **Show Activity**

  Show the detachable activity popover.

- **Show Integration Reports**

  Displays a summary of all lights for your targets, grouped by filter, and for each target additional details, grouping the light, dark, flat and bias images. Archived images are included in the report, but rejected images are not.

- **Show Tab Bar**

Show or hide the macOS tab bar on the current library window.

- **Show All Tabs** (`⇧⌘`)

  Switch to a view that displays thumbnail contents of each tab as a tile in the library window, or return to the standard full view.

- **Show/Hide Toolbar** (⌥⌘T)

  Show or hide the toolbar.

- **Customize Toolbar...**

  Choose which controls appear in the library window's toolbar.

- **Enter Fullscreen** (fnF)

  View Observatory at the full dimensions of your screen, or return it to a modest window.



The Album Menu

- **New Album** (⌘N)

  Create a new empty Album. If chosen while another album has been selected in the Library Navigator, the Album is created inside that album. To create an Album at the root level, select "All Images" first.

- **New Smart Album** (⇧⌘N)

  Create a new Smart Album and edit its criteria. If chosen while a folder has been selected in the Library Navigator, the Smart Album is created inside that folder. To create an Smart Album at the root level, select "All Images" first.

- **Edit...**

  Edit the name of an Album, or in case of a Smart Album, edit its criteria. You can also edit the name by clicking on it in the Library Navigator while the album is selected, or by using the Album Inspector.

  > Albums of the same type and at the same folder level, must have unique names.

- **Edit Note...** (⌘')

  Although you can add, view or edit an image or stack note using its corresponding inspector, it is more convenient to use the much bigger sheet that this menu item provides.

- **Attach File...**

  Choose a file to attach to the album or smart album that is currently selected in the Library Navigator.

- **Duplicate**

  Duplicate an Album or Smart Album. In case of an Album, all its images and Stacks are duplicated as well.

- **Add To Favorites**

  If you mark an album as a favorite, it will be added to the Favorites item in the Library Navigator. All images of an Album will implicitly be marked as favorite, including those you will add later to it. If you wish to mark a single image as favorite, you should choose **Image ▸ Add To Favorites** instead.

- **Remove From Favorites**

  Remove an album from the favorites item of the Library Navigator.

- **Move To Archive**

  Move an album to the Archive. This makes it invisible to Smart Albums and the Library Navigator search.

- **Move To Trash**

  Move an album to the Trash.

- **Put Back**

  Restore an album from the Archive or Trash.

The Stack Menu

A stack is set of images, all part of the same album. Usually these are images of the same object, or the same calibration image type, with the intend to combine them. Every stack has an associated “Stack Image”, which is the result of combining the images within the stack. To further process a Stack Image, one first has to create a Managed Master from it.

- **Stack** (^⌘S)

  Creates a stack of the selected images. The images all have to belong to the same album in order for you to stack them. Use this command to create master calibration images, or to combine images of the same object to improve the signal to noise ratio.

  The default type of stack created can be set in the General Settings. Images of type Flat and Light are automatically normalized. Images of type Light are automatically aligned as well. With the Stack Inspector these settings can be adjusted for each stack.

- **Unstack** (^⌘U)

  Unstack the selected images. They will remain part of the same album.

- **Pick** (^⌘8)

  Selects the pick image of the stack. The pick image is usually the most representative or best image of the stack, e.g. the sharpest one. It is referenced by some (if used) adjustments of other images in the same stack. Every stack has a pick. When a stack is created, or when you unstack a pick image, the earliest exposure in the stack is set as its pick image.

- **Accept** (^⌘1)

  Sets the weight of the selected images to 100 %.

- **Reject** (^⌘0)

  Sets the weight of the selected images to 0 %. If part of a stack, the image is ignored for the creation of the stack image.

- **Focus on Stack** (^⌘[)

  Focus the browser on the selected stack, revealing its sub-exposures.

- **Unfocus** (^⌘])

  Focus the browser on the currently focused stack’s album, or the parent of the currently focused album or smart album.

- **Select Stack** (^⌘L)

  With the browser focused on a stack, selects the resulting stack image.

- **Select Pick** (^⌘P)

  For a focused stack, selects the stack’s pick image.

- **Select Subs** (^⌘;)

  Selects the stack’s sub-exposures (all images that comprise the stack), except those that have been rejected.

  You typically choose this to quickly apply the same adjustments to each sub-exposure, and then check the results in the canvas using the Play/Pause toolbar button. You can inspect the final stacked image by choosing **Select Stack** (^⌘L).

The Image Menu

- **Type**

  Show or change the type of the selected images. Observatory automatically initializes the image type when importing images, but sometimes it may not be able to determine it. Therefore, after importing images, it is recommended to check and correct the image types for the newly imported images. Images can be filtered by type in the browser.

  The image type determines some of Observatory’s behavior. For example, master bias, dark and flat images are presented in the Calibrate adjustment for matching images, stacking dark frames creates a master dark, or when stacking light images they are automatically aligned and normalized.

- **Edit Note…** (⌘')

  Although you can add, view or edit an image or stack note using the inspector, it is more convenient to use the much bigger sheet that this menu item provides.

- **Resize Canvas…**

  When you import an image into Observatory, the canvas size of the image is the same as the image dimensions. When you apply adjustments to it, or when you combine images in a stack, you may wish to increase the canvas size by choosing this menu item.

- **Match…** (^⌘M)

  Displays a sheet to plate solve the selected images. Plate solving is a process to relate image pixels to sky coordinates. Observatory will use information from the selected images to set the initial values in this sheet.

  > If you press the option (⌥) key while selecting the **Image ▸ Match…** menu item, it will change into **Match With Master…** (^⌥⌘M). The initial value in the sheet will then not be based on the current image version, but on the master.

- **Blind Match…** (^⇧⌘M)

  Displays a sheet to plate solve the selected images. Plate solving is a process to relate image pixels to sky coordinates. Unlike the **Match** command it does not require an estimate of the image center and scale, but it does require an internet connection. It uses the services provided by https://astrometry.net.

  > If you press the option (⌥) key while selecting the **Image ▸ Blind Match…** menu item, it will change into **Blind Match With Master…** (^⌥⌘M). The matching will then not happen against the current image version, but on the master.

- **Unmatch**

  Remove the information that plate solving added from the image.

- **Reset…**

  Remove or replace tags, notes or metadata of the selected images. You would normally do this if your master image was changed by another application, or if you want to use a different magnitude limit for the automatically added tags of plate solved images.

- **Attach File…**

  Choose a file to attach to the selected images.

- **New**

  - **Version from Master**

    Creates a new image version from the master of the selected image. The new image is like a clean original, without any adjustments applied to it.

  - **Duplicate Version**

    Creates a duplicate version from the selected image version. It is an exact duplicate, except for its name.

  - **Master**

    Creates a new **Managed Master** from the selected image version or stack.

- **Show Sky Chart** (^⇧⌘C)

  Displays the sky chart in SkySafari centered on the coordinates of the selected matched image. This feature is turned off by default, and can be enabled in the General Settings. It requires SkySafari 6.1 or later.

  Note that SkySafari ignores the command if you have explicitly centered an object using “Center Selected Object” or the corresponding toolbar button. Click on another object in its sky chart or pan the chart before choosing **Show Sky Chart** in this case.

  Observatory will adjust the sky chart field of view to approximately match that of the image, but it is unable to control its orientation or flip it. Use SkySafari’s *Coordinates* and *Scope Display* panels to manually do this. SkySafari typically launches with your current time, and if the object you are viewing in Observatory is not currently visible, selecting **Show Sky Chart** may display the blue sky or an area below the horizon. To avoid this, in its *Horizon* panel, disable “Show Daylight” and set “Show Horizon & Sky as Transparent With Line”.

- **Focus on Album**

  Select the album the selected images are part of in the Library Navigator and browser.

- **Move To New Album**

Creates a new album and moves the currently selected images into this new album.

> If you press the option (⌥) key, the menu item will change into **Add To New Album**. Instead of moving the images into the newly created album, this will copy them instead.

- **Move To Album**

  Moves the selected images to another album.

  > If you press the option (⌥) key, the menu item will change into **Add To Album**. Instead of moving the images into the album, this will copy them instead.

- **Remove From Album**

  Removes the selected images from the currently selected Album in the Library Navigator. Removing an image from an Album moves it to the **Inbox**. If you want to remove it from the library, you should choose **Image ▸ Move To Trash**.

- **Add To Favorites**

  If you mark an image as a favorite, the Favorites item in the Library Navigator will displays the image's Album. Selecting it will only show its images you marked as favorite. If you wish to mark a whole Album as favorite, you should choose **Album ▸ Add To Favorites**.

- **Remove From Favorites**

  Unmark an image as a favorite.

- **Move To Trash** (⌘⌫)

  Moves an image to the Trash. It can be restored with **Image ▸ Put Back** as long as you didn't choose **File ▸ Empty Trash...**. Even if you empty the trash, this only applies to the references to the master image if it resides outside the library. Observatory will never remove images from the actual file system.

- **Put Back**

  Restores an image from the Trash. Images can be restored from the trash as long as you didn't choose **File ▸ Empty Trash...**. Even if you did, master images that reside outside the library will never be removed by Observatory.

- **Show Master FITS Header** (⌥⌘I)

  If the master of the current selection is a FITS file, then you can choose this menu item to view and search in its FITS header.

- **Show Master in Finder**

  Opens a Finder window with the folder in which the master image of the current selection resides, and select that master image. This menu item is not enabled for images that have a Managed Master, e.g. those that were downloaded using Virtual Observatory. If you wish to access those, you should choose **File ▸ Export ▸ Managed Master...** instead.

- **Open Master**

  Opens the master of the selected image version with the default application.

- **Open Master With**

  Opens the master of the selected image version with the chosen application.

- **Locate Master...**

  If Observatory lost track of your master image, choose this to point it to the correct location. Before doing this, it is usually better to check your Source Folders first, and use **File ▸ Import ▸ Locate Source Folder...** to locate moved Source Folders.

The Window Menu

When you have multiple library windows open in Observatory, use the Window menu to choose between them.

- **Minimize** (⌘M)

  Shrink the frontmost window down into the Dock.

- **Zoom**

  Switch the frontmost window between the biggest size possible and the last size you set.

- **Show Previous Tab** (^⇧⇥)

  macOS support grouping windows from the same application into a unified window with tabs for each document (similar to the tabs used by most web browsers). With multiple Observatory libraries sharing a window in this way, this command navigates to a previous tab in the row.

- **Show Next Tab** (^⇥)

  With multiple Observatory libraries sharing a window, this command navigates to the next tab in the row.

- **Move Tab to New Window**

  If an Observatory library is displayed as a tab in a window with others, this command detaches the document's tab into its own separate window.

- **Merge All Windows**

  Move all currently open Observatory library windows into a single window with the documents separated by tabs.

- **Image Persona** (`F1`)

  Hide the sidebar and show the Canvas in the library window. Select one or more images in the Browser beforehand.

  > To quickly switch to the Image Persona from the Library Persona, double click an image in the browser.

- **Library Persona** (`F2`)

  Show the sidebar and the browser.

- **Virtual Observatory Persona** (`F3`)

  Changes the center of Observatory's library window into that of the Virtual Observatory. Here you can search the vast online archives of astronomical images taken with the telescopes of professional observation sites. You can import them directly into Observatory.

  > If you press the option (⌥) key while selecting the **Virtual Observatory Persona** menu item and your currently selected image is plate solved, the Virtual Observatory will then use its center equatorial coordinates to initiate a search right away. This is handy way to search for images in the archives and your library that cover the same area as your current image.

- **Statistics Persona** (`F4`)

  Show the monthly session activity, filter and equipment usage, constellation coverage, and integration report for targets.

- **Open Canvas in New Window**

  Open the canvas in a separate window. If you have two monitors, this allows you to have the sidebar, browser and inspectors on one monitor, and the image canvas on the second. This option is only available for the Library Persona.

- **Show Console**

  Displays the Observatory Console window. It reports details about the tasks Observatory is executing, and their duration, as well as the measurements of the photometry tool.

- **Bring All to Front**

  Get all of the Observatory windows up in front of other applications' windows.

At the bottom of the Window menu is a list of all of your Observatory windows; choose one to bring it to the front.

The Help Menu

Access a variety of support resources using the Help menu in Observatory, including this documentation, release notes, and contact with our friendly Support Humans.

- **Search**

Search Help Topics in the User Guide and filter commands across all of Observatory's menus to find and select a specific command.

- **Observatory Help**

  View the Observatory User Guide.

- **Welcome...**

  Display the Welcome window.

- **News**

  See what's brewing at our headquarters.

- **Release Notes**

  View the Observatory release notes.

- **Forums**

  View the Code Obsession Forums on our website, where you can discuss the use of Observatory and related issues with us or other users.

  You can view discussions without subscribing. However, if you wish to post to a board, or receive new posts via email, you must join the forums first. To join, just visit its web page and choose the "Register" link.

  These forums are not official support channels. Anyone who encounters a problem with our software (or isn't sure if it's working correctly), or who would like to request a feature or enhancement, should contact tech support directly for assistance.

- **Service and Support**

  Visit the Observatory support page on the Code Obsession web site.

- **Contact Us**

  Compose an email to the humans among the Observatory team. We'd be happy to give advice, answer questions, or just listen to your feedback.



Glossary

The following is an alphabetical list of terms you'll encounter throughout the documentation, some of which may be unfamiliar or have special uses particular to Observatory.

- Astronomy
- Image Processing
- Observatory

Astronomy

- **2MASS**

  The Two Micron All-Sky Survey (2MASS) is a survey of the whole sky in three infrared wavebands around 2 micrometers.

- **Atmospheric Dispersion**

  In addition to refraction, light coming through the atmosphere suffers from dispersion, which results in different wavelengths of light being refracted by different amounts. Shorter wavelengths (e.g. blue) are refracted more and longer wavelengths (e.g. red) are refracted less, so the image of an object which suffers dispersion actually consists of a series of images, each of a different wavelength, slightly shifted relative to each other, with the shorter wavelength images at higher altitudes and the longer wavelength images at lower altitudes. Atmospheric dispersion is highest when objects are relatively low in the sky.

- **BSC**

  The Bright Star Catalog (BSC) contains 9096 stars brighter than magnitude 6.5. Observatory contains this catalog.

- **ESO**

  The European Southern Observatory (ESO) is a intergovernmental research organisation for astronomy. ESO has built and operated some of the largest and most technologically advanced telescopes. These include the New Technology Telescope (NTT), and the Very Large Telescope (VLT), which consists of four individual telescopes, each with a primary mirror 8.2 meter across, and four smaller auxiliary telescopes.

  Observatory can search and download images directly from the ESO Archive, including those obtained using the VLT (8.2 m),VST (2.6 m), VISTA (4.1 m), NTT (3.6 m) and the ESO 3.6 m telescope. If you have the right credentials, you can even download data that is still under the proprietary period.

- **DSS**

  The Digitized Sky Survey (DSS) is a digital version of several photographic atlases of the night sky.

  DSS has two generations. Observatory can search and download both DSS-I and DSS-II images.

- **Gaia Catalog**

  The Gaia catalog was created using the results obtained by the Gaia space telescope. Observatory contains the position and V, R, I magnitude information for stars in its Gaia DR2 catalog up to V magnitude 16. That's nearly 60 million stars. This can be extended up to V magnitude 20, for a total of over 800 million stars. Observatory uses this catalog for plate solving, overlays and photometry.

- **GOA**

  Gemini Observatory Archive. The Gemini Observatory consists of two 8.19 m telescopes, the Gemini North in Hawaii and the Gemini South in Chile.

- **HST**

  The Hubble Space Telescope (HST) is a space telescope that was launched into low Earth orbit in 1990, and remains in operation.

  Observatory can search and download images from the HST Mikulski Archive for Space Telescopes and Hubble Legacy Archive (HLA).

- **KOA**

  The W. M. Keck Observatory is a two-telescope astronomical observatory near the summit of Mauna Kea in the U.S. state of Hawaii. Both telescopes feature 10 m primary mirrors. Through the Keck Observatory Archive (KOA), Observatory provides access to the images obtained with the NIRC2 instrument.

- **Messier Catalog**

  The Messier objects are a small set of astronomical objects first listed by French astronomer Charles Messier in 1771.

  Observatory can overlay the objects in this catalog onto your images.

- **NED**

  The NASA/IPAC Extragalactic Database (NED) is an on-line astronomical database for astronomers that collates and cross-correlates astronomical information on extragalactic objects (galaxies, quasars, radio, x-ray and infrared sources, etc.).

  Observatory uses NED for its Virtual Observatory and Astrometric Matching.

- **NGC/IC Catalog**

  The New General Catalogue of Nebulae and Clusters of Stars (NGC) is a catalog of deep-sky objects compiled by John Louis Emil Dreyer in 1888. It contains 7,840 objects. Dreyer published two supplements, known as the Index Catalogues (IC). They contain a total of 5,386 objects.

  Observatory can overlay the objects in this catalog onto your images.

- **PGC2003 Catalog**

  This is a catalog containing 983,261 galaxies, all brighter than magnitude B~18. Observatory includes thePGC2003 catalog, and can overlay the objects in it onto your images.

- **PTF**

  Palomar Transient Factory Archive. A survey using the Palomar Samuel Oschin 1.22 m Schmidt Telescope.

  Observatory can search and download the level 1 images of this archive.

- **SDSS**

  The Sloan Digital Sky Survey (SDSS) is a multi-filter imaging and spectroscopic redshift survey using a dedicated 2.5 m wide-angle optical telescope.

  Observatory can search and download the imaging catalog data of Data Release 12 (DR12), which is the final data release of SDSS-III.

- **SHA**

  Spitzer Heritage Archive. The Spitzer Space Telescope is a 0.85 m NASA infrared-wavelength space telescope.

  Observatory can search and download the level 2 images of this archive.

- **SIMBAD**

  SIMBAD (the Set of Identifications, Measurements, and Bibliography for Astronomical Data) is an astronomical database of objects beyond the Solar System.

Observatory uses SIMBAD for its Virtual Observatory and Astrometric Matching.

- **SkyMapper Southern Sky Survey**

  Using a 1.3 m telescope at Siding Spring Observatory near Coonabarabran, Australia, the SkyMapper Southern Sky Survey is producing a digital record of the entire southern sky.

  Observatory can search and download Data Release 1.1 (DR1.1) images of this archive.

- **Tycho-2 Catalog**

  The Tycho-2 Catalog is a catalog of more than 2.5 million of the brightest stars. The catalog is 99% complete to magnitudes of $V_{11}.0$ and 90% complete to $V_{11}.5$. The Tycho-2 positions and magnitudes are based on the observations collected by the European Space Agency's Hipparcos satellite.

  Observatory includes this catalog.

- **WISE**

  Wide-field Infrared Survey Explorer. WISE is a 0.4 m NASA infrared-wavelength space telescope.

  Observatory can search and download the images of the WISE AllWISE Atlas.

- **ZTF**

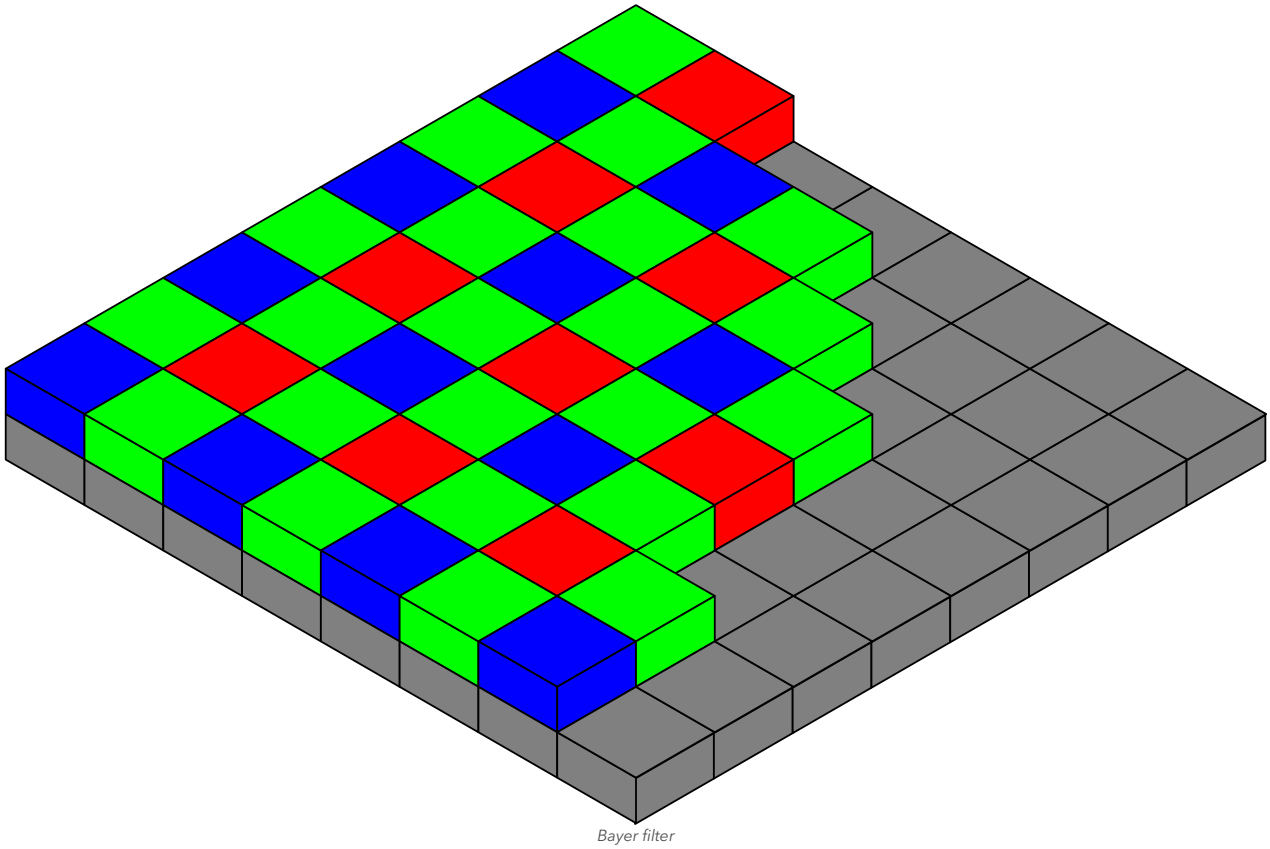
  Zwicky Transient Facility Archive. A survey using the Palomar Samuel Oschin 1.22 m Schmidt Telescope.

  Observatory can search and download images of this archive.

Image Processing

- **Bayer filter**

  A Bayer filter mosaic is a color filter array (CFA) for arranging RGB color filters on a square grid of photosensors. Its particular arrangement of color filters is used in most single-chip digital image sensors used in digital cameras to create a color image. The filter pattern is 50% green, 25% red and 25% blue, hence is also called BGGR, RGBG, GRGB, or RGGB.



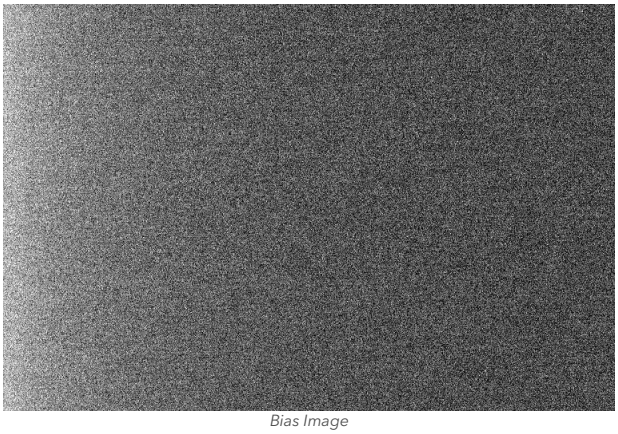
Bayer filter

- **Bias Frame**

  In addition to thermal noise, a CCD camera generates some noise due to its electronics that doesn't change with exposure time. A bias frame

records this noise.

The image below is a bias frame taken with a ST-7XE NABG camera cooled at -20 °C. On this camera, the shortest possible exposure is 0.11 seconds, not 0 seconds, but it will do for a bias frame.

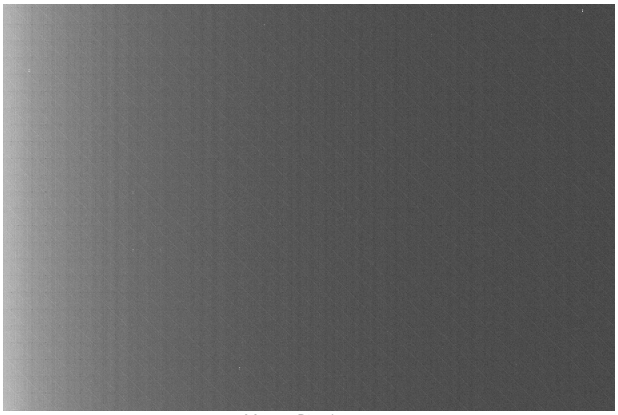


Bias Image

At first glance, you may think that this camera is defective. Let's take a closer look at this image:

- Although the image looks really noisy, it has very little noise in it. I have enhanced the contrast by setting the black and white points for displaying the image to 90 and 130 respectively. The very brightest pixel in the entire frame is 176 units, and the very darkest is 55 units. Since this camera produces 16 bit grayscale images with 65,536 available brightness levels, and it adds an offset of 100 to every pixel to prevent negative values from occurring due to noise, the overall average brightness value of 105 means that at this temperature the camera produces very little noise. The low-level mottling effect across the entire frame is very small.
- Another notable feature in this image is a gradient from left to right. The magnitude of the variations are very small, and this gradient is typical of many cameras. It occurs because of the time delay in reading across the chip. The pixels at left have a little more time to build up thermal noise, so they are brighter. The pixels at the left edge of the frame have an average value of 116. Pixels at the far right have an average value of 102. The gradient will occur in all frames, and is automatically dealt with when you reduce the images with dark, flat-field, and bias frames.

As with all calibration frames, you will normally not apply a single one to your images, but combine many into a master bias and use that for calibration. This is because calibration also introduces some noise from the calibration frames themselves, and by using master calibration frames you minimize that. An example is a median combination of the above and 199 other bias frames taken in the same sequence:



Master Bias Image

I have enhanced the contrast by using the same black and white points as before. Clearly the master bias is much less noisy than the single bias frame. You can now see a fine scale structure which is inherent to the CCD. You can also observe a few Hot Pixels.

- **Calibration**

  The process of applying dark, bias, and/or flat field frames to light frames.

- **Centroid**

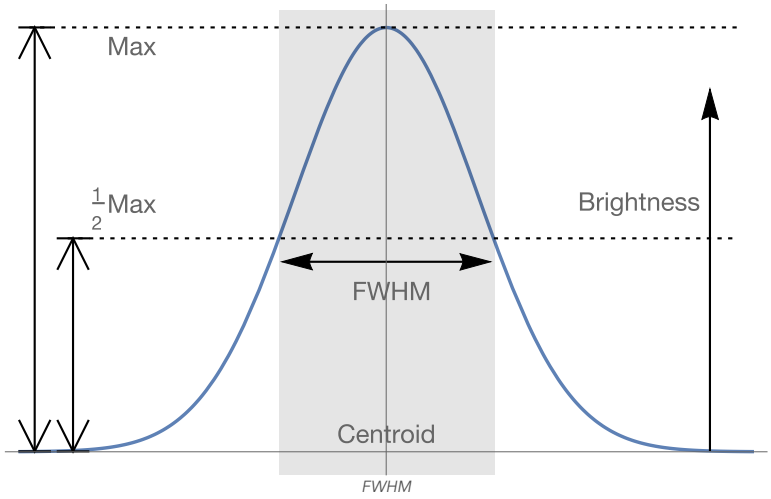
  A star's light is spread across several pixels by air turbulence and diffraction. The center is referred to as a centroid.

- **Dark Frame**

  Records the dark current (also called thermal current) that occurs during an exposure of a given duration and temperature. It is taken with the shutter closed. The dark frame is subtracted from the light frame of the same duration and temperature to remove the dark current. If the dark and light frame do not match in duration, a bias frame can be taken to scale the dark frame, and allow it to be applied to the light frame.

- **FWHM**

  The image of a star has a typical brightness profile as depicted below. The curve shows an idealized picture of the brightness levels of the pixels across a star image. With the brightest values at the top, this curve has most of the values falling near a central value (the centroid of the star image). There is no definite edge, but the Full Width at Half Maximum (FWHM) is a way to characterize the width of the star image. To find the FWHM, take the highest value, divide it by two, and measure the distance across the curve at that point.



- **Hot Pixel**

  A bright pixel in an image caused by a pixel sensor with a higher than normal dark current.

- **Flat Frame**

  An image which records the optical issues of your telescope and camera. Typically, the flat records vignetting as well as shadows from dust motes on your CCD and filters. By applying a flat frame, most of these optical issues can be cleaned up in your images.

- **Light Frame**

  Also called an image. Taken with the shutter open.

Observatory

- **Adjustment**

  An Adjustment is a nondestructive operation applied to an image. The image itself is not modified.

- **Album**

  A type of container in the Observatory library that may contain images and stacks of images. Albums can be nested.

- **Badge**

  A small icon Observatory places on an image in the browser to indicate that an adjustment, tag, or other change has been applied to it.

- **Browser**

  The part of the Observatory interface that displays the contents of the currently selected album and its child albums.

- **Canvas**

  An area in Observatory that displays the image currently selected in the Browser.

- **Focus**

  See Primary Selection.

- **Folder Format**

  A naming convention that you can apply to destination folders when images are exported. Observatory provides a number of preset folder formats, and you can also create and save your own custom folder formats.

- **Image**

  See Image Version.

- **Image Version**

  An image you see and change in Observatory is called a Version. Versions are based on the original master, and you can change, copy, and adjust them any way you want. In Observatory, only versions are ever changed. The masters are never touched. A Version is like a recipe that is applied to its Master. It is a representation of the Master.

  Throughout Observatory and its documentation the term “Image” and “Version” actually is short for “Image Version”. Unlike a Master, a Version typically doesn’t take up much disk space.

- **Library**

  In Observatory, a container file that holds albums with images. The masters of these images may reside inside as well as outside this container file. You can have multiple libraries.

- **Managed Master**

  A master that is stored inside the Observatory library itself. After its creation, it is never modified. Any changes to an image based on a managed master are applied to a Version of the master. A managed master has no corresponding source folder. Unlike regular masters, a managed master is permanently removed if all its versions are removed.

  You can export a Managed Master that was created by the Virtual Observatory by choosing**File ▸ Export ▸ Managed Master...**. This exports the original downloaded file.

  You can also create a Managed Master from an existing image or stack by choosing**Image ▸ New ▸ Master...**. You would typically only do this for a stack. You cannot export such kind of Managed Master though, only a Version of it.

- **Master**

  The source image that is referenced by Observatory. The master is never modified, so that the original image is preserved and can be used again. Anytime a change is made to the image, that change is applied to a Version of the master.

  When you import an image from your file system, it is not copied into the library, but a reference to it is stored in the library. Only when you download an image using the Virtual Observatory, it is copied into the library. The latter is named a Managed Master.

- **Master Version**

  Immutable Version of the master image. It always exists if a master exists, but doesn’t count towards the number of versions of a master.

- **Match**

  In Observatory, if an image is plate solved, or Matched, it can relate its image pixels to actual sky coordinates. For this it needs to know the center equatorial coordinates of the image, the projection used, and the transformation matrix. Observatory currently only supports Gnomonic (tangent plane, TAN) projections for Astrometric Matching.

  Masters may already contain all required information. For images that do not contain this information, Observatory can add it by choosing**Image ▸ Match...**. To make best use of all Observatory’s features, it is recommended to plate solve all images, except those that are for calibration only.

- **Name Format**

  A naming convention that you can apply to images as they areexported. Observatory provides a number of preset name formats, and you can also create and save your own custom name formats.

- **Offline**

  Images whose masters are currently unavailable to Observatory. Offline images appear in the Browser with a warning badge. Observatory currently does not support an offline workflow.

- **Pick**

  A single image in a Stack that is referenced by adjustments of other images in the same stack. It is usually the most representative or best image of the stack, e.g. the sharpest one. Every stack has a Pick.

- **Primary Selection**

  The most important image in an image selection. The image in focus in the canvas. The primary selection is identified by a thicker blue border. There can only be one primary selection in an image selection.

- **Rating**

  In Observatory, the process of adding a value to an image to indicate its quality in relation to other images in a selection.

- **Smart Album**

  Dynamic album in Observatory used to organize images by gathering them based on search criteria. Smart albums cannot be nested. To learn more about Smart Albums, see Using Smart Albums.

- **Source Folder**

  A source folder represents a folder in the file system, outside of the Observatory library. Because the macOS Sandbox restricts access to the file system, you need to explicitly give Observatory permission to access the folders in which your images reside. Neither these folders, nor their contents, is ever modified by Observatory.

- **Stack**

  A set of images, all part of the same album. Usually these are images of the same object, or the same calibration image type, with the intend to combine them. Every stack has an associated "Stack Image", which has no master, but is the result of combining the images within the stack.

  Creating a stack does not alter the original images. Use this to create master calibration images, or to combine images of the same object to reduce noise.

- **STF**

  The Screen Transfer Function (STF) is a histogram transformation Observatory applies to an image before rendering it in the canvas. The image itself is not modified. It can be configured in the Display Panel.

- **Tag**

  A descriptive word about the subject in an album or image. Albums and images can have multiple tags, some of which are automatically added by Observatory.

- **Version**

  See Image Version.



FAQs

Does Observatory use a single library like Photos or iTunes?

No. An Observatory library is treated as a document. You can create as many different libraries as you wish, and have multiple open at the same time. You can even create temporary libraries which you do not explicitly save to disk, but discard after use.

When importing images into a new library, does Observatory copy all images?

No. Importing only copies the metadata of the images into the library. The library contains links to your images.

Can I rename image files or move them after I have imported them into a library?

Yes. As long as you do not move your files to another disk, you can rename and move them without breaking the links. And even if you do break the link, it is easy to restore it from within Observatory.

If I import the same folder twice, will this result in duplicate images?

No. During importing, Observatory computes an SHA1 hash of each image file and stores it along its metadata. This slows down importing, but ensures that you will never end up with duplicates, even if you rename or move images between imports.

What's inside an Observatory library?

An Observatory library is a document package – an ordinary folder that is presented by macOS Finder as a single file. Read the What's in a Library article to learn more about Observatory Libraries.

Does Observatory support the images of my camera?

Observatory supports FITS, XISF (PixInsight), SBIG, DNG, NEF, CR2, TIFF, JPG, and many more image formats. It uses the system-level support for RAW images provided by macOS. The list of supported cameras can be found here:

- https://support.apple.com/en-us/HT211241 (macOS 11 Big Sur)
- https://support.apple.com/en-bh/HT212821 (macOS 12 Monterey)
- https://support.apple.com/en-us/HT213267 (macOS 13 Ventura)
- https://support.apple.com/en-us/HT213775 (macOS 14 Sonoma)
- https://support.apple.com/en-us/120534 (macOS 15 Sequoia)
- https://support.apple.com/en-us/122870 (macOS 26 Tahoe)

We cannot guarantee that these lists are up to date or correct though. If you are concerned whether it will support your files, then please try the demo or contact us before purchasing Observatory. Please refrain from sending images by email, but share one or more with us using for example iCloud Drive.

What are the software and hardware requirements for Observatory?

Observatory requires a 64-bit processor and macOS 11 (Big Sur), macOS 12 (Monterey), macOS 13 (Ventura), macOS 14 (Sonoma), macOS 15 (Sequoia) or macOS 26 (Tahoe). A minimum of 8 GB RAM is required, and a SSD is highly recommended. Observatory is a macOS Universal app, which can run natively on both Apple silicon and Intel-based Mac computers.

How do I uninstall the Observatory Demo application?

After purchasing *Observatory* it is recommended to remove the demo application. Just drag*ObservatoryDemo* from your *Downloads* folder to the trash and empty it.

The following step is optional and at your own risk:

In Finder, choose **Go ▸ Go to Folder...**, enter `~/Library/Containers` and click *Go*. From the new Finder window that will open, drag the folder `com.codeobsession.ObservatoryDemo` to the trash. *Do not remove anything else from this folder!*

Does Observatory take care of all my image processing needs, including stacking video clips of planets?

Observatory is not a full featured image processing application, but it does support limited preprocessing to help you better organize your library. Basic image calibration, registration, stacking and adjusting images is supported, all nondestructively, without creating any intermediate files or modifying your master images.

Is the documentation available as a PDF?

For reading the documentation offline you can download a PDF version of this user manual at https://codeobsession.com/files/Observatory%20User%20Guide.pdf.

⇪

What's in a Library



Observatory Library

An Observatory library is a document package – an ordinary folder that is presented by macOS Finder as a single file. To gain a better understanding of what Observatory does with your images, lets take a high-level look at what is inside a library.

A library may contain the following folders:

- **Attachments**

  Observatory allows you to attach files to images and albums. You can for example attach an observation log or research paper to an album, to quickly look into or open it while working in Observatory. Usually you would link the attachments, but you can also decide to embed them in the library, in which case they end up here.

- **Notes**

  This folder contains the notes of your images and albums. These notes are extracted automatically from your images when you import them (e.g. FITS `COMMENT` and `HISTORY` keywords), but you can also add your own.

- **StoreContent**

  This folder contains the main database of an Observatory library.

- **Masters**

  This folder contains the original files you downloaded using Virtual Observatory as well as the managed masters you created when choosing **Image ▸ New ▸ Master**.

  After they have been created, none of these files will ever be altered. Only if no image version refers it they are deleted. They are off-limits for the **Image ▸ Show Master in Finder** and **Image ▸ Open Master** menu items. You need to choose one of the**File ▸ Export** menu items if you wish direct access to these files. This is by design, because by enforcing immutability, Time Machine integration is much more space efficient, and you can be certain that data obtained through Virtual Observatory is unaltered.

- **Versions**

  This folder contains many small (~ 1 KB) files, one for each image version, that contain metadata. They are usually accompanied by a few helper files.

When you import an image into a library, Observatory doesn't copy the image, but extracts the metadata (dimensions, exposure date/time, exposure duration, etc), normalizes it, and stores it in the library's database. It does this for many different types of images, including FITS, XISF (PixInsight), SBIG, DNG, NEF, CR2, TIFF, JPG, etc.

It stores this original normalized data, but also creates a first "version" of it, which is what you see and can edit in the Inspectors.

Key is that it doesn't copy the actual pixel data of the image. It only maintains a reference to the original file. This master image is not copied, moved, or altered. It remains external to the library. The file reference is stored such that renaming or moving the master file on the same disk will usually not break the link. And if the link is broken, then you can choose **Image ▸ Locate Master…** to fix it.

Copying a version also doesn't copy the master image, but only the much smaller metadata. It is therefore a very efficient operation. Changes applied to an image always are applied to a version. For example, if you rotate an image in Observatory, it doesn't actually rotate the master image, but only adds a "prescription" to the image version.

This approach means that you can for example create one -90° rotated version of a master image, and other +90° rotated version of the same master image, and it would barely use any additional disk space.

The main difference between a master image and a managed master image, is that the former lives outside the library, while the latter is stored inside the library. A second difference of course is that a managed master cannot be altered, but by using an external editor you *can* alter a regular master. Observatory does detect if you do alter a master, and allows you to quickly synchronize the metadata using **Image ▸ Reset…**.

