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Introduction

Welcome to the Cahall Observatory!

Thayer Academy's state-of-the-art observatory has recently been updated to include a motorized, computer-controlled dome and telescope mount, as well as a large-format CCD imaging camera. The system is fully connected to the school's network, and is accessible via the Internet from anywhere in the world.

The purchase and installation of the system was made possible by a grant from Edward E. Ford Foundation to the Academy's science department specifically earmarked for the cause. Installation was complicated and took a considerable amount of time and effort by the project's main supporters: physics teacher and astronomy enthusiast Jamie Formato and science department head, physics teacher, astronomy teacher, and general science guru Don Donovan.
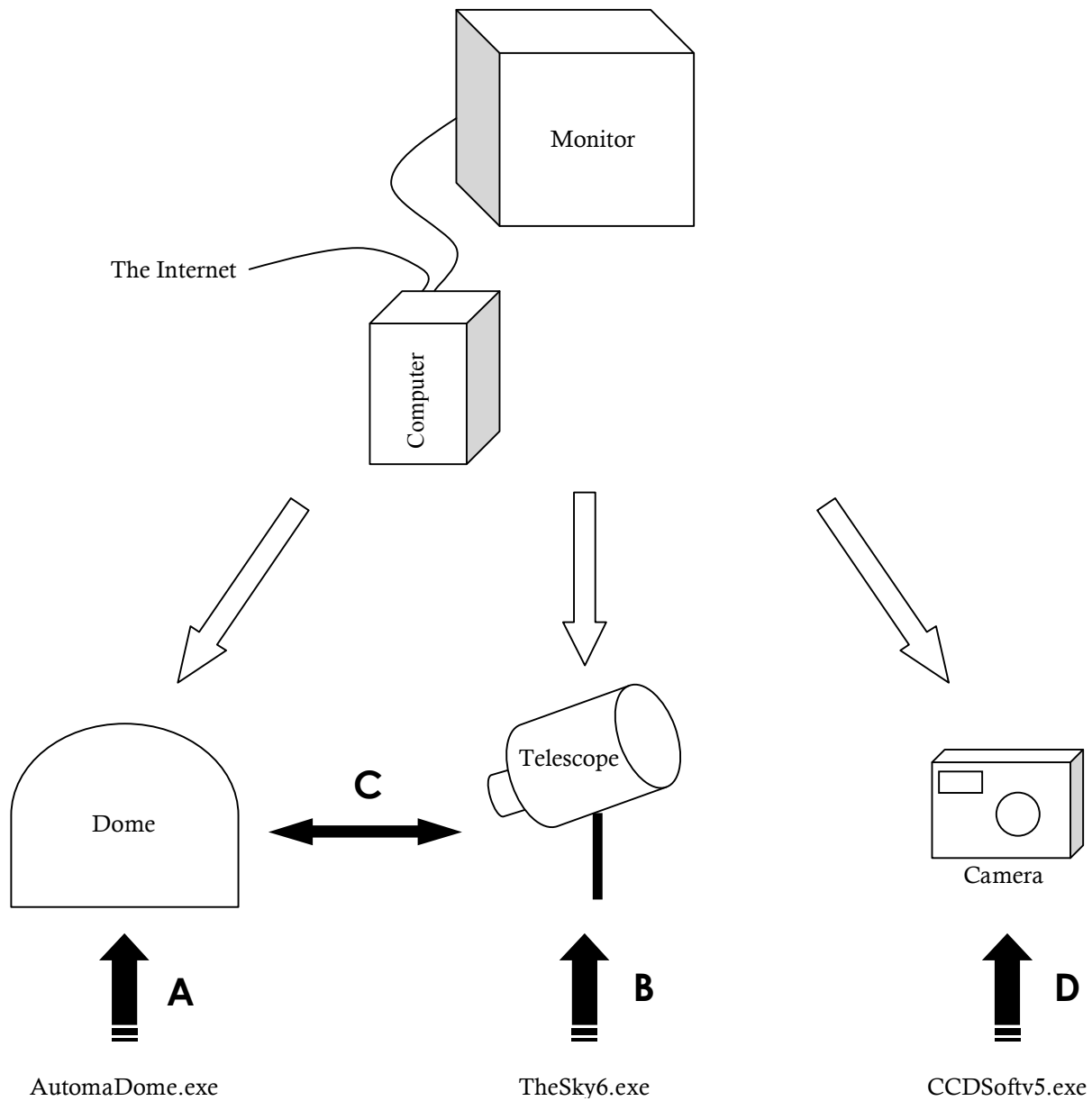
For the end of school year 2006-2007, Mr. Formato proposed a senior project trip to the New Mexico Skies Guest Observatory in Mayhill, NM. We were interested in the project, but had little experience with astronomy. We approached Mr. Formato about possible options for the project, and, knowing our interest and background in information technology, he mentioned the option of creating a manual for the newly installed system. Faced with the opportunity to leave our mark on Thayer and to help future generations of astronomers use the system, we eagerly began work on the manual.

What we found before we could begin the manual, however, was that we not only had to become acquainted with the system; we also had to make it work. All the systems were installed and in place, but many were not functioning to capacity. Feeling that it would be pointless to write a manual about a partially functioning system, we began a long debugging process. Thus, by the time we completed this manual, the Browser Astronomy component was up and running, as was the rest of the system.

Manuals should be easy to read, easy to navigate, and easy to understand. They should keep in mind and cater to their target audience. What we have come up with in *Cahall Observatory: The Definitive Manual* keeps you, the astronomy student, in mind, and we hope that it will prove useful as you continue to study astronomy through imaging.

An Overview of the System

This brief technical introduction to the system as a whole is intended as a supplement to the step-by-step instructions that more fully explains the connections you will be making. As an observatory user, you do not need to understand this entire explanation.

Monitor

The Internet

Computer

Dome

C

Telescope

Camera

A

AutomaDome.exe

B

TheSky6.exe

D

CCDSoftv5.exe

Link **A**

In the first connection you will make, the AutomaDome.exe application begins talking to the dome. The dome and the computer will continue talking throughout everything you do at the observatory; in addition to being the first connection you make, it is the last one you will remove

A.1.: "Home" the Dome

When you click "Find Home" in either TheSky6's Dome Controller or AutomaDome, the dome mechanism will rotate until it finds its home. The dome recognizes its home position through encodings on the gears that turn the apparatus.

Link **B**

The second connection you will make will be between the planetarium application (TheSky6.exe) and the telescope (or, more specifically, the robotic telescope mount). TheSky6 can move the telescope to point it at objects stored in the database, and will automatically track the object as it moves through the sky.

Link **C**

To make everything work together, this link is crucial. Link C illustrates the interoperability of TheSky6 and AutomaDome by linking the two applications together. This link between the applications enables TheSky6 to tell the dome to follow the telescope

Link **D**

The final connection to be made is the one between the camera software (CCDSoftv5.exe) and the camera itself. The camera software is permanently connected to the planetarium software; that connection never needs to be established. The camera software can control exposure lengths, filters, and cooling, among other camera features.

Letters corresponding to these four links are placed throughout the *Initial Setup* and *Closing Up* sections.

Initial Setup of the Telescope System
(In The Dome)

Once the computer is turned on:

1. Log In:
   ‣ Username: **Administrator**
   ‣ Password: **c0bs06** (the 0's are numbers, not letters)

! On the right side of the observatory computer's desktop are three icons: AutomaDome, TheSky6, and CCDSoft. They are lined up as pictured to the left.

2. Connect the AutomaDome software to the dome:
   ‣ On the desktop, double click the "AutomaDome" icon.
   ‣ Click on the "Dome" menu of the window that pops up.
   ‣ Point to "Link."
   ‣ Click "Establish."
     A You have just linked the computer to the dome.
   ‣ Minimize the window.
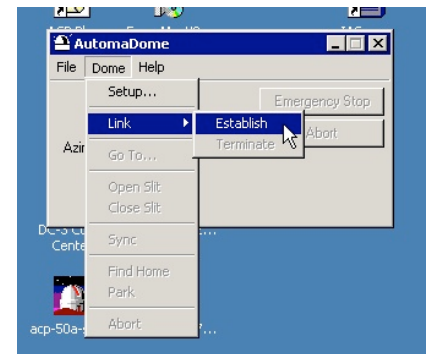
3. Connect the planetarium software (TheSky6) to the telescope:
   ‣ On the desktop, double click the "TheSky6" icon.
   ‣ Click on the "Telescope" menu of the window that pops up.
   ‣ Point to "Link."
   ‣ Click "Establish."
     B You have just linked the computer to the telescope.
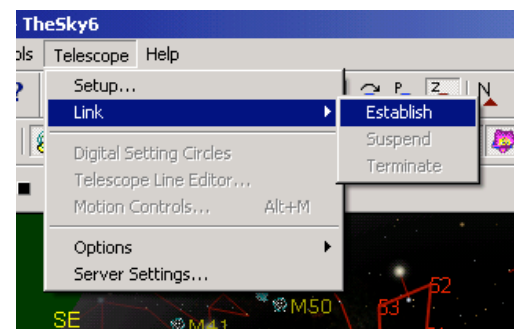
4. Connect the planetarium software to the dome:
   ‣ Hit *D* on the keyboard to bring up the "Dome Controller" window.
   ‣ Click the "Dome" menu of that window.
   ‣ Point to "Link."

Cahall Observatory: The Definitive Manual
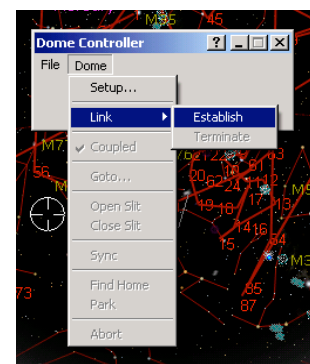
▸ Click "Establish."

C You have just linked the telescope to the dome

▸ Minimize the "Dome Controller" window.

5. "Home" the telescope and the dome:

▸ Click on the "Telescope" menu of the "TheSky6" window.

▸ Point to "Options."

▸ Click "Find Home."

A.1. You have just moved the telescope and the dome to their predetermined, safe, home positions.

▸ Minimize the window.
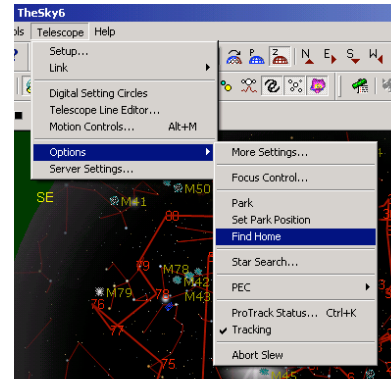
6. Connect the imaging software (CCDSoft) to the camera:

▸ On the desktop, double click the "CCDSoft" icon.

▸ Click on the "Camera" menu of the window that pops up.

▸ Click "Setup"

▸ Click "Connect" on the right side of the window that pops up.

D You have just linked the computer to the camera.
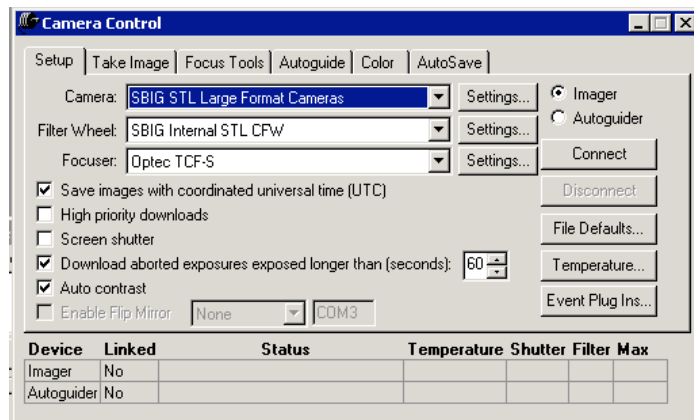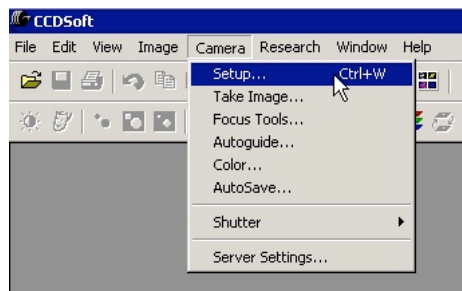
7. Turn on the temperature control for the camera:

▸ Click on the "Temperature" button of the "Camera Control" window.

▸ Check "On."

▸ In the box indicated as "Temperature Setpoint (°C):" replace -5.00 with -20.0.

▸ Check "Fan on."

▸ Click "OK."

▪ This will reduce the temperature to -20.0°C, which will reduce electronic noise in the image.

Cahall Observatory: The Definitive Manual
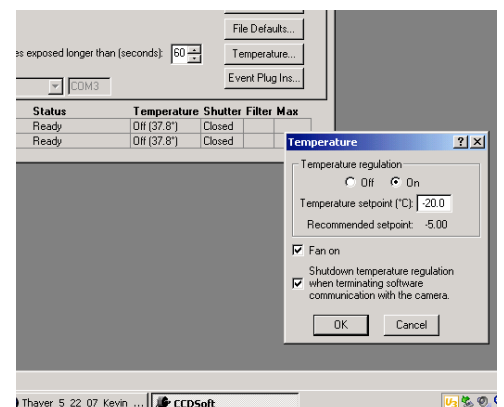
8. Open the dome's slit:
   ‣ Click on the minimized AutomaDome window.
   ‣ Click on the "Dome" menu.
   ‣ Click "Open Slit."
     ▪ The dome takes about two minutes to open. AutomaDome will read "Open Complete. Error = 0(0)" when the dome opens correctly.
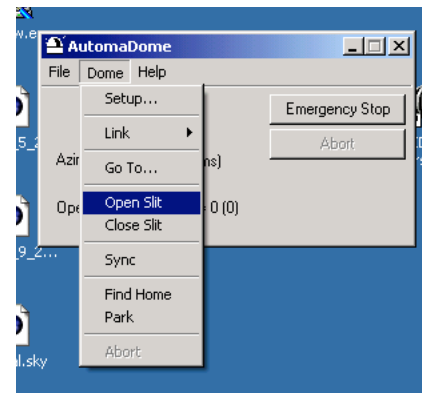
! If anything other than "Error = 0(0)" appears, contact either Mr. Formato or Mr. Donovan.

The observatory is now ready for use.

Pointing the Telescope Assembly

Once the system is ready to go, you may slew the telescope to any object in the sky. The telescope we have is a Meade LX200 12" SCT on a Paramount ME robotic mount. TheSky6 shows which objects are up at a given time, and controls the telescope's position.

Picking an Object

There are a few ways to choose an object to look at. TheSky6 allows you to click on an object in the planetarium view, search for an object by its common or astronomical name and navigate a list of objects in the database. All three ways get to the same end result. What you know of the object you wish to search will determine your search method.

Method 1: Click an Object
  ‣ This is the easiest method of object selection. If the object you want to look at is up and visible in TheSky6's view:
    ▪ Click on the object you would like slew to.
    ▪ The "Object Information " window will appear. At the bottom of that window, simply click "Slew" to point the telescope at the object.
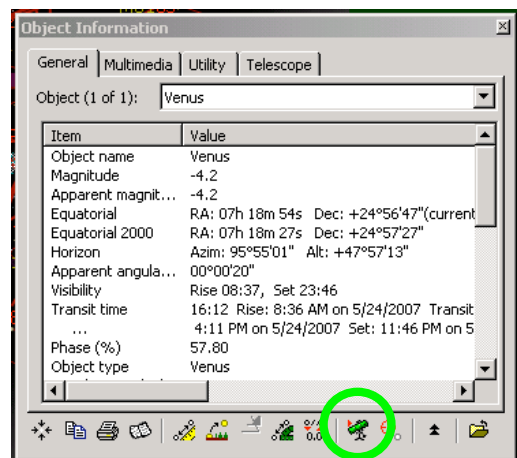
NEVER slew to objects within the red and purple band across the meridian in TheSky6s view. Doing so will move the telescope to a mechanically unstable position, and damage the mount.

Method 2: Search by Common or Astronomical Name
  ‣ To bring up the "Find" window:
    ▪ Hit *F* on the keyboard.
    ▪ The window contains a text field at the bottom in which you may type an object's full or partial common name or its astronomical name.
      • **For example**, you may search for either "sombrero galaxy" or "M104" to find the same object.
    ▪ Clicking "Find" (or hitting Enter on the keyboard) will bring up the "Object Information" window (pictured above) for that object. Click "Slew" to point to the object.
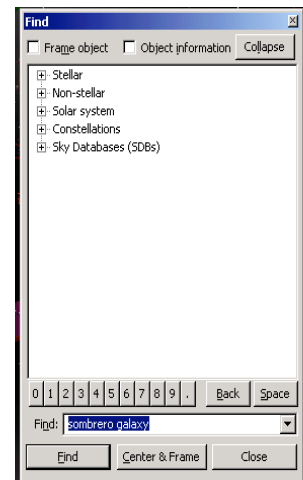
Method 3: Navigate the Database

- Hit *F* on the keyboard.
- As pictured above, you will see a list of object types: Stellar, Non-stellar, Solar system, Constellations, and Sky Databases (SDBs). Click the "+" sign next to an object type to pull down a list of categories.
- Search through the categories to find an object of interest, and click the object.
- Then click "Find".
- This will bring up the "Object Information" window. Click "Slew" to point to the object.
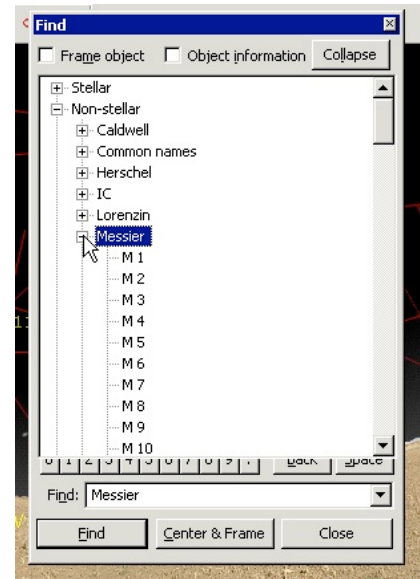
Acquiring Images

The goal of the observatory equipment, beyond simply visual observing, is to take pictures for research and display. The camera on our telescope is a SBIG (Santa Barbara Instrument Group) STL-11000 Large Format CCD Camera. Though the images you take will eventually end up in color, the camera itself only takes pictures in monochrome (shaded black and white). In order to end up with a color image, you will use the camera's filters, take monochrome images, and lay them on top of each other. The camera has a wheel inside that can rotate eight filters in front of the lens. We have five installed, of which you will commonly use four: red, green, blue, and luminance. You will select the desired filter in CCDSoft.

Coupled with our Meade LX200 12" SCT telescope, which has a focal length of just over 3000mm, the camera has a high resolution (just over half an arcsecond per pixel). However, since our skies are not dark enough to achieve that resolution, the pixels are treated as "bins" and taken three by three to let in the same amount of light. With the "binning" method we get the highest resolution possible with our sky.

1. Select the filter:
   In the "Take Image" tab of CCDSoft's "Camera Control" window:
   ▸ Click the drop-down menu next to the word "Filter:"
   ▸ Select your filter of choice for this exposure.
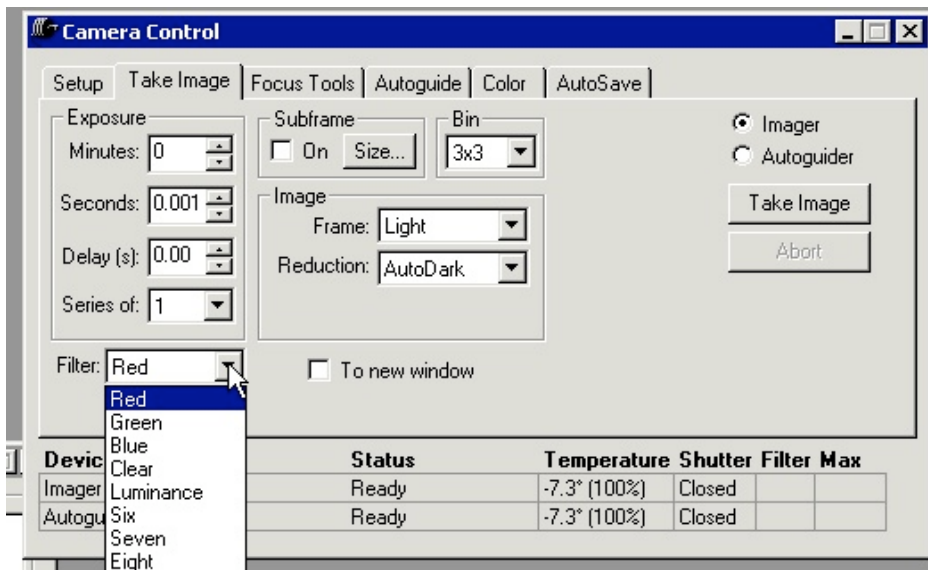
2. Set the exposure length:
   Still in the "Take Image" tab:
   ▸ Type in an exposure length. What you choose for exposure lengths will depend on the darkness of the sky and the brightness of the object.
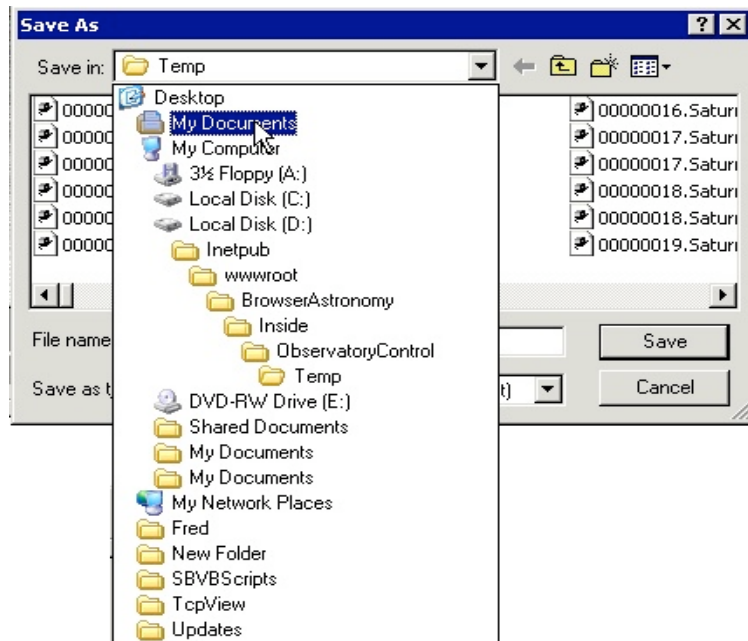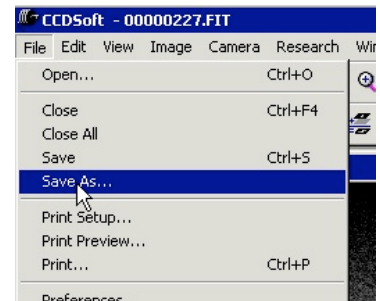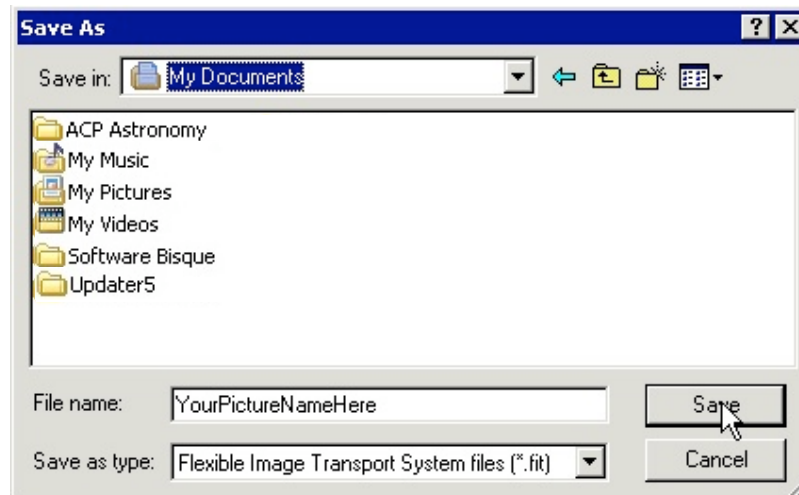
3. Click "Take Image."

4. Save the Image:

After taking a picture:

▸ Click on the picture.
▸ Click on the "File" menu of the CCDSoft window.
▸ Click "Save As…"
▸ Click on the "Save In:" drop-down menu
▸ Click "My Documents."

▸ If desired, create a new folder by clicking this icon:
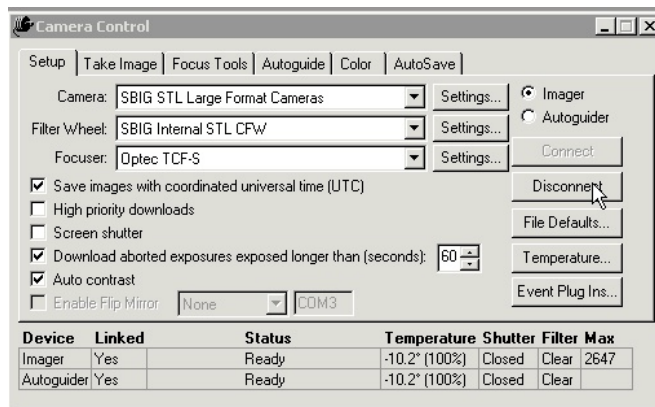▸ Type in the desired file name in the "Save As:" box.
▸ Click "Save."

Closing Up

After you have finished taking your pictures, you must de-link all the systems. You will notice that the procedure is almost the reverse of the initial setup.

1. De-Link the Computer and the Camera:
    ▸ Pull up the CCDSoft window.
    ▸ In the "Camera Control" window, select the "Setup" tab.
    ▸ Click "Temperature."
    ▸ Uncheck the "Fan On" box.
    ▸ Click the word "Off."
    ▸ Click the "OK" button.
    ▸ Again, in the "Camera Control" window, click "Disconnect."
       D You just de-linked the computer from the camera.
    ▸ Click the "File" menu.
    ▸ Click the "Exit."
2. De-Link the Telescope and the Dome:
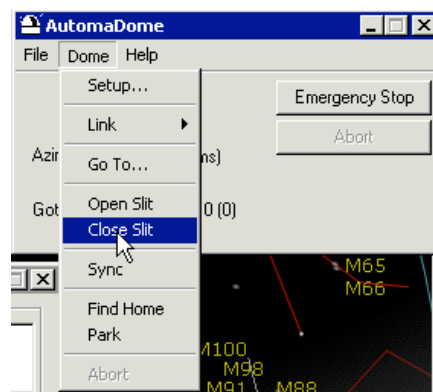   ▸ Pull up the "TheSky6" window.
    ▸ Pull up the "Dome Controller" window.
    ▸ Click on the "Dome" menu.
    ▸ Point to "Link."
    ▸ Click "Terminate."
       C You just de-linked the telescope from the dome.
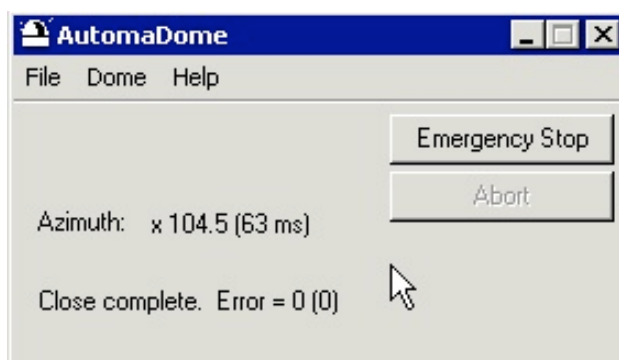   ▸ Click the "File" menu.
    ▸ Click "Exit."
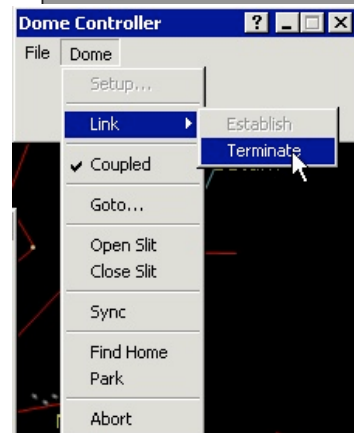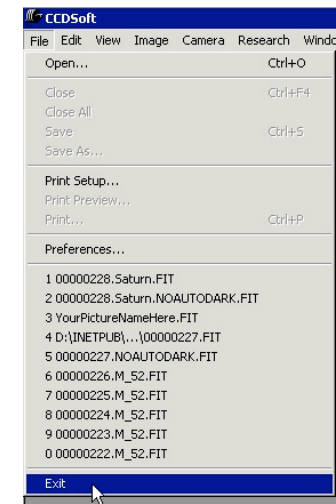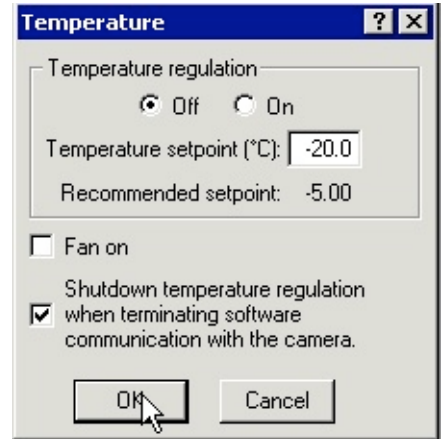
3. Close the Dome's Slit:
   ‣ Pull up the "AutomaDome" window.
   ‣ Click on the "Dome" menu.
   ‣ Click "Close Slit"
     ▪ The dome takes about two minutes to close. AutomaDome will read "Close Complete. Error = 0(0)" when the dome closes correctly.

! **If anything other than "Error = 0(0)" appears, contact either Mr. Formato or Mr. Donovan.**
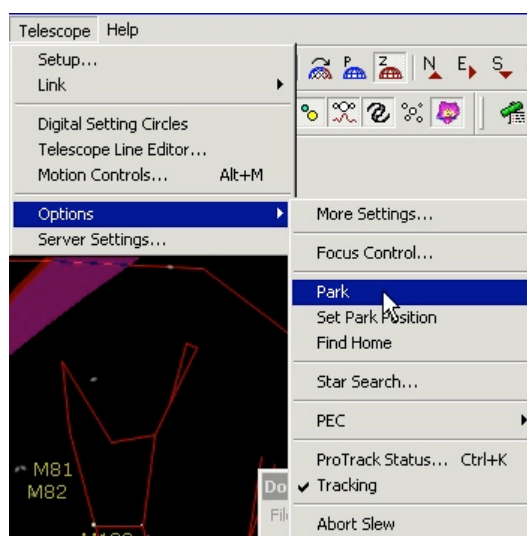
4. Park the Telescope and De-Link the Telescope and the Computer:
   ‣ Pull up the "TheSky6" window.
   ‣ Click the "Telescope" menu.
   ‣ Point to "Options".
   ‣ Click Park.
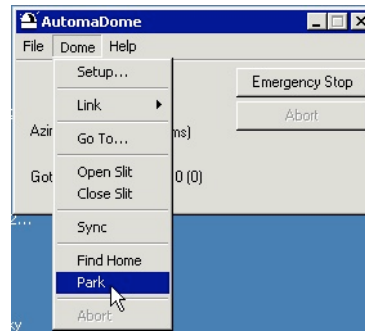   ‣ A window will pop up; when it closes, the telescope will be in its parked position.

   B You just de-linked the computer from the telescope.
   ‣ Click the "File" menu.
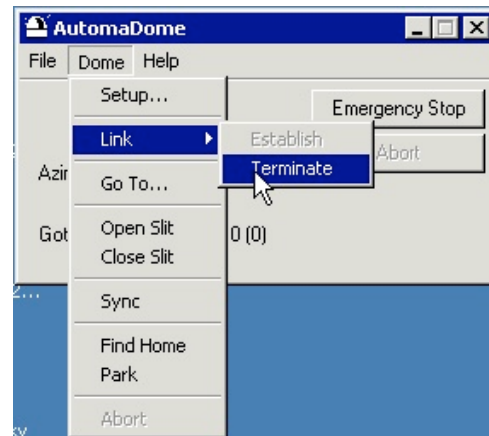   ‣ Click "Exit."

5. Park the Dome
   ‣ Pull up the "AutomaDome" window.
   ‣ Click the "Dome" menu.
   ‣ Click "Park".
     ▪ This will move the dome to its parked position, but will NOT de-link the computer from the dome.

6. De-Link the Computer and the Dome:
   ‣ Click the "Dome" menu, again.
   ‣ Point to "Link."
   ‣ Click "Terminate."
        You have just de-linked
     A the computer from the dome.

One of the most important features of our observatory setup is the ability to access the system remotely—both from computers on campus and from personal computers at home. You will access TheSky6, slew the telescope, and control the camera via your internet browser (Internet Explorer, Firefox, Safari, etc.).

Before you start using the observatory's robotic telescope, you should have an idea of what you would like to accomplish during your observing session. For instance, say you wish to take images of the M57, M31 and M45. What times are they visible? What do you want your exposure times to be? Will you be imaging in color or grayscale?

When planning your observing session, keep in mind that the best results will be achieved if you look west/southwest due to light pollution from campus and from Boston; you are welcome however to point the telescope anywhere in the sky (except the meridian). Note that because of the windscreen on the dome, you cannot image below an altitude of 30 degrees. If you point the camera at the windscreen and take an image, the image will appear as noise.

You must have registered for an account at the observatory before you can be scheduled for a session. When you have decided on your goals for an imaging session, contact Mr. Formato with this information. Please specify the hours that you wish to use the observatory, and try to be as flexible as possible so as to accommodate the weather. You will receive an email shortly before your session is scheduled to begin letting you know the status of the dome and camera. Please note that internet users cannot open the dome or link the camera; this will be done by Mr. Formato before your session begins. When you are finished with your session, please email Mr. Formato with a brief note telling him that you are done.

How to Use Browser Astronomy

1. Register/Log in.
   ‣ Open your web browser and go to http://www.thayer.org/observatory
   ‣ If it's the first time you log into the system, you will need to create a username and password. To do so, click the blue "Register" link.
   ‣ Enter your name, an email address that you can check, a username, and a password, and click submit. In the future, you will use the username you just created to log in when scheduled.

▸ Return to the main login page by clicking the "Login" button.

▸ Enter your username and password on the page and click submit.

2. Point the telescope

▸ When you first log in, you will see a window that looks like a section of TheSky6's window. You can move the window around using the buttons at the bottom.

▸ The white rectangle shows the dome's field of view. It will move with the telescope.

▸ To slew to an object, you must type the object's name in the box next to "Object Name (e.g. "M101"):" and click the "Slew To" button.
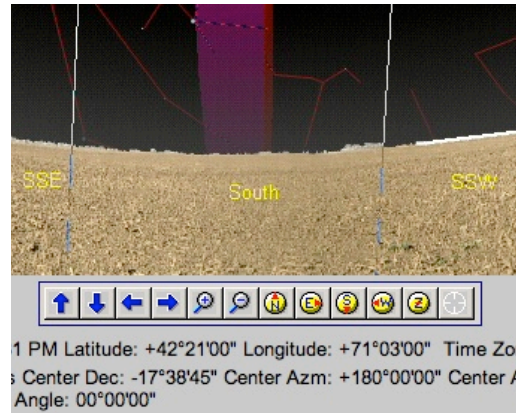
‣ When you slew the telescope, you will get a page that gives you the progress of the slew and tells you when the slew is complete. You will then be directed back to the main page.

! Note: Unlike TheSky6, the sky chart in Browser Astronomy is not interactive; in other words, nothing happens if you click on it.

3. Confirm camera settings
    ‣ To reach the camera settings page, scroll to the bottom of the main page and click the "Camera Settings" link.
    ‣ The resulting page will provide you options to change the filters and reduction type, among other settings. You will use this page mostly to change filters only.
    ‣ After you make the appropriate changes, click the "Submit" button to save them and return to the main page.
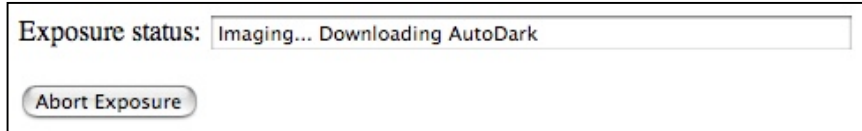
4. Take a picture
   ‣ On the main page, simply enter an exposure time in the box next to "Exposure Time (seconds):" and click the "Take Image" button.
   ‣ Clicking "Take Image," will bring up a series of screens, similar to the slewing screens, telling you the status of the image.

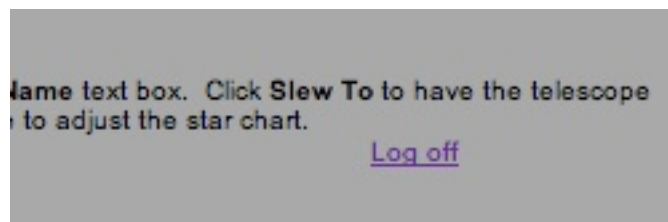Exposure status: Imaging... Downloading AutoDark

(Abort Exposure)

   ‣ Once it is complete, you will get a reduced image in your browser window. To save the image as a GIF (standard image) file, right-click on the image and go to "Save Image As…" or "Save Image to the Desktop" or similar. To download the raw FITS image file—which can only be opened in certain applications—scroll to the bottom and click the link that reads "Click here to download the associated FITS."

Here is your image!

Click here to download the associated FITS
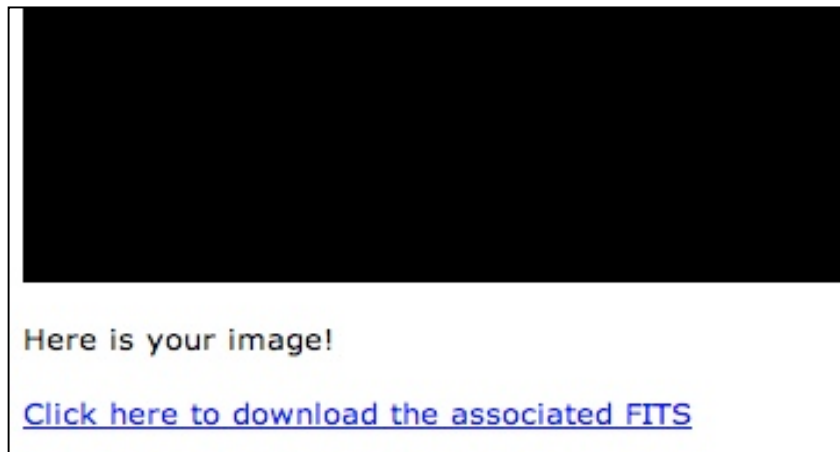
5. Log Off
   ‣ After you have finished taking images, return to the main page. Scroll down to the bottom and click the "Log off" link to end your session.

lame text box. Click **Slew To** to have the telescope to adjust the star chart.
                                              Log off

   ‣ Once you have logged off, you can close your browser or navigate to other pages.