

Planetarium Simulator

User Guide

www.HubbleStars.com

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History

Hubble was first written in the mid-1980s, and was enjoyed by thousands of astronomical enthusiasts.

Unfortunately, it was written with software tools of that era that later became obsolete, and the program would no longer run under Windows-XP or later (*circa 2000*).

Myself, I have missed being able to use Hubble for many years now. But now, the time has finally come when I decided I would finally rewrite it.

Hubble-II is the rebirth of the original *Hubble Planetarium Simulator*.

As I've worked on the re-write, I've found and fixed many subtle bugs, and made vast amounts of additional enhancements that I'd never gotten around to tackling back then.

So give the new **Hubble-II** a try. I hope you will enjoy using it and learning about our universe as much as I have!

1 Introduction

Hubble-II is a software app which runs on *Microsoft Windows* platforms. It provides astronomical simulations in the same way as seen at a planetarium. Hubble will show the past, present and future skies as viewed from anywhere on Earth.

The program can display the positions of the stars, planets and comets in our solar system as they orbit our Sun. It can provide numerical data on celestial bodies, such as rise and set times, right ascension / declination, azimuth / altitude, distances from the sun and earth, and more. Hubble will even display the positions of the moons of Jupiter as they orbit their planet.

Program options allow you to select the date / time to view, your latitude and longitude on Earth, the direction of view, automatic time updating, and much more. Using time updating modes, Hubble can display a complete day's movement of the heavens, demonstrate the retrograde motion of the planets, or one of many other astronomical simulations.

To introduce you to the wide range of features offered by Hubble, several demonstration setups have been supplied with the program. To run these demonstrations, use the [Restore Custom Configuration](#) option under the File option on the main menu bar. This will allow you to load pre-configured setups which exercise different aspects of the program and will give you ideas on how you can create your own simulations using the various configuration settings.

2 Quick Start Guide

If you're looking to get up and running as quickly as possible, just to see what Hubble-II is all about, here are the most important things to know.

1. Setup your current location on earth. The program should have guided you through this the first time you started it, but you can always go back and make changes. Use the [Location Manager](#), which you can find access to from the main program screen.
2. Select the display you would like to view. Choose the [Horizon](#), [Solar System](#), [Jupiter's Moons](#), or one of the [other](#) displays.
3. You have two choices..
 - a. Select how you would like the time to advance. You can choose System Time, which uses the system clock of your computer, or you can choose to animate the displays with an artificially faster rate of time. Use the [DateTime Manager](#), which you can find access to from the main program screen.
 - b. Load one of the [Custom Demonstration Configurations](#) that allow Hubble-II to show off what it can do.
4. Now press the "Auto +" button on the DateTime Manager to watch stars, planets and comets move across the heavens.

An important note to make...

Tooltips Are Your Friend! If you are questioning what a button, label, text field, or legend means or how to use it, tooltips are provided with explanations for many of them. Simply hover the mouse over the thing in question.

Hot Keys Are Your 2nd Best Friend Access to the many functions of Hubble-II is made easier through the use of fast action hot keys. With the press of special key combinations, features can be enabled, disabled, and changed without having to access the menus. This can be especially useful while viewing a sky animation. As an example, you can turn Constellations on and off, enable the display of comets, or change the speed of the animation. Check out the [Hot Keys section](#) of this user guide for a complete list.

3 System Requirements

Hubble was designed to run under Microsoft Windows 7 (or better). Starting with Windows 7, the required .NET libraries (version 4.6.2) will automatically be installed in your system.

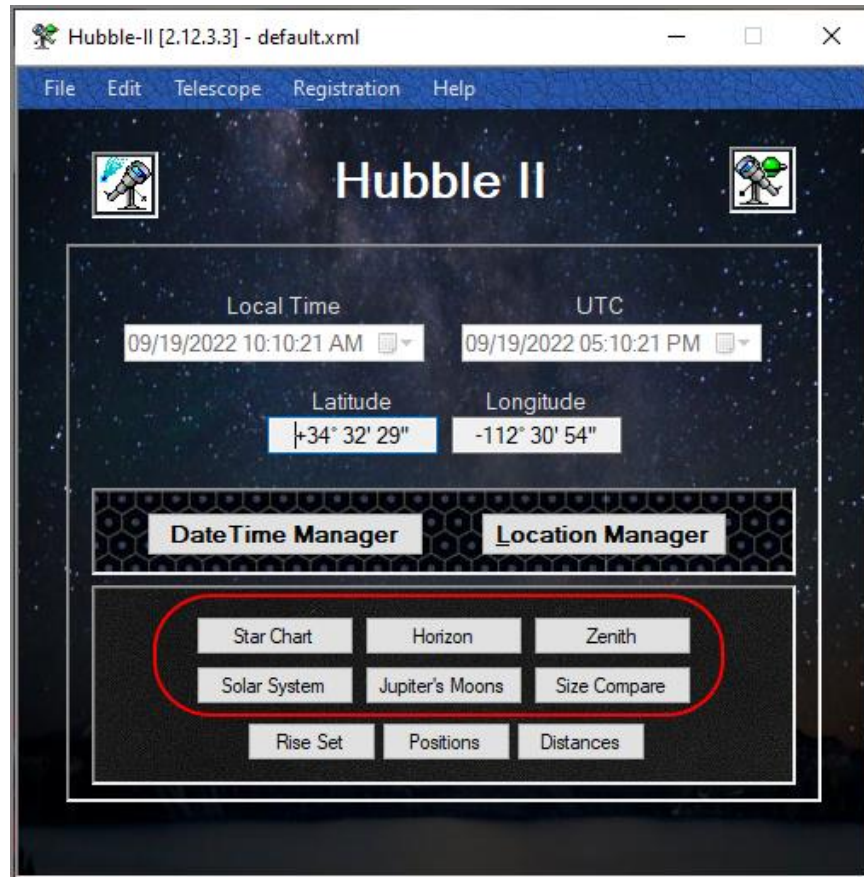
For optimal performance, the computer should have at least a 1 GHz processor, and at least 2GB of RAM. Systems with less than the recommended processor and memory will still run Hubble-II, however do to the mathematically intensive nature of the software, performance may suffer.

4 Astronomical Displays

There are two types of displays provided by Hubble-II, Graphical and Numerical. Each of the sections below will describe those displays and how they're used.

The graphical displays are just as the name implies; they provide graphical images of the heavens. The Numerical displays provide detailed numeric values pertaining to positions, distances, and rise / set times.

4.1 Graphical Display



The buttons in this section select the Graphical Displays. These are the displays which show, as the name implies, astronomical information in image / graphics form. The graphical displays that are available include:

[Horizon Display](#)

[Zenith Display](#)

[Star Chart Display](#)

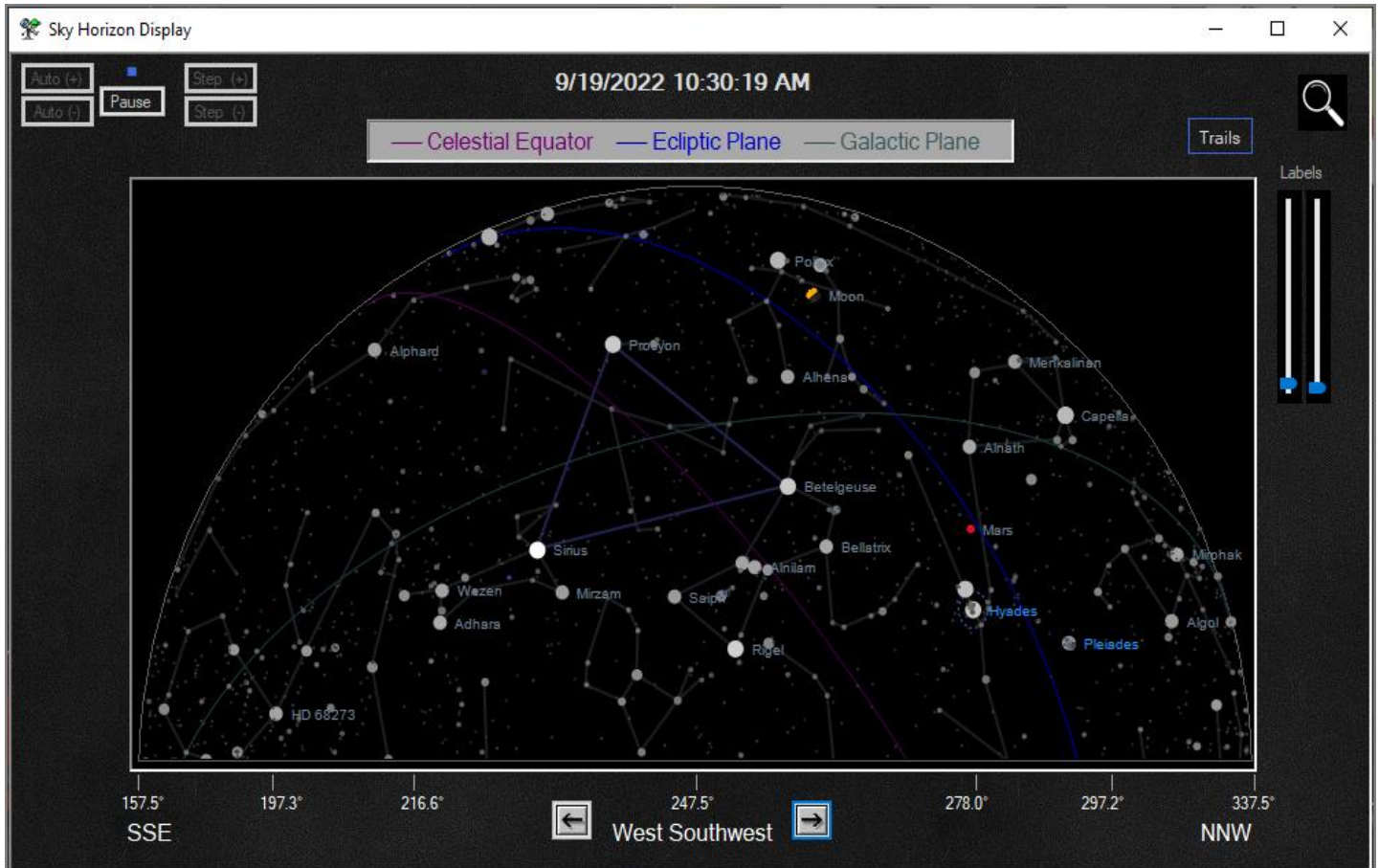
[Relative Sizes Display](#)

[Solar System Display](#)

[Jupiter's Moons Display](#)

Each of these displays are explained in more detail in the following sub-sections.

4.1.1 Horizon Display



The Horizon display shows the sky as seen from Earth when looking in a specific direction, at a [specific time of day](#), from a [specified location on Earth](#).

The display is a 2D representation of the 3D sky out in front of you. The left side of the display is what would be seen looking over your left shoulder, as is the right side over your right shoulder. The top of the display shows what you would see directly over your head. Because of the transformation from a normal 3-dimensional sky to the 2-dimensional display screen, the distortion increases as you approach the edges of the arc.

Another way to visualize what the display is representing is; image you are sitting in the middle of the planetarium. You see in front of you half of the planetarium dome. The difference is that at the planetarium, the dome is 3-dimensional, and your field of view would not be large

enough to see the complete half dome all at one time. With the Horizon Display, the complete half dome is compressed onto the flat screen.

The View Direction can be changed by pressing the **Left or Right arrow** buttons. As you change the display's view direction, it's as though you were turning your body to look in that new direction.

Panning the horizon can also be performed by rotating the mouse wheel (if your mouse has one), or by simply dragging the display left or right by holding down the Left mouse button as you move the mouse pointer across the display.

The display can quickly be centered on any point in the sky by Right Clicking that location with the mouse.

View Direction is the same as is measured using a common magnetic compass.

North, NNE, North East, ENE, East, ESE, , West, WNW, North West, NNW

To save changes to these parameters, the [Save Custom User Configuration](#) feature must be used.

Refer to the following for additional features and configuration options of this screen:

[Leave Trails](#)

[Time Updating](#)

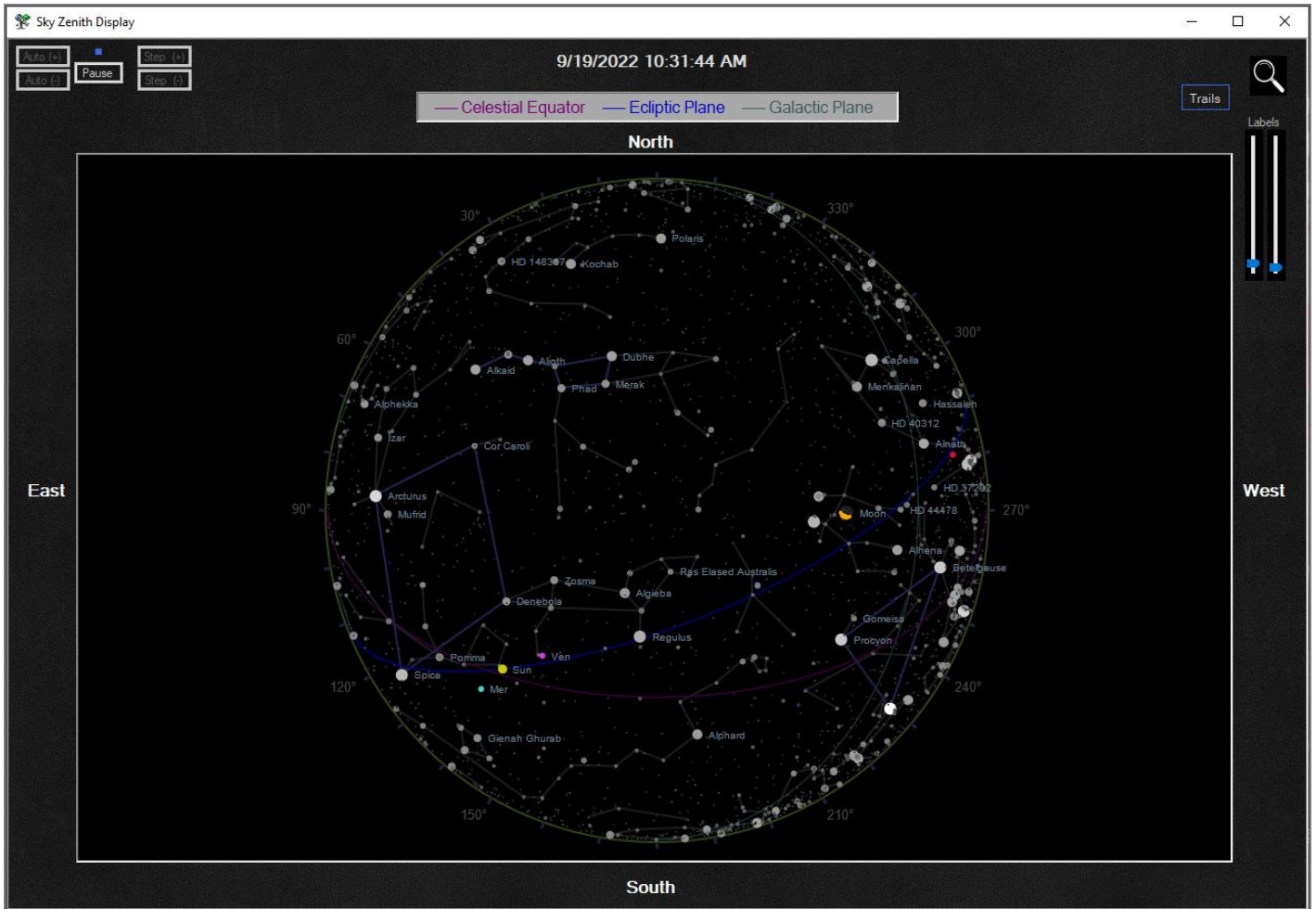
[Magnitude Setup](#)

[Enlarged Stars](#)

[Planet Selection](#)

[Object Identification](#)

4.1.2 Zenith Display



The Zenith display shows the sky as seen from Earth when looking directly overhead, at a given [time of day](#) from a [specified location on Earth](#). The top of the displayed circle represents the compass direction of North, the bottom of the screen is South, right is to the West and the left side of the circle is toward the East horizon. Another way to visualize what this display is depicting is; if you were to lie on your back and look up at the sky, this is what you would see. The edges of the circle are all 360 degrees of the horizon around you.

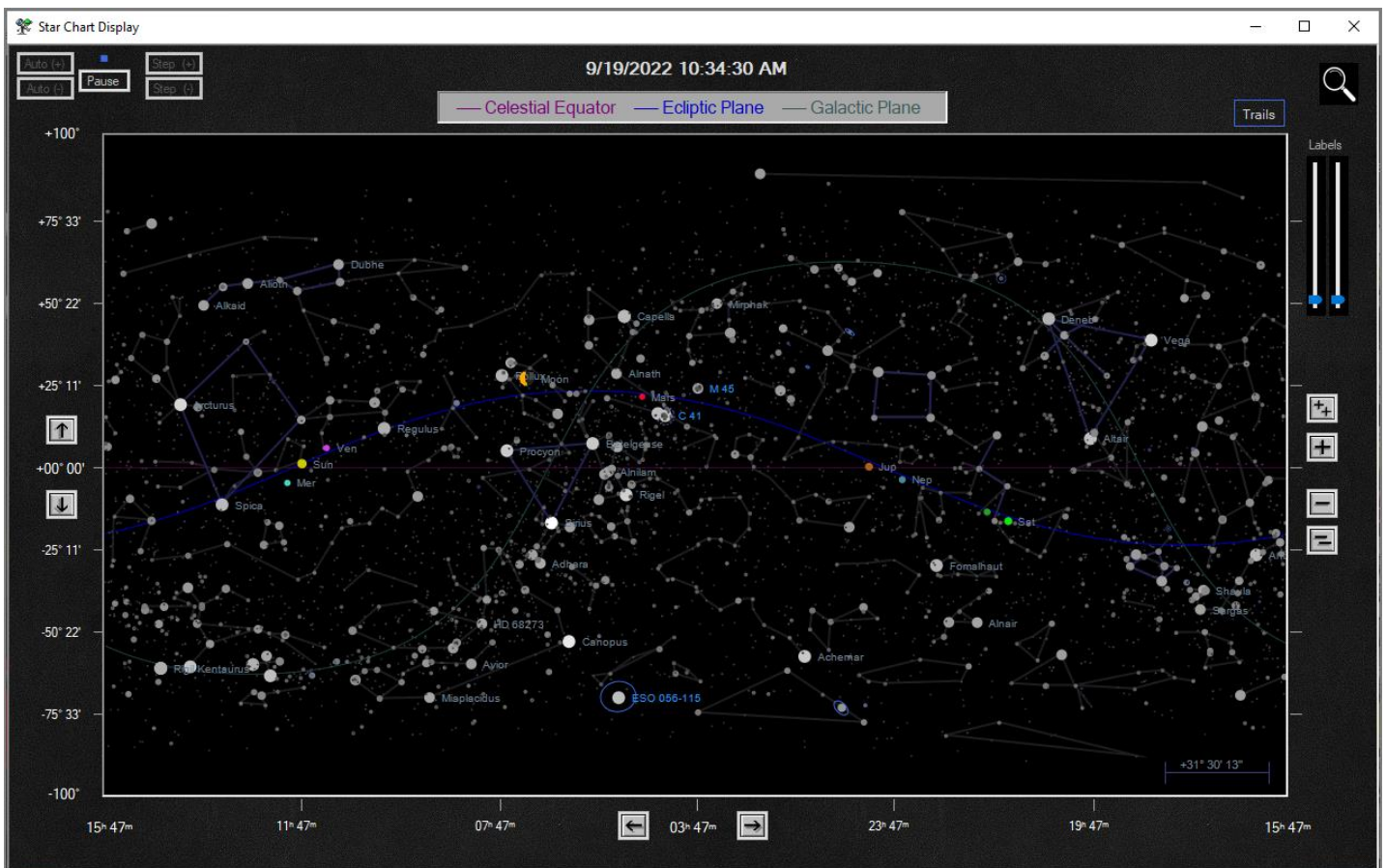
Keep in mind that distortion increases as you approach the edges, aka the 360-degree horizon.

Refer to the following for additional features and configuration options of this screen:

[Leave Trails](#)

- [Time Updating](#)
- [Magnitude Setup](#)
- [Enlarged Stars](#)
- [Planet Selection](#)
- [Object Identification](#)

4.1.3 Star Chart Display



This display represents a 'Star Chart', located at given [Right Ascension](#) / [Declination](#) coordinates. All objects within the boundaries of the window are displayed. This display is useful for zooming in on a region of the sky, the same way a telescope would be able to zoom in on a particular area of the sky. The Star Chart produces a display similar to those found in astronomy handbooks.

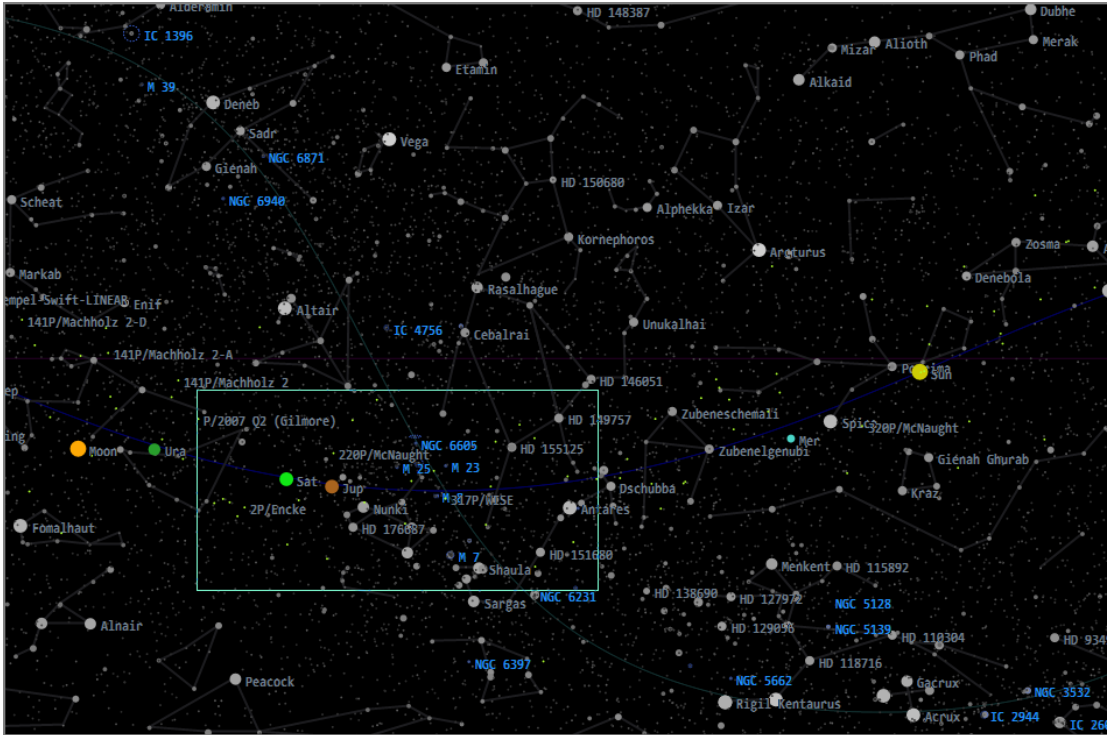
The width of the display is interpreted as the amount of right ascension covered from the left side of the window to the right. The amount of declination covered in the display is calculated automatically to give the correct scaling.

While viewing the Star Chart, the center of the display can be moved in Right Ascension / Declination using the **Left / Right arrow buttons** at the bottom of the display. The center location of the star chart can also be moved by holding down the left mouse button and dragging the mouse across the screen. As well, the display can quickly be centered on any point in the sky by Right Clicking that location with the mouse.

Using the buttons on the right side of the display will allow you to zoom in and out. The topmost button zooms all the way in, using the maximum zoom. The bottom most button zooms all the way out, using the minimum zoom.

Zooming can also be performed by rotating the mouse wheel (if your mouse has one). Holding the Ctrl key down while rotating the mouse wheel will Pan the Star Chart in Right Ascension. Holding the Shift key down while rotating the mouse wheel will Pan the Star Chart in Declination.

Zooming into any region of the star chart is made easy using 'Rubber banding'. To zoom into a specific area, hold the Ctrl key down while dragging the mouse across the display with the left button pressed. An area representing the zoomed in portion will be bounded by the colored rubber band line. When the mouse button is released, the display will be redrawn and zoomed in to the highlighted area. To abort the zoom operation, release the Ctrl key *Before* releasing the mouse button.



Rubber-Banded area using the mouse will zoom in on the selected area

A quick way to re-center the Star Chart is provided. Double click on the middle Right Ascension label at the center bottom of the display to reset the right ascension to 12h 00m 00s. Or, double click on the middle Declination label at the left center of the display to reset the declination to +00° 00'.

Refer to the following for additional features and configuration options of this screen:

[Leave Trails](#)

[Time Updating](#)

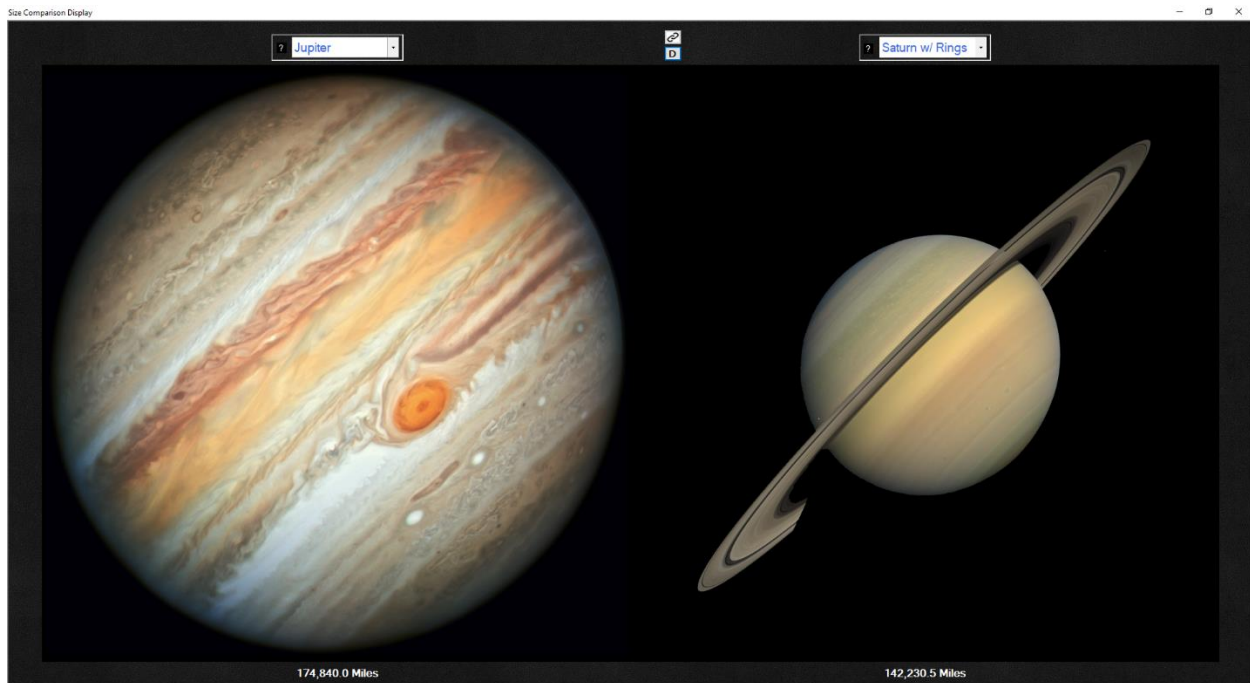
[Magnitude Setup](#)

[Enlarged Stars](#)

[Planet Selection](#)

[Object Identification](#)

4.1.4 Relative Sizes Display



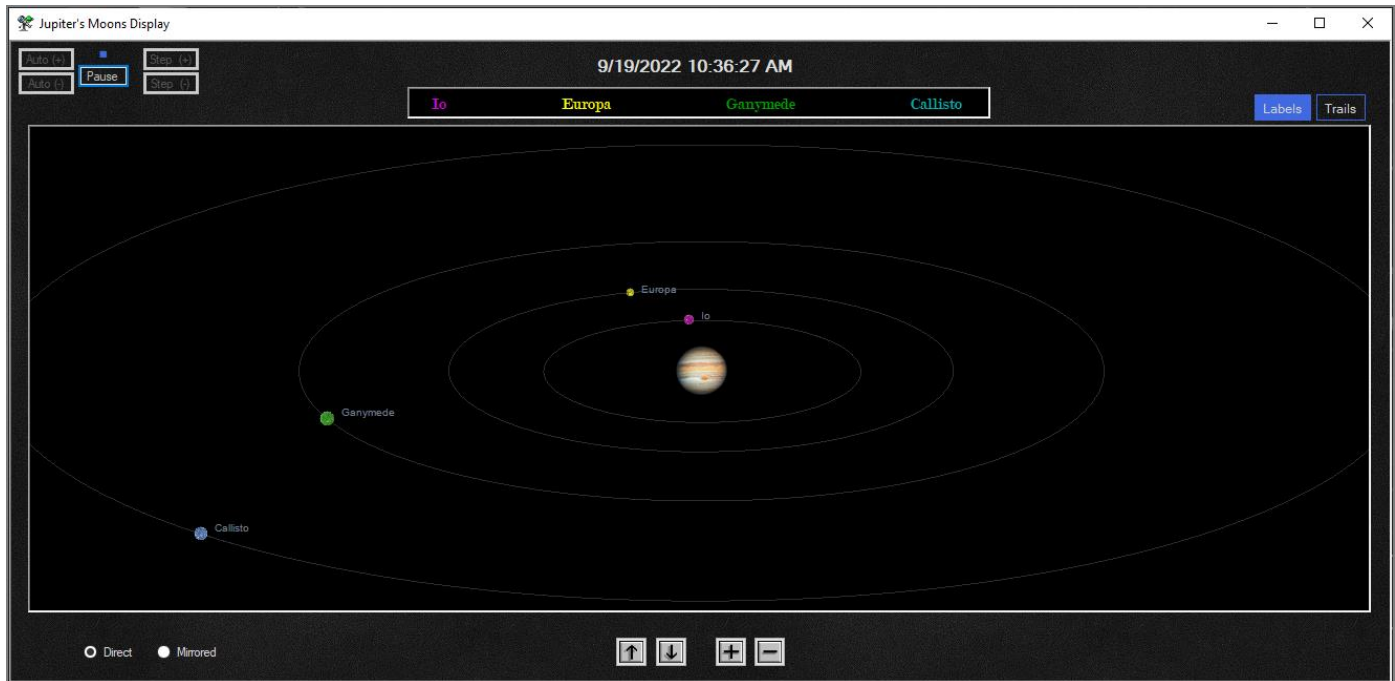
The Relative Sizes display allows the user to visualize the difference in size between any two planets, stars, moons, or comets. The display draws the two bodies to relative scale, and each body's diameter is shown in the user's selected [Units of Measure](#). The numeric values which appear between the two bodies show the ratio of the size of the larger to the smaller one.

To change either the left or right body from the one currently displayed, select a new body from the drop down lists. Pressing the 'D' (or subsequently the 'S') button at the top of the display changes the sorting order of the lists. When a 'D' is present, bodies are being sorted according to their Distance from the sun. When an 'S' is present, bodies are being sorted according to their Size. If you forget which is which, a tooltip is presented by hovering the mouse over the button.

When the 'chain link' button is pressed, the mode is switched between linked and unlinked. When the link is shown, changing a body on one side of the display pushes that body to the other side of the display before making the change in selection.

Note: If one of the bodies appears not to be visible, this is because the size difference is so great that it is beyond the resolution of the display.

4.1.5 Jupiter's Moons Display



The Moons of Jupiter display shows the position of the four major moons of Jupiter as they orbit their planet. Using the Up / Down buttons, the view perspective tilt can be changed. Pressing the **Up button** moves the perspective of the observer up from the plane of the moon's orbits toward the North Pole of Jupiter. Pressing the **Down button** moves the observer's perspective back down toward the plane of moon's orbits. The + and – buttons will zoom in toward, or farther out, from Jupiter.

Zooming can also be performed by rotating the mouse wheel (if your mouse has one). If you press the Ctrl button while rotating the mouse wheel, the tilt (view perspective) is changed just as if the Up button or Down button were pressed.

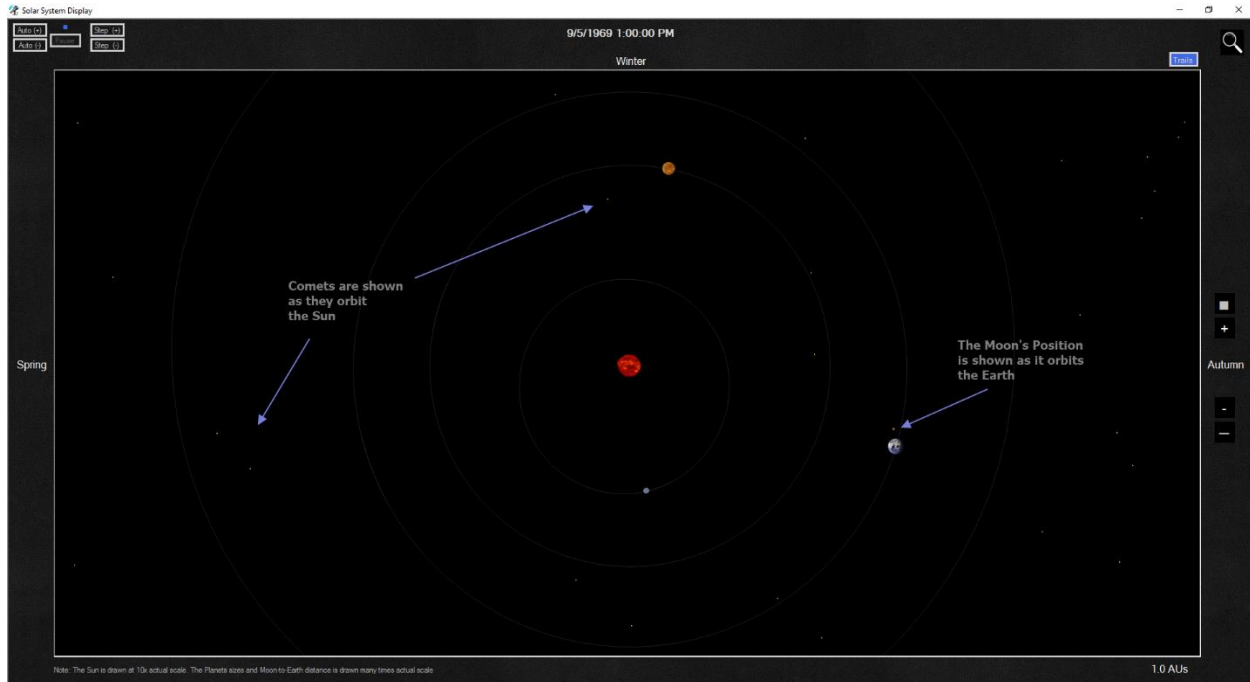
The Direct vs Mirror selection is given to change the display to represent what would be seen looking either through binoculars (naked eye view) or through the reversed view of a Schmidt-Cassegrain, Newton or Dobson telescope.

Refer to the following for additional features and configuration options of this screen:

[Time Updating](#)

[Leave Trails](#)

4.1.6 Solar System Display



This display shows the position of the planets and comets as they orbit the Sun. The view is from above the plane of the solar system with planets moving counter clockwise around the Sun.

The position of the Earth's Moon as it orbits the Earth is also shown. The position of the Moon, in relation to the Earth and the Sun, allow you to visualize why the moon goes through its phases.

Using the buttons on the right side of the display will allow you to zoom in and out. The topmost button zooms all the way in towards the sun, using the maximum zoom. The bottommost button zooms all the way out away from the sun, using the minimum zoom. Zooming can also be performed by rotating the mouse wheel (if your mouse has one).

Refer to the following for additional features and configuration options of this screen:

[Leave Trails](#)

[Time Updating](#)

[Planet Selection](#)

[Object Identification](#)

4.2 Numerical Displays



There are two types of displays provided by Hubble-II, Graphical and Numerical.

The numerical displays are just as the name implies, they provide numeric data and information about objects within the solar system. The numeric data includes values pertaining to positions, distances, and rise / set times of the planets and our Sun and Moon.

4.2.1 Planetary Rise / Set Time Display

Body	Phase	Mag	Rise Time	Rise Azim	Set Time	Set Azim	Is Up	Total Rise Time
Mer	0.0%	+11.5	06:21	92.5°	18:12	266.1°	^	11:53
Ven	99.1%	-4.0	05:41	84.1°	18:10	276.1°	^	12:31
Mars	86.7%	-1.0	22:16	62.4°	+12:28	297.2°		14:14
Jup	100.0%	-2.9	18:33	88.8°	+06:42	270.6°		12:07
Sat	99.9%	+0.8	16:32	109.4°	+03:08	250.6°		10:34
Ura	100.0%	+5.7	16:46	105.4°	+03:42	254.0°		10:50
Nep	100.0%	+7.8	18:05	93.4°	+05:52	266.0°		11:46
Moon	10.6%	-6.4	02:54	64.9°	17:13	291.4°	^	14:19
Sun	100.0%	-26.7	06:17	89.4°	18:31	270.9°	^	12:09

*Click entry for Daily times *Right-Click to Center

This display provides numerical information about the Rise and Set times of the planets, Sun and Moon.

The included with the rise and set time of each object, is the total time the object is above the horizon. The Azimuth that the Rising and Setting occur at is also show. The '*Is Up*' column indicates if the object is above the horizon at the displayed time.

4.2.1.1 Planetary Daily Rise / Set Time Display

The following display shows the rise and set information for a particular body, 3 days prior through 7 days after the current date. The display is accessed by clicking on one of the bodies in the Rise / Set Times display that was discussed above.

On this display, the *Is Up* ('^') indicator refers to whether the particular body would be above the horizon at the 'current' time displayed in the upper right corner of the window for each of the listed dates

Date	Phase	Mag	Rise Time	Rise Azim	Set Time	Set Azim	Is Up	Total Rise Time
09/19/2022	100.0%	-2.9	18:46	88.6°	*06:56	270.8°		12:07
09/20/2022	100.0%	-2.9	18:42	88.7°	*06:51	270.8°		12:07
09/21/2022	100.0%	-2.9	18:38	88.8°	*06:46	270.7°		12:07
09/22/2022	100.0%	-2.9	18:33	88.8°	*06:42	270.6°		12:07
09/23/2022	100.0%	-2.9	18:29	88.9°	*06:37	270.6°		12:06
09/24/2022	100.0%	-2.9	18:25	89.0°	*06:33	270.5°		12:06
09/25/2022	100.0%	-2.9	18:21	89.0°	*06:28	270.4°		12:06
09/26/2022	100.0%	-2.9	18:16	89.1°	*06:24	270.4°		12:05
09/27/2022	100.0%	-2.9	18:12	89.2°	*06:19	270.3°		12:05
09/28/2022	100.0%	-2.9	18:08	89.2°	*06:14	270.2°		12:05
09/29/2022	100.0%	-2.9	18:03	89.3°	*06:10	270.2°		12:04

*Note: Phase and Magnitude are at Noon for each day

Since, in particular for our Moon, the rise and set times change dramatically from day to day, it can be unclear if the rise or set times pertain to the current Display Date, the Previous, or the Next Date. To remove this ambiguity, extra symbols may be displayed along with the rise and set times.

In the above example screenshot, it is currently the morning of 9/22. The '+' prefix on the set times of Jupiter (+06:42) indicate that the rise time shown is for 9/22, but the set time will occur on the subsequent day, 9/23 06:42 AM. Note again, the rise time has no extra symbol, so the rise time will occur on the Current day, 9/22 06:33 PM.

If the rise or set times include a '+' prefix, that would indicate that the time applies to the Next day.

Any time the Moon is currently *Risen*, the time it rose is shown as its Rise Time, and the time it will set is shown as its Set Time. But, if the Moon has already set for the Display Date, then the Rise Time and the Set Time refer to the next time it will rise.

The display also shows the [Phase](#) and [Magnitude](#) of each object. While the Phase and Magnitude on the Rise Set Times screen are for the Date & Time displayed in the upper right ('current' time), the Phase and Magnitude on the Daily Rise Set Times screen are the values calculated at Noon on each of the days.


The calculations for rise and set times attempt to adjust for parallax and atmospheric refraction, however they can sometimes appear to not match perfectly with observed times. This happens because the times shown assume a perfect sea-level horizon, and elevations in local terrain can have an effect of up to multiple minute differences.

Refer to the following for additional features and configuration options of this screen:

[Time Updating](#)

[Planet Selection](#)

4.2.2 Planetary Position Display



The screenshot shows a window titled "Planetary Positions" with a blue background. At the top right, the date and time "5/10/2020 8:04:39 AM" are displayed. Below this is a table with five columns: "Body", "Right Asc", "Declination", "Altitude", and "Azimuth". The table lists data for Mer, Ven, Mars, Jup, Sat, Ura, Nep, Moon, and Sun. Each row is color-coded: Mer (blue), Ven (orange), Mars (red), Jup (green), Sat (yellow), Ura (cyan), Nep (magenta), Moon (brown), and Sun (black).

Body	Right Asc	Declination	Altitude	Azimuth
Mer	03 ^h 39 ^m 00 ^s	+20° 24' 12"	25.7°	82.0°
Ven	05 ^h 23 ^m 35 ^s	+27° 36' 56"	9.0°	62.6°
Mars	22 ^h 06 ^m 49 ^s	-13° 35' 03"	40.8°	193.9°
Jup	19 ^h 57 ^m 03 ^s	-20° 52' 29"	21.0°	223.3°
Sat	20 ^h 17 ^m 23 ^s	-19° 49' 17"	24.6°	219.8°
Ura	21 ^h 36 ^m 44 ^s	-14° 58' 19"	37.5°	202.5°
Nep	23 ^h 26 ^m 16 ^s	-04° 46' 12"	49.8°	166.0°
Moon	18 ^h 13 ^m 33 ^s	-24° 13' 50"	2.0°	238.5°
Sun	03 ^h 11 ^m 54 ^s	+17° 51' 02"	30.0°	88.1°

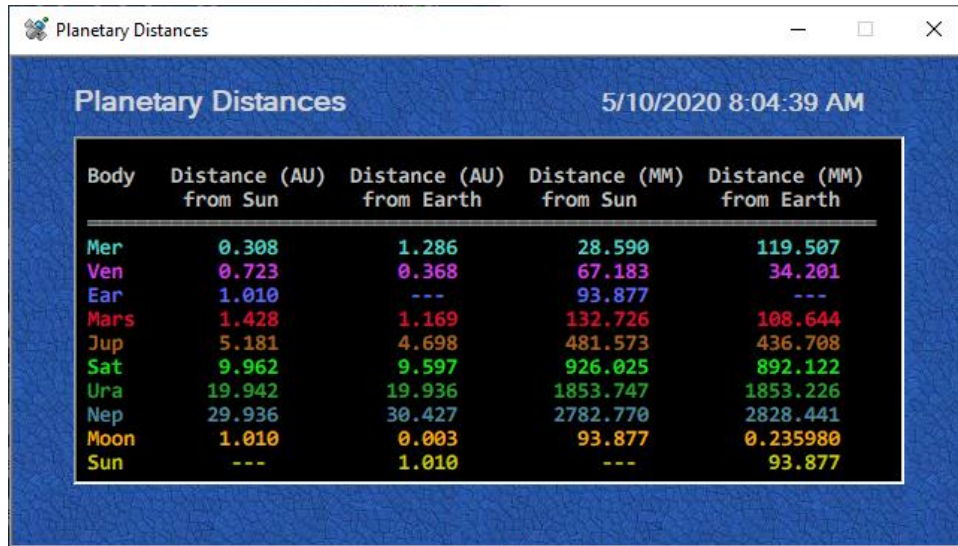
This display provides numerical information about the planets, Sun and Moon's position with respect to Earth. The [Right Ascension](#), [Declination](#), [Altitude](#) and [Azimuth](#) are displayed for each object.

Refer to the following for additional features and configuration options of this screen:

[Time Updating](#)

[Planet Selection](#)

4.2.3 Planetary Distances Display



The screenshot shows a window titled "Planetary Distances" with a timestamp of "5/10/2020 8:04:39 AM". The window contains a table with the following data:

Body	Distance (AU) from Sun	Distance (AU) from Earth	Distance (MM) from Sun	Distance (MM) from Earth
Mer	0.308	1.286	28.590	119.507
Ven	0.723	0.368	67.183	34.201
Ear	1.010	---	93.877	---
Mars	1.428	1.169	132.726	108.644
Jup	5.181	4.698	481.573	436.708
Sat	9.962	9.597	926.025	892.122
Ura	19.942	19.936	1853.747	1853.226
Nep	29.936	30.427	2782.770	2828.441
Moon	1.010	0.003	93.877	0.235980
Sun	---	1.010	---	93.877

This display provides numerical information about Distances of the planets, Sun and Moon's. The distances of each of the objects is listed from both the Earth and the Sun.

The distances are measured in both [AUs](#) and in millions Miles (or Kilometers), depending on the setting of [unit of measure](#).

Refer to the following for additional configuration of this screen:

[Time Updating](#)

[Planet Selection](#)

4.3 [Common Functionality for Graphical Displays](#)

This section highlights some of common features that are applicable to the graphical displays

4.3.1 Undo and ReDo Operators

Sometimes it is desirable to go back to a prior viewing location on a graphical display. For this, 'Undo' and 'ReDo' operations are provided with respect to Zooming / Panning on the Horizon, Star Chart and Solar System displays.

Pressing **Ctrl-Z** will restore the previous position(s) and/or zoom factor(s) of the display prior to the zooming or repositioning.

Ctrl-Shift-Z will Re-Do the last Zooming / Panning operation(s) that was Un-Done by a prior Ctrl-Z press. (Note: Ctrl-Y can also be used for Re-Do)

4.3.2 Centering Display on an Object

By right-clicking on an object, or even an empty area of a graphical display, the display will be centered on that object or area. Also, all other will graphical displays will be adjusted to be centered on the same object.

4.3.3 Celestial / Ecliptic / Galactic Plane Lines

On the Horizon, Zenith, and Star Chart displays, the Celestial, Ecliptic and Galactic planes are displayed. These planes represent the following:

4.3.3.1 Celestial Plane

This line indicates the great circle of the imaginary Celestial Sphere on the same plane as the equator of Earth. In other words, the Celestial Equator is an abstract projection of the Earth's Equator into outer space.

This plane of reference is the basis of the Equatorial Coordinate System.

4.3.3.2 Ecliptic Plane

The Ecliptic Plane indicates the imaginary plane containing the Earth's orbit around the sun. In the course of a year, the Sun's apparent path through the sky lies in this plane.

Note how all the *Zodiac Constellations* lie in this plane. Also note how all the Planets and Moon traverse the sky roughly along this plane.

4.3.3.3 Galactic Plane

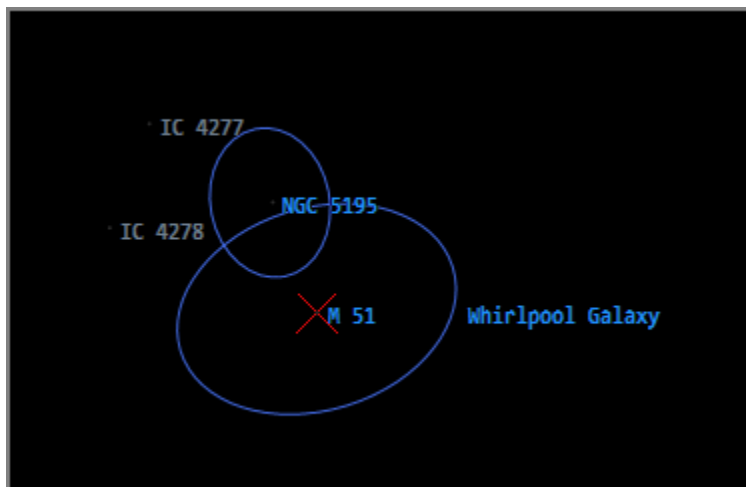
The Galactic Plane indicates the plane on which the majority of stars in our galaxy lie. This broad band of faint light across the night sky is often referred to as the 'Milky Way'.

The core of our Milky Way Galaxy lies in the direction of the constellation Sagittarius.

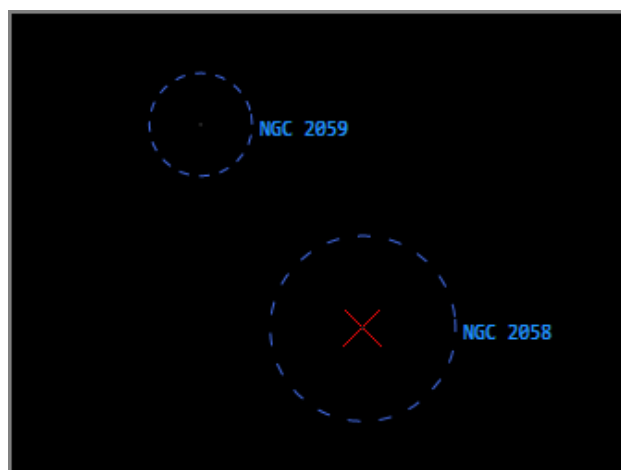
4.4 Diffuse Object Boundary Regions

Galaxies, Nebulae, Clusters, HII Ionized Regions, Super Nova Remnants, etc do not have well defined sharp boundaries. They appear to be somewhat diffuse, and cover more of a blurred area. These object's boundaries are drawn around their central point. Each type of diffuse object has a particular shape and color to its boundary to make it visually distinct and easier to identify at a glance. The shapes are as follows:

Galaxy boundaries are drawn with a solid blue ellipse



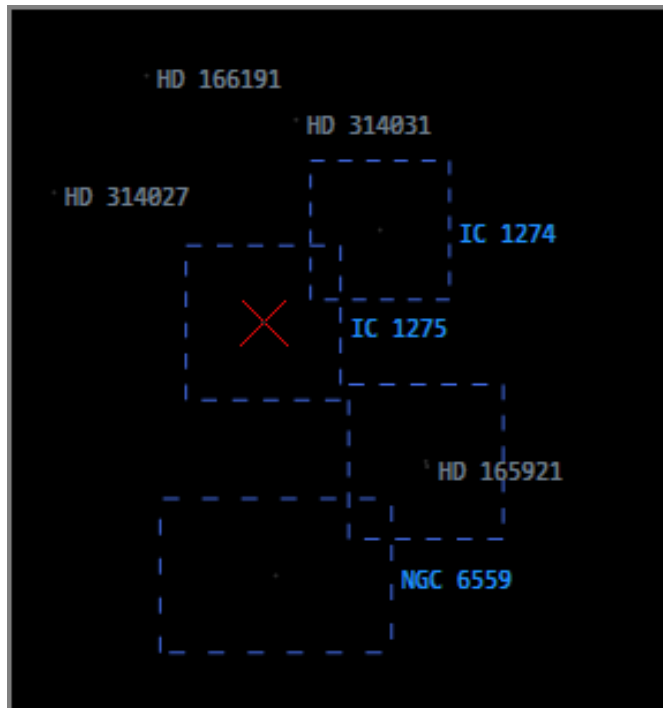
Cluster boundaries are drawn with a dashed blue ellipse



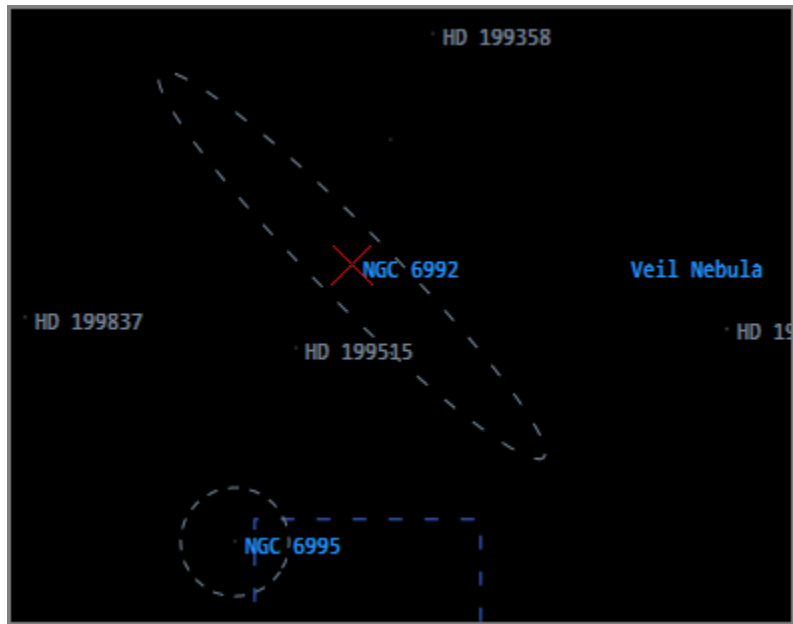
Nebulae are drawn with a solid blue rectangle



HII Ionized Regions are drawn with a dashed blue rectangle

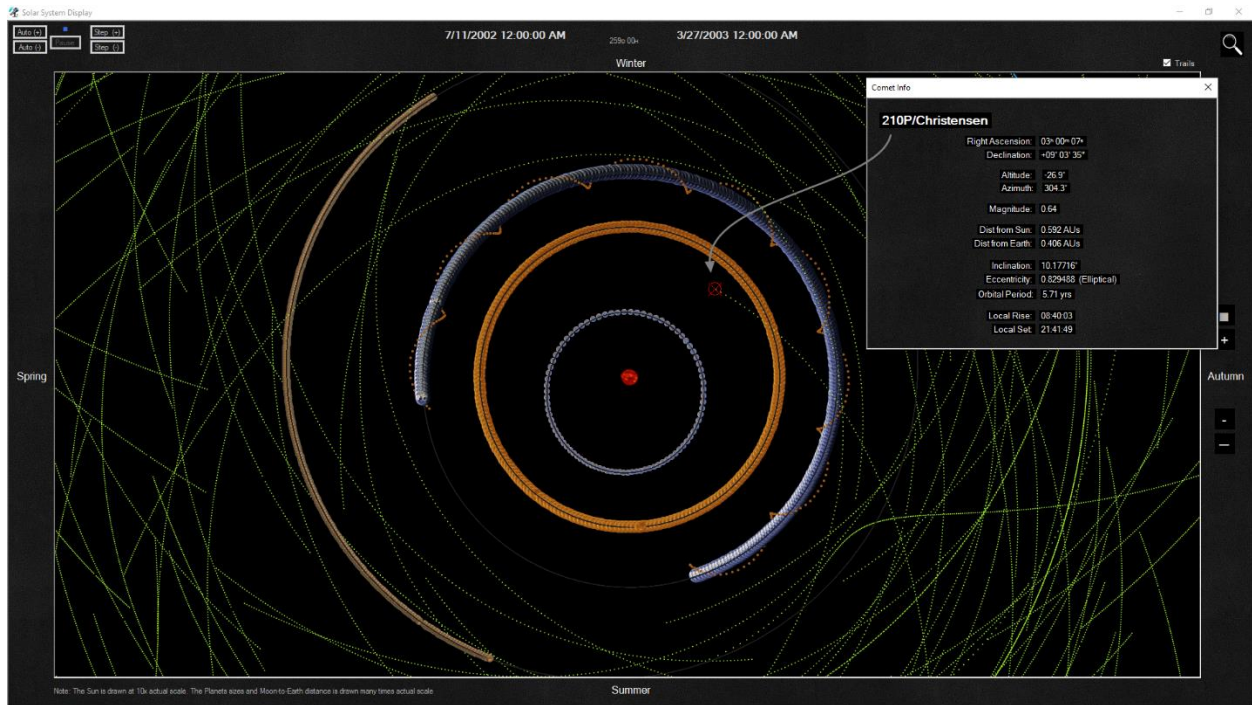


Other diffuse objects, such as Super Nova Remnants are drawn with a gray dashed ellipse



Diffuse Object Boundaries are drawn to their specific horizontal and vertical radii. They are also rotated to the appropriate angle that would be seen when viewed through a telescope.

5 Planet, Comet and Deep Space Object Identification



When in the *Horizon*, *Zenith*, *Star Chart* or *Solar System* displays, you have the option to use the mouse point to select an object on the screen for identification. The object to be identified is selected using the '*target sighting*' cursor. This is the cursor which appears when the mouse pointer is moved over the black portion of the display when it supports this feature. If the cursor is positioned within the capture range of an object, and the Left mouse button is pressed, it will lock on to that object and display information about it in a pop-up window as shown below.



Note: clicking on the '?' symbol of the Star Info display will give a pictorial description of *Spectral Types*.

Depending on which type of object was selected, applicable information is tailored to it.

5.1.1.1 Aiming a Telescope Mount

These *Selected-Object pop-ups* provide the ability to point a Telescope at them. Clicking on the “GoTo” button will Slew the telescope mount to the object’s Right Ascension / Declination. More information on this feature is available in [Telescope Mount Control](#) section of this User Manual.

To use this feature, the telescope mount must be under the control of the [ASCOM Platform](#). As well, this feature is only available to [Registered Users](#) of Hubble-II.

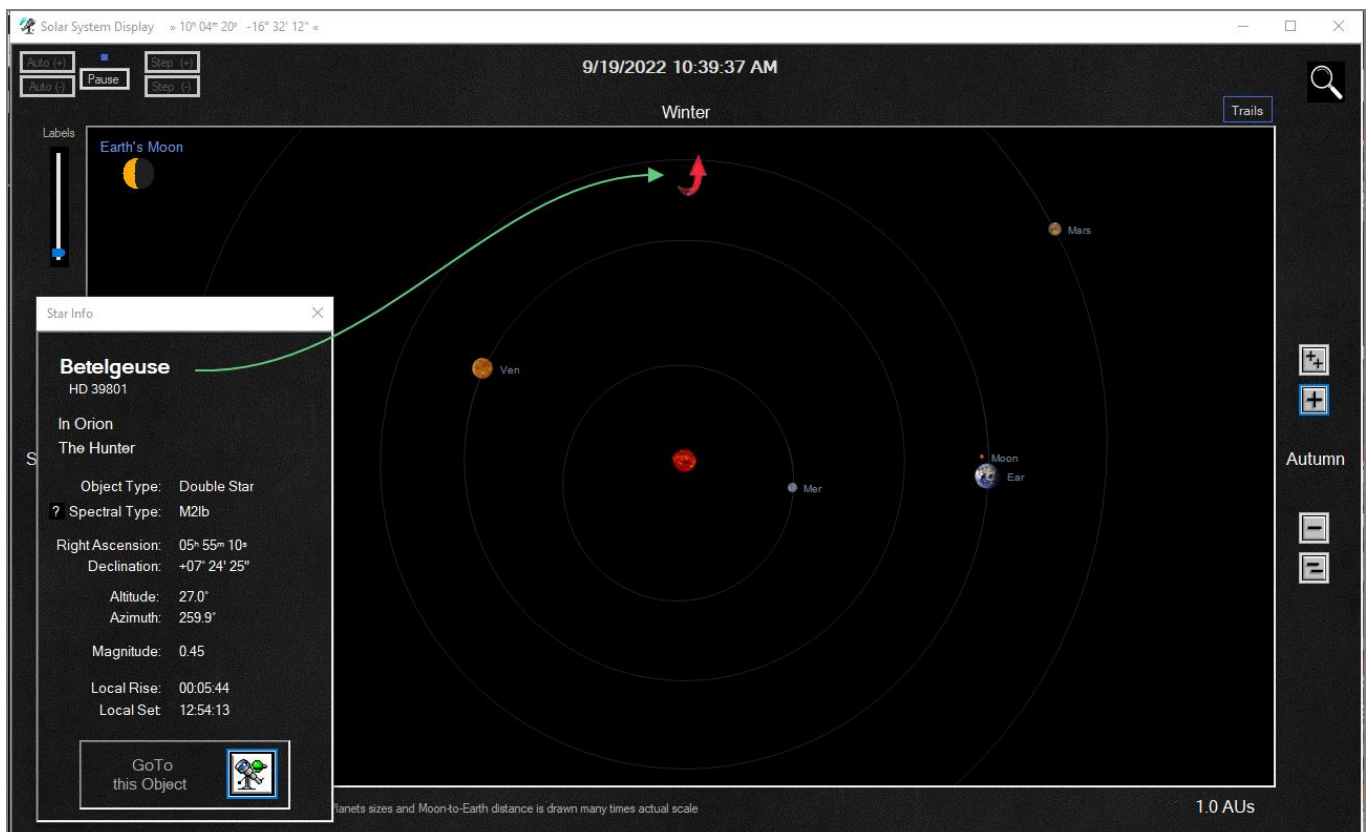


This pop-up will be displayed when the Telescope is slewing

All of other currently open graphical displays which are also showing the selected object will also be Marked. This can be helpful in identifying the location of the same object in the other views of the sky.

If a Star is marked on either the Horizon, Zenith, or Star Chart displays, it cannot be marked on the Solar System display. This would be impossible since the Star is so far from our Solar System. The Solar System display will however present an arrow showing the relative direction of that Star. (Note: this also applies when using the Find Object feature)

The following image shows an example of that **“Relative Direction Arrow”** when Betelgeuse was selected. Betelgeuse, in the constellation Orion, is visible in Winter months because it is on the ‘Winter’ side of our Solar System.



Depending on which type of object is being selected, the following information may be included:

[Altitude](#) and [Azimuth](#)

[Right Ascension](#) and [Declination](#)

Distance from Sun and Earth (in [AUs](#))

[Phase](#) of the object.

[Magnitude](#) of the object.

Constellation the object is part of.

Meaning behind the Constellation's name.

i.e. Orion, "THE HUNTER"

Name of the object.

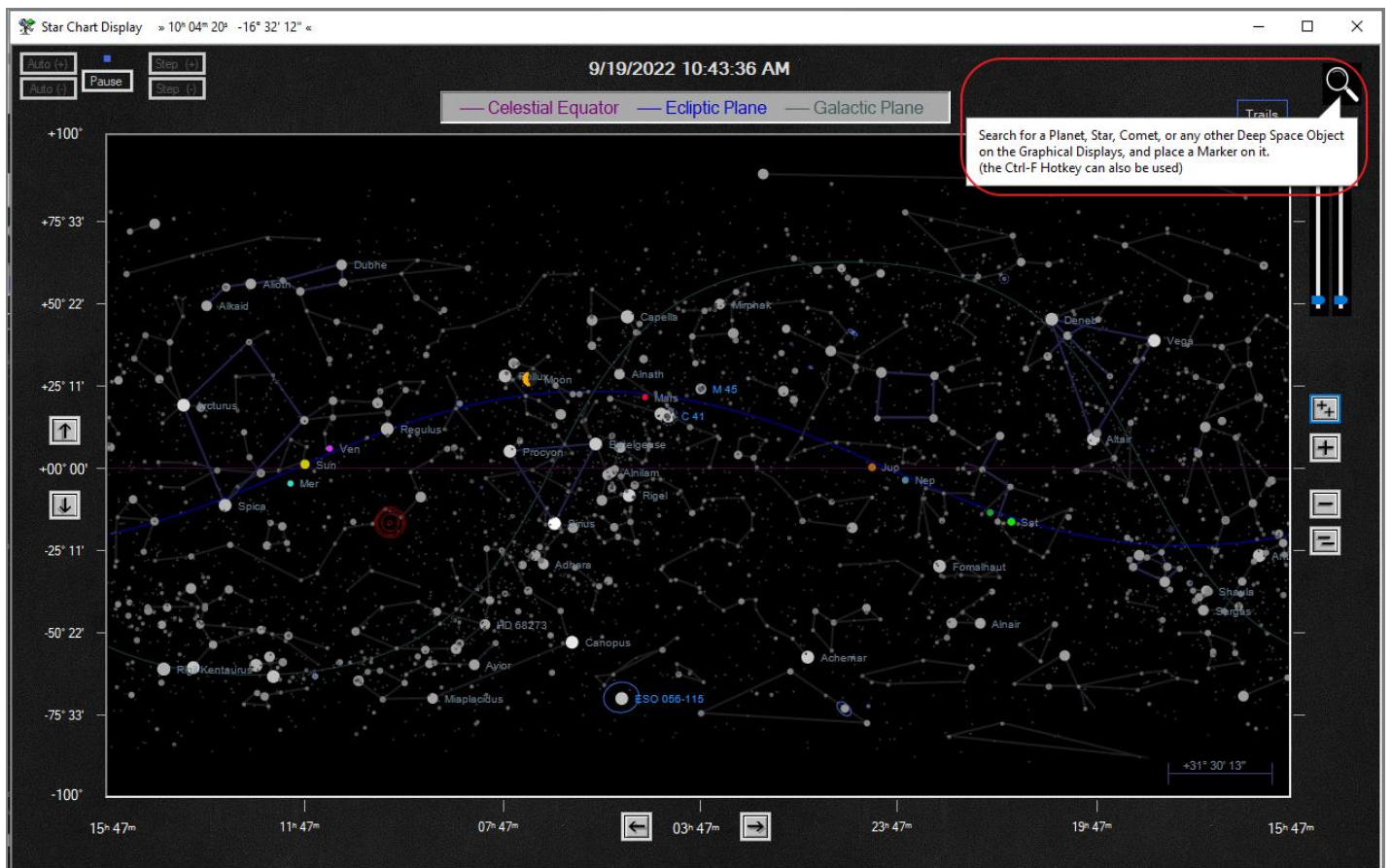
Spectral Type of the object.

Star Type

i.e. Planet, Comet, Star, Double Star, Nebula

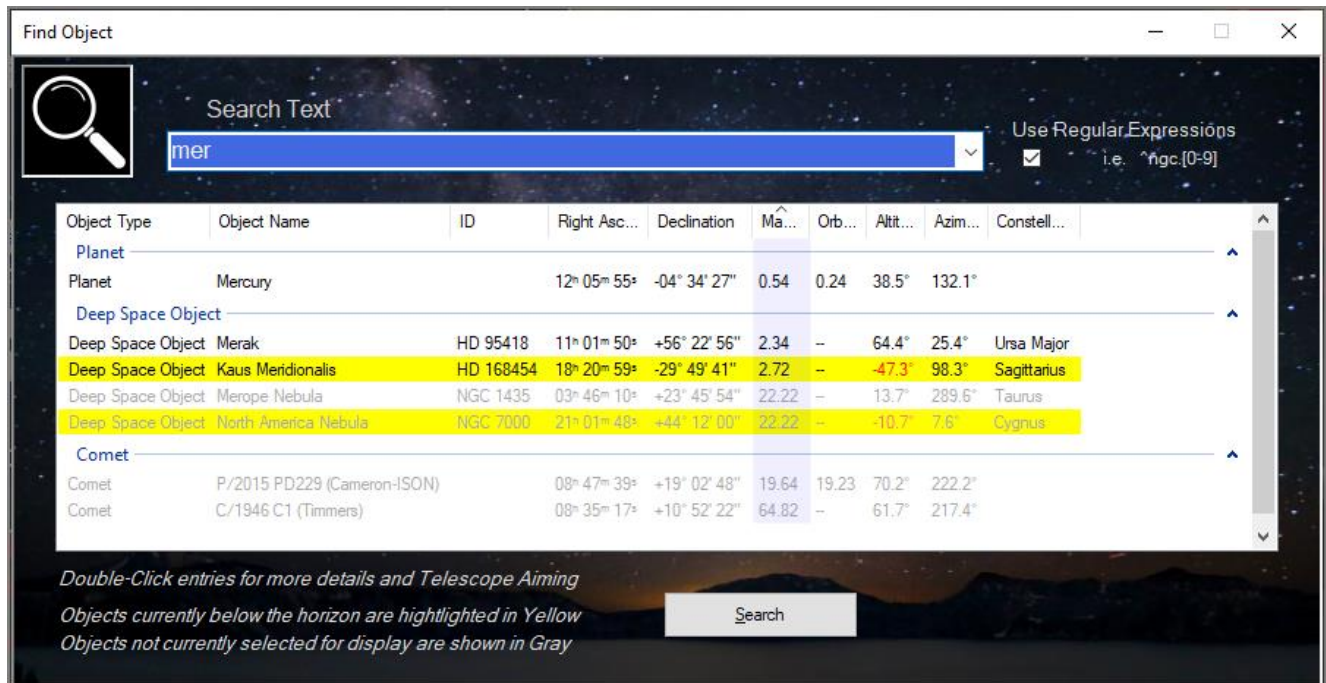
6 Find Object Feature

The [Object Identification](#) feature, which was previously described, gives you the ability to identify any object that is being displayed on one of the [Graphical Displays](#). But what if what you want is the other way around? You have an object in mind, and want to know more about it, but don't know where it is in the sky. This is where the **Find Object** feature comes in handy!



On the graphical displays you will find a Magnifying Glass icon in the upper right corner of the screens. Clicking this icon will launch the Find Object dialog window as seen below.

Note: the Ctrl-F hotkey will also bring up this dialog



Above is an example of the Find Object dialog. It shows a search having been performed on the partial name of “Mer”. As can be seen, one Planet, four Deep Space objects, and Two Comets have names that include the text string of ‘Mer’.

(Note that there is a ‘Use Regular Expressions’ option. A brief explanation of Regular Expressions can be found [here](#))

Objects that match the search will appear in the list, categorized by the type of object they are. Each object will also have some of its basic information displayed along with the name. This can help to narrow down which object you’re looking for. Some of the entries may be highlighted in **Yellow**, which indicates that they are currently below the horizon at your defined location.

Double clicking any of the entries will place a visual marker at the object on all of the graphical displays that are currently active. Note that if the object is currently below the horizon, it will not be marked on either the Horizon or the Zenith displays. However, the object will still be marked on the Star Chart and/or Solar System displays.

Some of the entries in the list may be shown in Light Grey. This indicates that in the [Preference Settings](#) window they are not currently enabled for display. This may be that either they are not enabled, or their magnitude is below the set threshold for display. The visual marker placed on these objects will appear to select a blank space on the graphical displays at the position that would normally be showing them. Note that a maximum of only 50 objects of each Object Type (Planet, Deep Space Object, Comet) will be shown in the search results.

Sometimes a display’s view area will have to be adjusted to be able to show the selected object. If so, this will be done automatically.

On the Horizon view, if the object is above the horizon, but the current view direction of the Horizon display isn't including the portion of the sky that contains the selected object, the Horizon display's views will be panned to look in the appropriate direction.

On the Star Chart, if the display is currently zoomed in to a portion of the chart that doesn't allow the selected object to be shown and marked, the view will be automatically adjusted to set the middle of the Star Chart's viewing area to the right ascension / declination of the selected object.

On either the Horizon or Star Chart display, if the object being marked is too close to the edge of the display, the view will be adjusted as well.

On the Solar System view, the zoom factor of the display will be dynamically adjusted to include the Planet or the Comet being marked. However, it is impossible to mark objects outside of our solar system, like Stars. In this case, the object is not marked, but an arrow indicating its direction relative to the solar system will be displayed.

Note that all active displays which are able to show the current position of the selected object will have a marker placed on the object.

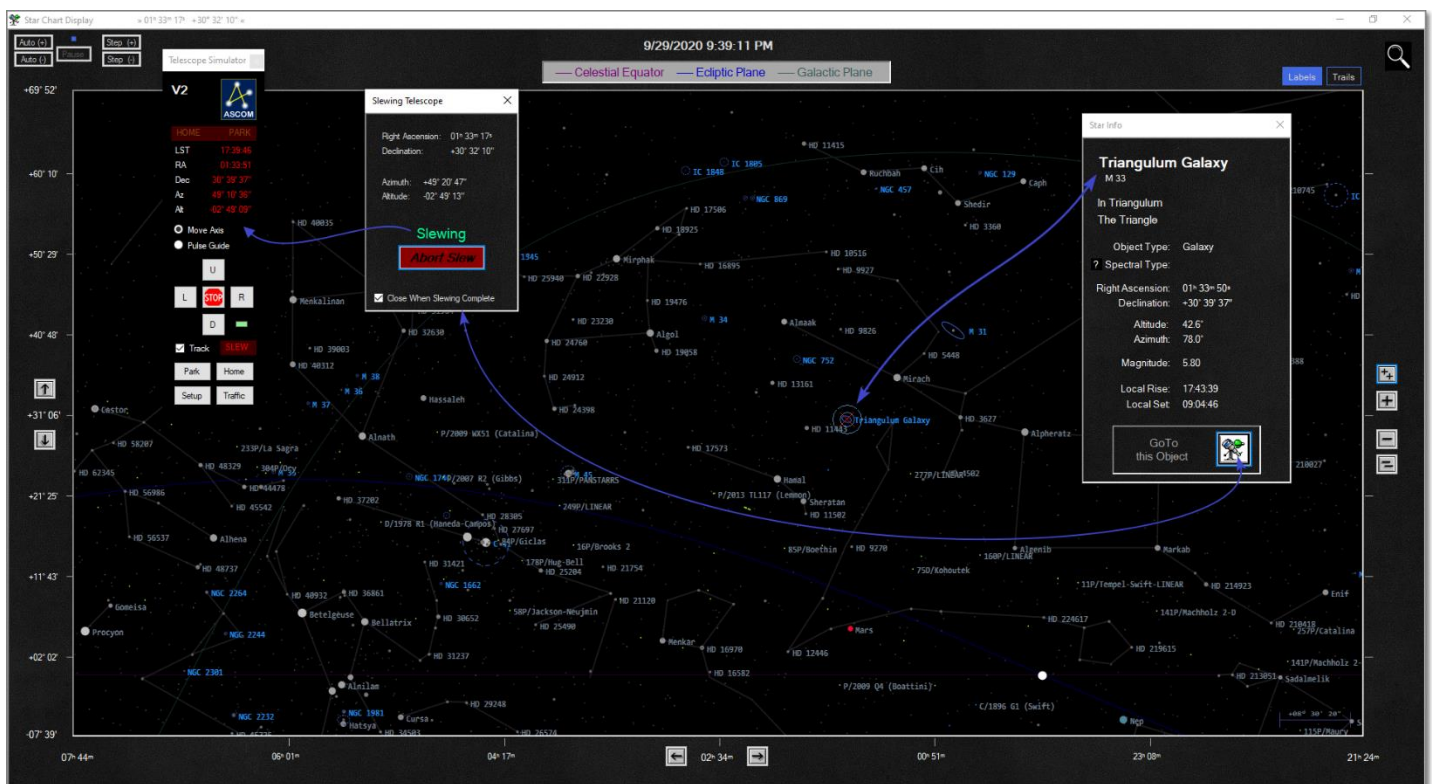
Not only can you search for specific Planets Stars, Deep Space Objects by name, you can also search using the following Key Words.

- **"Planets"** will list just our solar system's Planets
- **"Comet"** will list all Comets
- **"Deep"** will add all objects contained in the file **"C:\ProgramData\Hubble-II\DataFiles\DeepSpaceExtras.xml"** to the list
- **"Sun"** will place our sun to the list
- **"Moon"** will place our moon to the list
- **"Telescope"** will place the current position of the Telescope Mount to the list
 - o Note: There must be an ASCOM controlled telescope connected and active for this keyword to work

7 Telescope Mount Control

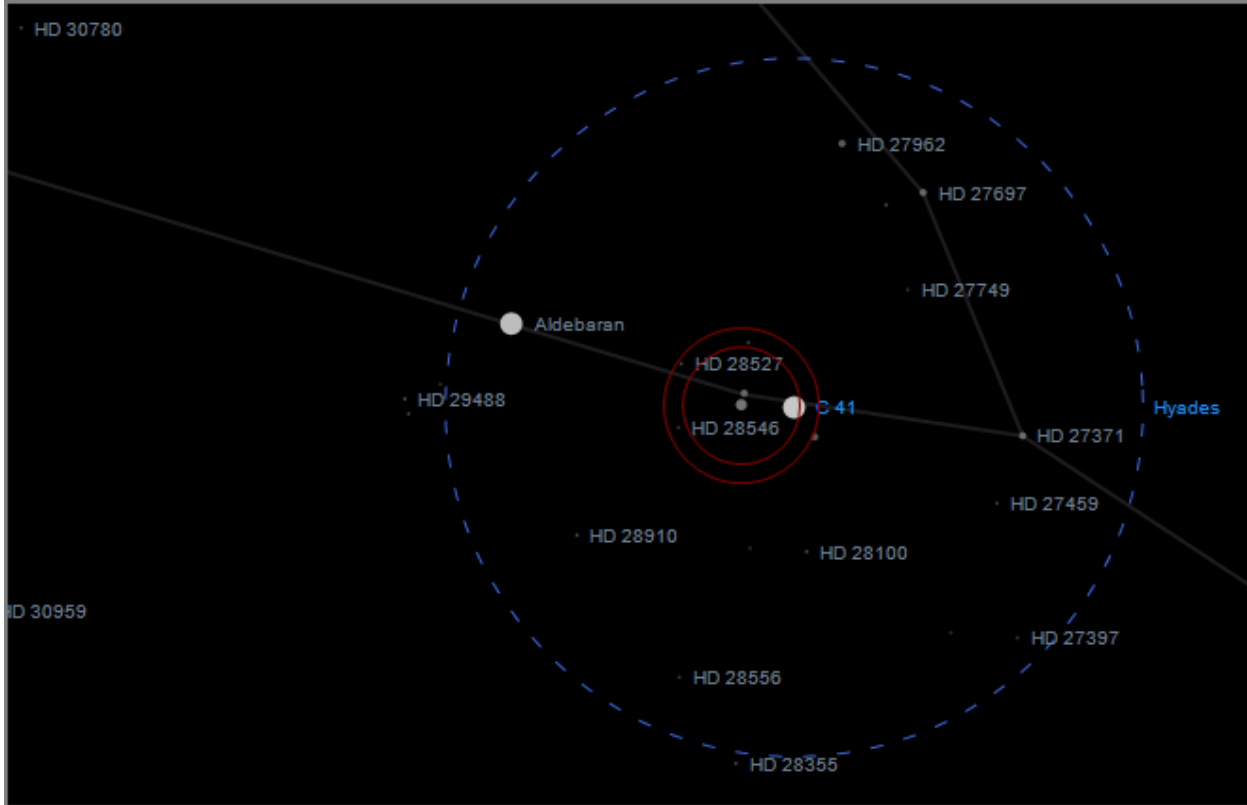
Hubble-II has the ability to control, and monitor, the position of a telescope mount if it is being used through the [ASCOM Platform](#). After selecting a Planet, Star, DSO, Comet or Asteroid, a PopUp Information window will appear. This selection could have been made either by clicking on a celestial object appearing on one of the [graphical displays](#), or by using the [Find Object](#) feature. If a telescope mount is actively being accessed through ASCOM, the “GoTo” button will be illuminated. Pressing that button will instruct the telescope mount to slew to the right ascension / declination of the object. If the telescope’s configuration settings have been placed in ‘Tracking Mode’, the telescope should then maintain its aim at that location in the sky. (note: this is a function of your telescope mount, not Hubble-II)

Note: the Telescope Simulator in the screen shot below represents the physical telescope mount controller that is part of your physical telescope.



Telescope Mount control with Hubble-II

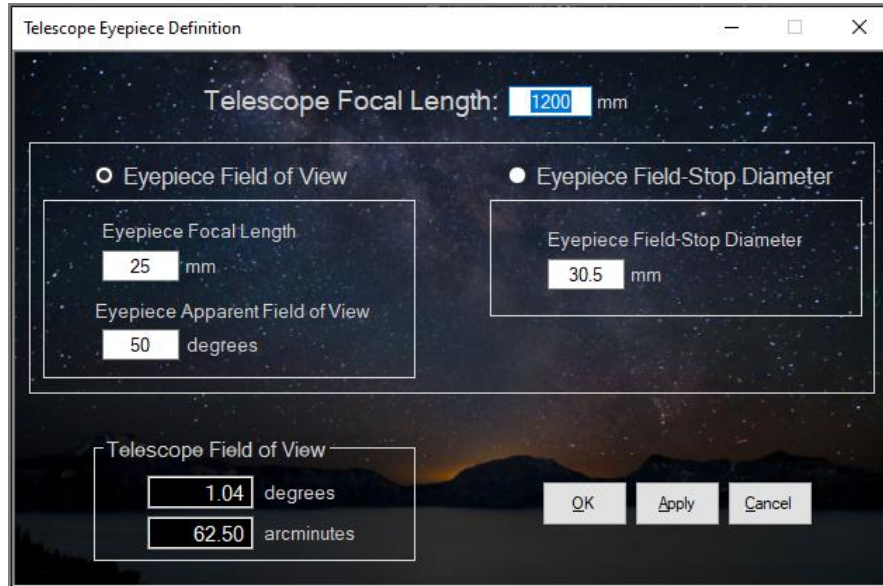
Hubble-II also monitors the telescope’s aimed-position in the sky. With an ASCOM telescope mount connected, the current location that the telescope is aimed in the sky is marked on the graphical displays. (to enhance the marker’s visibility, Ctrl-Alt-Shift-T will toggle drawing it darker)



Display of current Telescope Mount Aimed Position

To use this feature, the telescope mount must be under the control of the [ASCUM Platform](#). As well, this feature is only available to [Registered Users](#) of Hubble-II.

7.1 Telescope Eyepiece Definition



Telescope Eyepiece Definition Screen

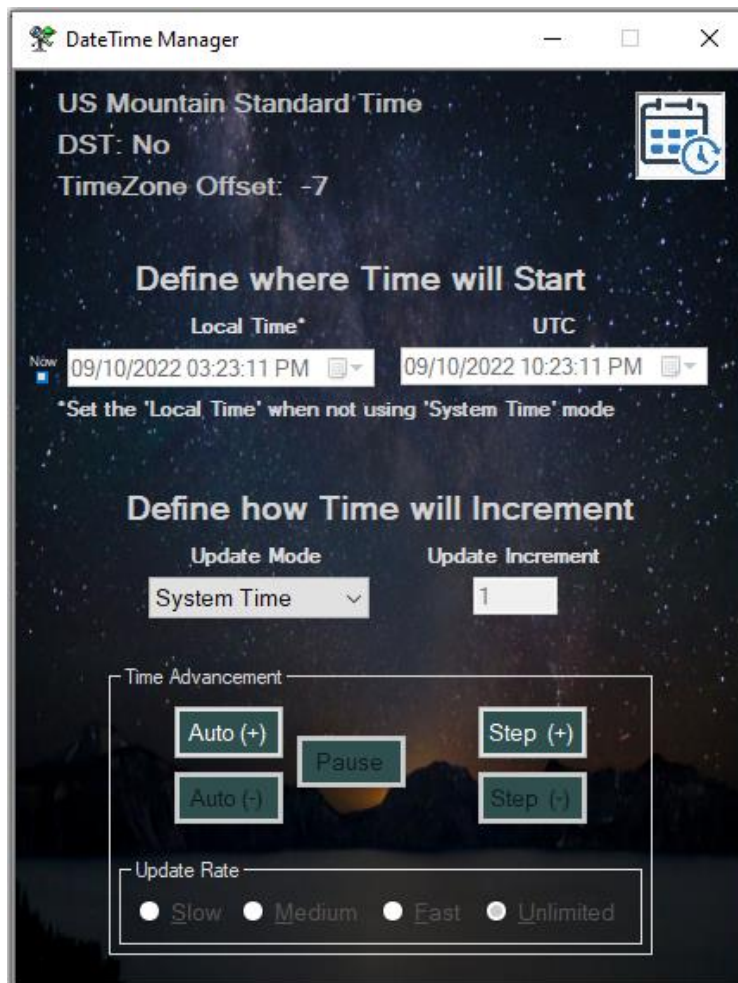
When looking through the eyepiece of a telescope, only a limited **Field Of View** is seen. This field of view is determined by the optical characteristics of the telescope's eyepiece.

By configuring these characteristics within Hubble-II, the program's graphical displays can draw this Field-of-View on the display so that you'll have an idea of what celestial bodies will be seen when looking through the actual telescope.

The calculation of Field of View is supported in two different ways. Both use the Telescope's Focal Length. With that, you can either select the **Eyepiece Field of View** method or the **Eyepiece Field-Stop Diameter** method. Choose whichever you have the specs for, and enter the values. The **Telescope Field of View** will be calculated as you enter those values.

To access this configuration screen, use the menu option of "Telescope / Define Eyepiece..." on the Main display's menu bar.

8 DateTime Manager



This dialog is used to define the date and time for which the displays are drawn, and to define how much time passes on each consecutive display advancement.

Update Mode - If *SYSTEM TIME* mode is selected, the computer's internal system clock is used to derive the time for each consecutive display advancement. Any of the other Update Modes is considered a *User Defined Time*.

Selections of update modes, other than *SYSTEM TIME*, use the *User Defined Time* values as described below. Incrementing each consecutive display is done by adding the *Update Increment* to the current displayed time, according to the Update Mode.

'Day' increments can be made in [Solar Days](#), [Sidereal Days](#), or [Lunar Days](#).

Update Increment defines how much time (of the specified Update Mode) is added to each consecutive display advancement. It is used whenever the Update Mode is not set to *SYSTEM TIME*.

The value of *Update Increment* is ignored in *SYSTEM TIME* mode, since the update to the time is simply the new system time.

Update Rate controls how fast the Update Increment amount is applied to calculate the next display time. The following are the settings and what they mean...

Slow - The time between Display Updates is done slowly, at 2 updates per second. Slowing down the display update rate may help make the movement of objects more distinct.

Medium - The time between Display Updates is done at a more moderate rate, at 10 updates per second.

Fast - Display Updates are done at an even Faster rate, up to 20 updates per second.

Unlimited - Display Updates are done at the Fastest rate possible, basically as fast as your CPU can calculate and your Graphics Card can draw!

Note: that this causes a Very High system load, and display animations may stutter if the system can't keep up.

Month, Day, Year, Hour, Minute, Second are used to set a '*User Defined*' start time. These values are used as the time for all update modes other than the *SYSTEM TIME* mode.

The user defined time on the left is specified in [Local Time](#), including Daylight Savings Time when applicable. The user defined time on the right is specified in [UTC](#). Either Local or UTC time can be entered, and the other will automatically be set accordingly based on the settings in the [Location Manager](#).

To save changes to these parameters, the [Save Custom User Configuration](#) feature must be used.

The **Time Advancement** buttons are composed of 5 separate buttons. The function of all 5 buttons in changing the time and repaint the display according to the new time. These buttons are:

Auto (+) Starts the program *incrementing* automatically by the Update Mode and Update Increment. The display continues to increment the time until the **Pause** button is pressed.

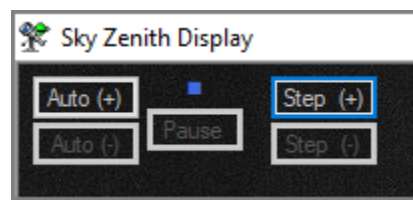
Auto (-) Does the same as Auto (+) but *decrements* the time by the Update Mode and Update Increment. The display continues to decrement the time until the **Pause** button is pressed.

Pause After Auto (+) or Auto (-) have been pressed, and the display time is being automatically advanced, Pause will stop that advancement.

Update (+) *Increments* the time *once* by the Update Mode and Update Increment.

Update (-) *Decrements* the time *once* by the Update Mode and Update Increment.

8.1 Mini DateTime Manager



On each of the Graphical Displays, a mini DateTime Manager is provided. This will allow starting, pausing, and stepping of the display time without having to bring up the full DateTime Manager.

By doubling clicking the small blue square button on the Mini DateTime Manager, the full DateTime Manager will be launched and brought forward.

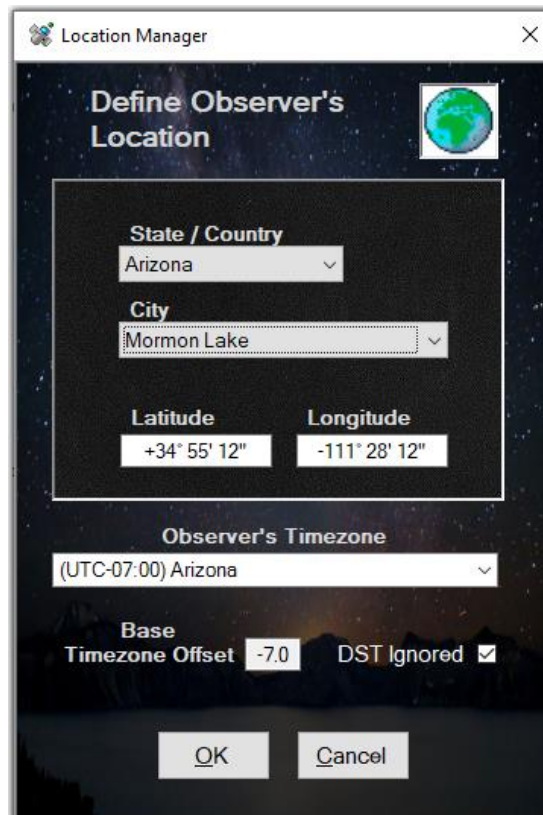
NOTES:

During Auto Updating, some of the buttons are grayed, indicating that they are not available until the Pause button is pressed.

If the current Update Mode is the SYSTEM TIME mode. The Auto (-) and Update (-) buttons are not available and will be grayed.

See the [Time Updating](#) menu for more information on how time is incremented.

9 Location Manager



The Location Manager is where you define where you are viewing the sky from on Earth. Depending on where you are viewing the sky from, and the display you are viewing, bodies appear in different positions in the sky. Value on the [Numerical Displays](#), Rise and Set times for example, also rely on knowing your location on the planet.

Your location definition is used on the following screens:

[Horizon](#)

[Zenith](#)

[Planetary Rise / Set Times](#)

[Planetary Positions](#)

[Planetary Distances](#)

Longitude is the observer's [longitude](#) on Earth.

West of the Prime Meridian is **negative** and East is **positive**.

Example: Mpls, Mn. is approximately -90
 Columbus, Ohio is approx. -80

Latitude is the observer's [latitude](#) on Earth. North of the Equator is **positive** and South of the equator is **negative**.

Example: Mpls, Mn. is approximately +45
 Columbus, Ohio is approx. +40

Complete the setup of the Location Manager by entering your State or Country, and then choosing the city. The longitude and latitude for that city will populate automatically. If you would rather hand-enter a longitude and latitude, Hubble will find the nearest State / Country and City to that location and fill those fields in. Note: Latitude and Longitude can be entered in either the H° M' S" format, or in the D.ddd decimal number format.

Observer's Timezone describes the difference between [GMT](#) and [Local Time](#). If the State / Country and City are known, the observer's time zone may be automatically filled in. If it is not, you can manually select the appropriate selection.

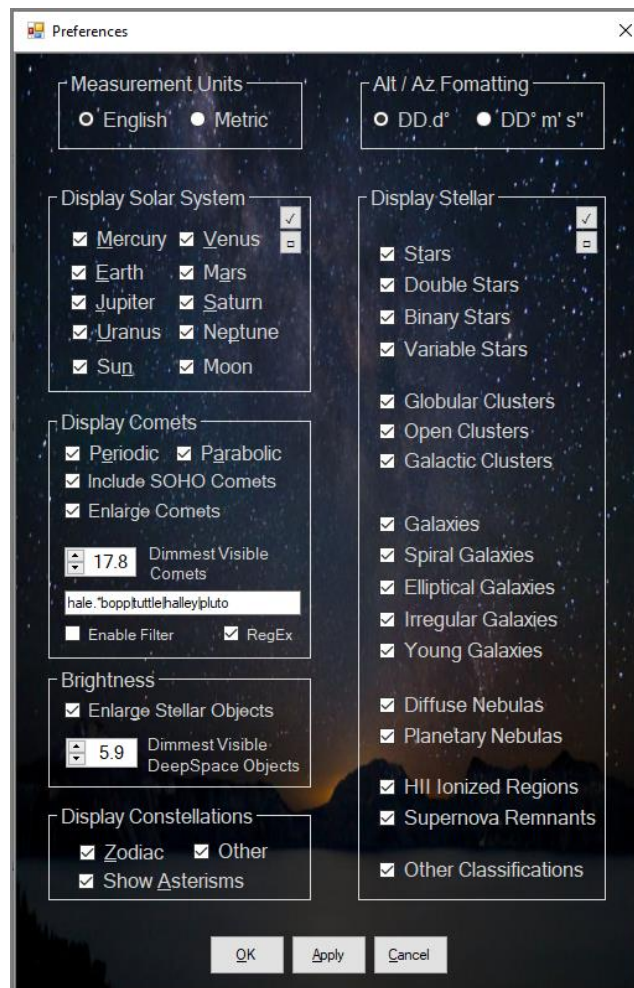
Base Timezone Offset is the value that is the difference between the selected timezone and [Greenwich Mean Time](#) (during non-DST dates). Upon choosing the Observer's Timezone, this value should be automatically populated. If for some reason it is not correct, it can be manually overridden.

Example: USA Central Time is a -6.
 USA Eastern Time is a -5.
 New Zealand is a +12.
 Arizona Time is always a -7.

DST Ignore is an option that overrides whether the selected timezone supports [Daylight Savings Time](#). When an Observer's Timezone is selected, that is known to not adopt DST, this value can be checked to override the default for that selected timezone. Arizona is an example of a state that does not change to DST.

To save changes to these parameters, the [Save Custom User Configuration](#) feature must be used.

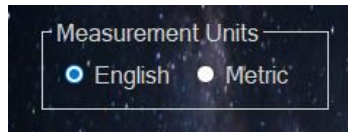
10 User Preferences



On the Main window, under the menu selection of “Edit / Preferences”, will open a form that will allow you to customize your User Preferences. Below is a description of each of those preference sections.

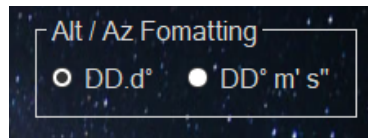
To save any changes you make to these settings, the [Save Custom User Configuration](#) feature must be used.

10.1 English or Metric Units



When units of measure are shown, this setting allows the choice between English and Metric units.

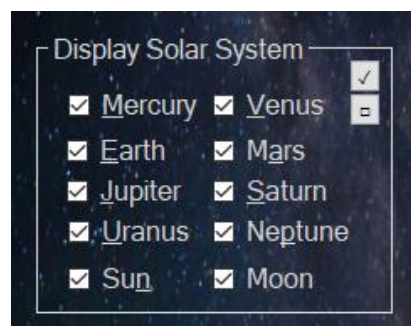
10.2 Altitude / Azimuth Formatting



This provides the option of having Altitude and Azimuth displayed as either Degrees with a decimal fraction, or in the format of Degrees / Minutes / Seconds.

This setting affects the Planet, Comet and Deep Space Object popup information dialogs as well as the Planetary Position and Rise / Set Time windows.

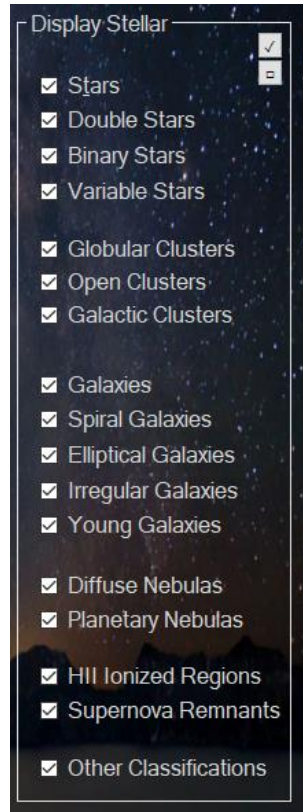
10.3 Solar System Objects Selection



This menu allows the selection of which objects within our solar system will be displayed. The setting applies to both the [Graphical Displays](#) and the [Numerical Data Display](#). If the object is checked, it will be displayed, otherwise it will be hidden.

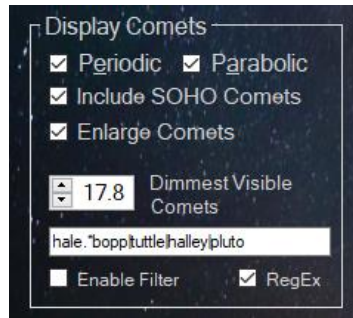
On the Solar System display, the Moon will be displayed any time the Earth is being displayed, regardless of its setting on this screen.

10.4 Stellar Objects Selections



Enabling the Deep Space Stellar objects will allow them to be displayed / or removed from the Graphical Displays.

10.5 Display Comets



The two selections, Periodic and Parabolic, allow you to enable the displaying of these types of comets on the Graphical Displays. Periodic comets (green) orbit the Sun, returning periodically after so many years. Parabolic (blue) comets fall in towards the Sun on a trajectory that ejects them from our solar system, never to return again.

The selection of 'Include SOHO Comets' is available if Parabolic Comets are being displayed. When selected, comets discovered by the [SOHO satellite](#) will be included. There are a lot of these comets, and the display speed will be impacted by including them.

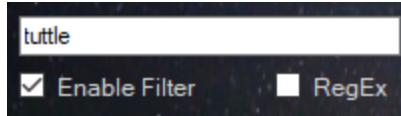
The Dimmest Visible Comets setting allows you to limit the number of comets displayed. Since comets closer to the Sun are generally brighter, filtering by apparent magnitude will be effectively limiting comets to those closer to the Sun.

Enlarge Comets is similar to Enlarge Stars. It causes comets to be drawn as a cross for increased visibility.

10.5.1 Filtering Comets by Name

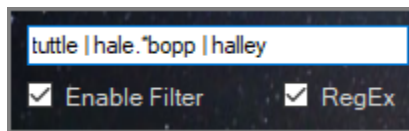
To help limit the number of comets being display, Hubble-II provides a filtering mechanism. When 'Enable Filter' is checked, only comets whose name matches the search string will be display.

Note that when Filtering is used, the value of 'Dimmest Visible Comet' is not used. All comets that match the name will be displayed regardless of their current magnitude.



In this example, only comets that have “tuttle” in their name will be displayed. To be clear, All comets that have “tuttle” somewhere in their name will be displayed. i.e. ‘41P/Tuttle’, ‘8P/Tuttle’, etc.

10.5.1.1 Using Regular Expressions as a Filter



In this example, regular expressions are being used. Regular Expressions are an advanced concept, beyond the scope of this user guide. But a quick introduction will explain the basics.

The example filter string of “tuttle | hale.*bopp | halley” would match any comets with their names containing “tuttle”, OR “Hale{any group of characters}Bopp” OR “Halley”.

(all matches are Case Insensitive)

Here are some simple basics.

- The “|” character means OR. “123|456|abc” matches on names containing “123” OR “456” OR “abc”.
- “.*” means that any group of characters are a match. So “abc.*xyz” would match on any names that are like “abc34892c3c32tfxyz”
- [0-9] means any number in the range from 0 through 9. So “P/202[0-9]” will match on any comet with names like “P/2020”, “P/2021”, ... “P/2029”
- [1,3,5,9] means it will match those specific numbers. So “P/202[1,3]” will display any comet with names like “P/2021” or “P/2023”
 - o [1,3,5,9] can be written in a simpler form of [1359] as well
 - o [abjkq] is also valid. It matches against any of the characters in the list (a, b, j, k, or q)
- Combining the last two concepts, “[CP]/202[0,2]” is valid too. Comet “C/2020” would match, as well as Comets with names like “P/2020” and “C/2022”
- While the above examples like [1378] are matches against a single character (1, 3, 7, and 8), ‘words’ can be OR’d together for matching as well. “[2022|halley|tuttle]” matches against “2022” OR “halley” OR “tuttle”. So, all the comets with “halley”, “tuttle”, or “2022” in their names will be displayed.
- To exclude particular comet name(s), use a syntax like this “^(?!test|extras)”. It will display all comets that don’t contain the string “test” or “extra” in their names.

For a more in-depth explanation of Regular Expressions, [here’s a website](#) to get you started.

In general, keep in mind that the more comets being displayed, the slower the update rate will be on the [graphical displays](#).

If you are a [Registered User](#), you also have the ability to add your own comets. The [CometsDataExtras.txt](#) file can be added to. As new comets and asteroids are discovered, you'll be able to add them to the file and track their orbits through the solar system and beyond.

Note: Only registered copies of *Hubble-II* display Parabolic Comets

10.6 Brightness Selections



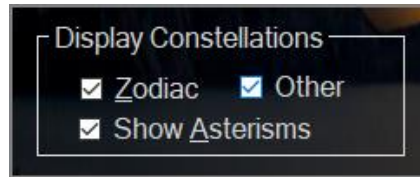
10.6.1 Enlarged Stellar Objects

If set, brighter Deep Space objects will be drawn larger than dimmer Deep Space objects. Although this selection creates objects which are not true to size, it may be helpful to better visualize and identify objects by intensity.

10.6.2 Dimmest Object

This setting defines a limit on the dimmest Deep Space object that will be drawn on the displays. After changing the value, hovering over the value will show the number of objects that will be drawn at that limit setting. Note that no matter how Dim this value is set to, there are never more than 25,000 objects drawn on the displays.

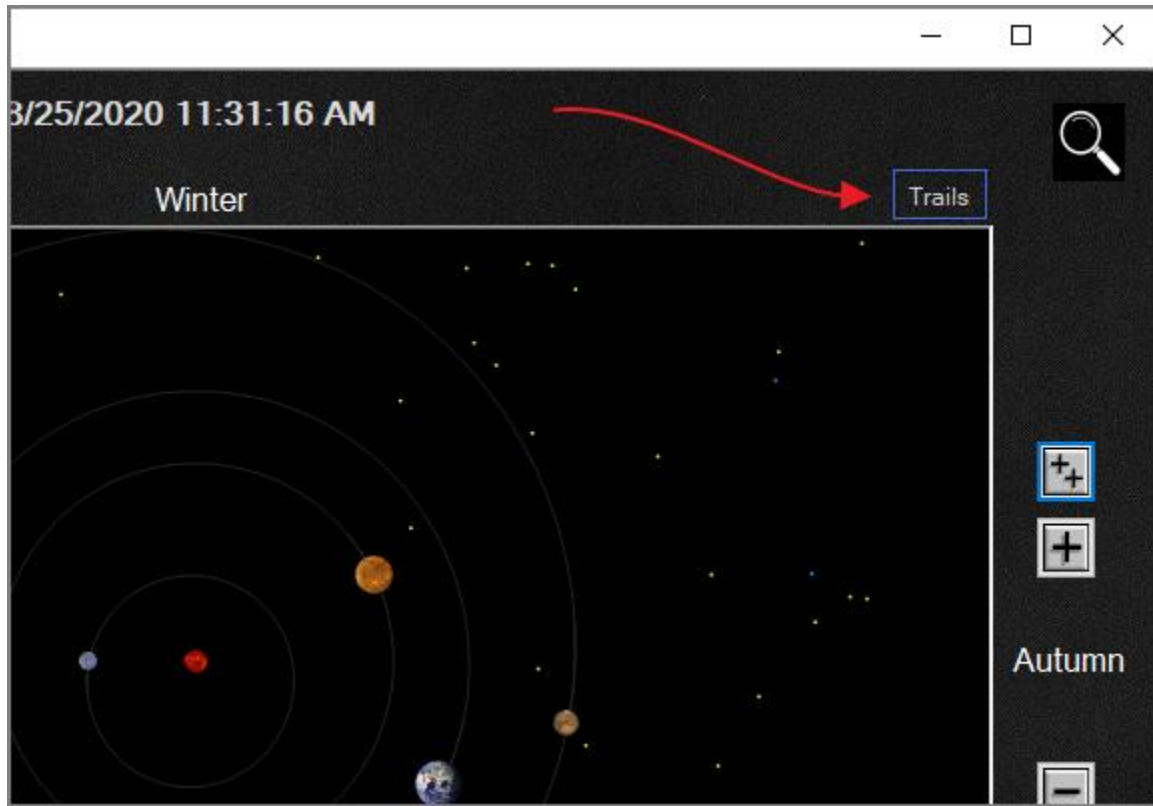
10.7 Display Constellations



When checked, Constellations are displayed on the Star Chart, Horizon, and Zenith graphical displays. Constellations are divided into two categories, those that are part of the [Zodiac](#), and all the rest.

Drawing the constellations shapes is moderately CPU intensive, and can have an impact on the rate at which [Demonstrations & Animations](#) are played.

10.8 Leaving Object Trails



Trails selects whether the bodies on the [graphical displays](#) leave a trail behind themselves as they move. This is useful for examining the paths they follow. The configuration of this setting is not on the User Preferences screen, but rather is controlled individually on each of the graphical displays. The selection checkbox is in the upper right corner of each graphical display.



When Leave Trails is selected, the Date and Time displayed at the top of the screen changes. The current time is copied to the left side of the window, the current time is displayed on the right side, and the amount of time that has passed is shown in the middle.

This shows the time that the bodies started leaving trails and is useful for seeing how much time passed to generate the trail paths showing on the display.

11 Hot-Key Quick Access

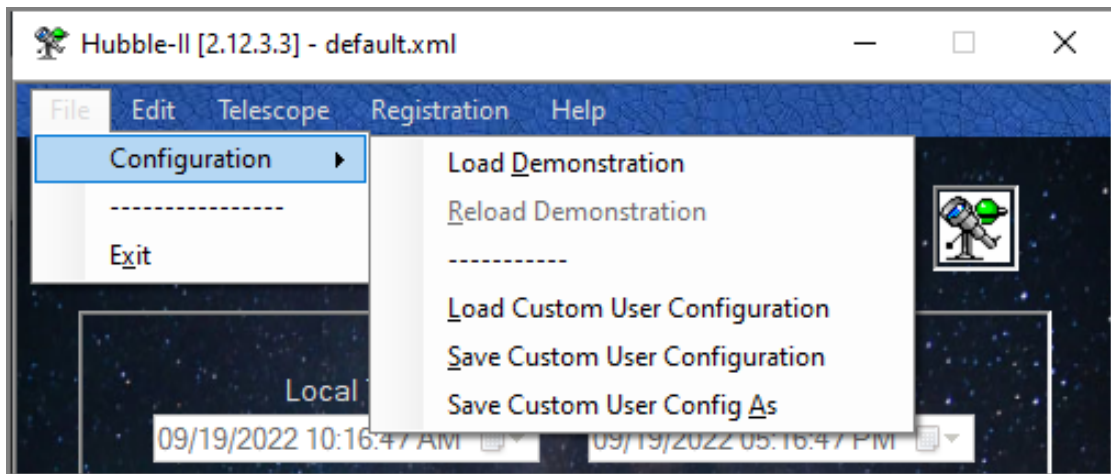
For quick access to the different Displays, as well as some of the more common configuration settings, Hot-Key combinations are provided. While on any of the displays within Hubble-II, pressing these key combinations have the effects as described in the table below.

These Hot-Keys can make changing settings more convenient, without having to leave the display you're currently viewing. This can be especially helpful while viewing animations. The following are most of the available Hot-Keys; use F1 in the application for the complete list.

F1	Launch the HotKey Definitions dialog
Alt M	Bring the M ain display forward
Alt H	Launch the H orizon display
Alt Z	Launch the Z enith display
Alt C	Launch the Star C hart display
Alt S	Launch the S olar System display
Alt J	Launch the J upiter Moons display
Alt I	Launch the S ize Comparison display
Alt R	Launch the Planetary R ise/Set Times display
Alt O	Launch the Planetary p ositions display
Alt D	Launch the Planetary D istances display
Alt F (or Ctrl F)	Launch the F ind Object dialog
Alt P	Launch the P references menu
Alt T	Launch the Date T ime Manager menu
Alt L	Launch the Date L ocation Manager menu
Ctrl C	Toggle the current state of whether C ometes are being displayed
Ctrl G	Toggle the G rid lines on the active graphical display
Ctrl T	Toggle the current state of whether a T elescope mount is connected
Ctrl Alt Shift T	Toggles the drawing of the T elescope Position Marker to be either Normal or Enlarged / Darkened
Ctrl N	Toggle the state of whether C onstellations are displayed
Ctrl E	Toggle the current state of whether Deep Space Objects are being drawn in an E nlarged representation
Ctrl O	Toggle the current state of whether c ometes are being drawn in an enlarged representation
Ctrl Z	Undo the prior Z oom/pan operation(s) (Horizon, Star Chart, and Solar System displays)
Ctrl Shift Z (or Ctrl Y)	Redo the last UnDo of Zoom/pan operation(s)

+	Start Auto Incrementing Display Update Timer (forward)
-	Start Auto Incrementing Display Update Timer (backward)
Ctrl +	Single Step Display Update Timer (forward)
Ctrl -	Single Step Display Update Timer (backward)
Space Bar	Stop Auto Incrementing Display Update Timer
Ctrl Alt T	Set the Update Mode to 'SysTem Time'
Ctrl Alt O	Set the Update Mode to 'by MOnths'
Ctrl Alt D	Set the Update Mode to 'by Solar D ays'
Ctrl Alt I	Set the Update Mode to 'by SIdereal Days'
Ctrl Alt L	Set the Update Mode to 'by Lunar Days'
Ctrl Alt U	Set the Update Mode to 'by LUnar Months'
Ctrl Alt H	Set the Update Mode to 'by H ours'
Ctrl Alt M	Set the Update Mode to 'by M inutes'
Ctrl Alt S	Set the Update Mode to 'by S econds'
Ctrl Alt 1 through Ctrl Alt 0	Set the Update Amount value from 1 to 10
F3	Close the currently active display window or dialog box (does not close the Main Form)
Esc	Same as F3, but not for Graphical or Numeric Displays, or the Main Form
Ctrl W	Close the currently active W indow
Ctrl X	Close all display windows and E Xit Hubble

12 Custom Configurations and Demonstration Setups



Hubble-II offers the ability to Save Custom User Configurations, or load preexisting ‘*Demonstration*’ configurations. As an example, after first defining your geo-location on Earth, along with your other favorite preferences, you can save this as your ‘Favorite’ Custom User Configuration. As startup, *Hubble-II* will automatically reload the last ‘Favorite’ configuration you were using the last time you ran the program.

As each configuration is created, you are able to add a full description of its purpose. This description will then be presented each time that configuration is loaded.

Demonstration Configuration are pre-canned examples of what Hubble-II can do. They are also each intended as a mini astronomy lesson.

Note: Writing over preexisting Demonstration Configurations is not allowed. However, you can save the demonstration configuration under a new name as your own Custom User Configuration. You can then modify that copy as much as you wish.

12.1 Demonstration Configurations

Hubble-II includes predefined Demonstration Configurations. These demonstrations are provided to show you some examples of what the program can provide in the way of automated presentations. They are also provided as as a mini astronomy lesson. When you load a demonstration configuration, you will see a pop-up window that explains the astronomical significance of that particular demo.

Just like saving your 'Favorite' configuration, you can create your own demonstrations and save them for quick access.

13 Daylight Savings Time (DST)

Your system clock should always be set to the correct [Local Time](#). This includes daylight savings time if applicable. If daylight savings time is not instituted where you are located, or you do not want to set your system's clock in daylight saving time, Select **DST Ignored** on the [Location Manager](#) screen. This will instruct the program not to make any corrections for daylight savings time, and will expect the clock to be set to Local Standard time.

To save changes to this selection, the [Save Custom User Configuration](#) feature must be used.

14 DeepSpaceExtras.xml File Format

[Registered Users](#) are able to add objects to the file called `/DataFiles/DeepSpaceExtras.xml`. The DataFiles directory can be found in `"C:/ProgramData/Hubble-II/DataFiles/"`

The following shows 2 example objects in that file. To add additional objects, duplicate either the yellow or the green highlighted sections and replaces the details for the new object.

Most of the fields are self-explanatory, but following describes a few of the less apparent.

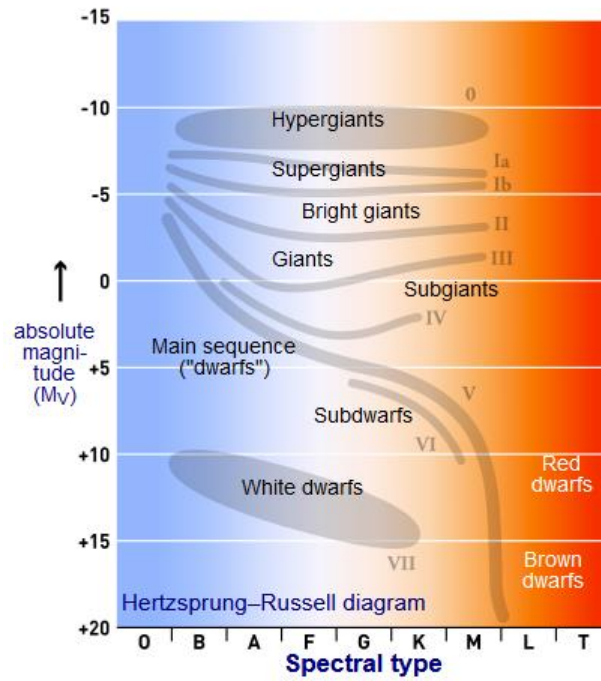
Constellation gives the name of the Constellation the object lies in. It may be left blank.

StarType defines the Type of 'star' the object is, and are the same as the selections under the menu option of "Edit / Preferences". Valid values are:

- SS – Star
- SV – Variable Star
- SD – Double Star
- SB – Binary Star
- NP – Planetary Nebula
- ND – Diffuse Nebula
- GY – Young Galaxy
- GE – Elliptical Galaxy
- GI – Irregular Galaxy
- BS – Barred Galaxy
- GS – Spiral Galaxy
- GP – Spherical Galaxy
- CO – Open Cluster
- CG – Globular Cluster
- GC – Galactic Cluster
- SA – Messier Object
- – Undefined

SpectralType describes the colors that the body is generating.

Use values such as "F2" (but the field is free-format if you choose)



The file, which is a standard XML layout, has the following format:

```
<?xml version="1.0" encoding="utf-8"?>
<ArrayOfDeepSpaceXmlObject xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <DeepSpaceXmlObject>
    <Name>Example Deep Space Object One</Name>
    <RightAscension>12.0</RightAscension>
    <Declination>-10.1</Declination>
    <Magnitude>-1.11</Magnitude>
    <Constellation></Constellation>
    <StarType>SS</StarType>
    <SpectralType></SpectralType>
  </DeepSpaceXmlObject>
  <DeepSpaceXmlObject>
    <Name>Example Deep Space Object Two</Name>
    <RightAscension>0.00001</RightAscension>
    <Declination>-0.1</Declination>
    <Magnitude>-2.11</Magnitude>
    <Constellation></Constellation>
    <StarType>SS</StarType>
    <SpectralType></SpectralType>
  </DeepSpaceXmlObject>
</ArrayOfDeepSpaceXmlObject>
```

15 CometData.txt File Format

This file contains the orbital elements for periodic and parabolic comets.

The CometData.txt file, which contains the orbital elements for all comets, is located in the file folder named

“C:/ProgramData/Hubble-II/DataFiles/CometData.txt”

The data in this file comes directly from NASA’s JPL comet database.

If you are a [Registered User](#), you can view the over 3,500 comets contained in this file.

Non-Registered Users are limited to viewing the first 50 Comets.

Since comet orbits are highly influenced by the gravitational pull of the Sun and planets, their paths drift significantly from orbit-to-orbit around the Sun. This has the effect of making the comet data a perishable item, far more than the variations in the orbits of the planets themselves.

Given that, comet orbital values should NOT be considered 'permanent', and at some point need to be updated. A general rule of thumb is that a comet's orbital parameters are accurate for one to two passes of perihelion. Longer than that, and the accuracy of the comet's positional calculations quickly degrades. Updating comet data is easily done using the data file that can be download from JPL [at this link](#). (Information about the data can be [found here](#))

To refresh the data in CometData.txt, simply use the [JPL link](#) to download and overwrite the CometData.txt file.

Although it is not required to understand the format of the data coming from NASA/JPL, the cometdata.txt file has the following format:

Num		Number assigned to the asteroid or comet. Numbers are only assigned to secure short-period (<200 year) comets.
Name		Name given to the numbered asteroid or comet. Note: if the name is prefixed with a dash character ("-"), the entry is effectively 'Commented Out' and ignored.
Epoch	(MJD)	Epoch of the elements represented as the Modified Julian Date (MJD), which is defined as the Julian date - 2400000.5.
q	(AU)	Perihelion distance.
e		Eccentricity of the orbit
i	(deg)	Inclination of the orbit with respect to the J2000 ecliptic plane
w	(deg)	Argument of perihelion (J2000-Ecliptic)
Node	(deg)	Longitude of the ascending node (J2000-Ecliptic).
Tp		Time of perihelion as a calendar date (YYYYMMDD.DDD) where "YYYY" is the year, "MM" is the numeric month, and "DD.DDD" is the day and day fraction.
Ref		Orbit solution reference (not used by Hubble-II)

NOTE: ALL fields must be filled in. Currently, minimal verification is performed on the data.

NOTE: If the name is prefixed with a dash character (“-”), the entry is effectively ‘Commented Out’ and ignored.

15.1 User Defined Comets

Also available to Registered Users is the ability to add comets to a separate Extra Comets file, **“C:/ProgramData/Hubble-II/DataFiles/CometDataExtras.txt”**

This file is of the same format is described above.

Num / Name	Epoch	q (perih dist)	eccentricity	inclination	w (arg of perih)	longi of asc node	Epoch Date	Ref (not used)
C/2020 P1 (Neowise Test)	59101	45.05381720839782	1.000296889185875	45.05381720839782	8.894962102747048	53.53936560237292	20200909.0	JPL 10
Test Comet Number One	59101	1.01	0.000	0	8.894962102747048	53.53936560237292	20221122.0	
Test Comet Number One-A	59101	1.01	0.000	70	8.894962102747048	53.53936560237292	20221122.0	
Test Comet Number Two	59101	0.5	0.000	0	8.894962102747048	53.53936560237292	20221122.0	
Test Comet Number Three	59101	0.15	0.000	0	8.894962102747048	53.53936560237292	20221122.0	
Test Comet Number Three1/2	59101	0.075	0.000	0	8.894962102747048	53.53936560237292	20221122.0	
Test Comet Number Three1/4	59101	0.045	0.000	0	8.894962102747048	53.53936560237292	20221122.0	
Test Comet Number Four	59101	3.11	0.000	90	8.894962102747048	53.53936560237292	20221122.0	
Test Comet Number Five	59101	1.01	0.500	0	8.894962102747048	53.53936560237292	20221122.0	
Test Comet by Jupiter 8	59101	5.0	0.1	10	8.894962102747048	233.5393656037292	20231122.0	
Test Comet by Jupiter 188	59101	5.0	0.1	10	188.8949621747048	53.53936560237292	20231122.0	
Pluto's Orbit	59101	29.6460770414	0.2444	17.16	224.06676	110.30347	20240115.0	

Example of what the CometDataExtras.txt file could look like

As an example, let’s say we’d like to add asteroid “2022 EB”. The orbital data given on the [NASA / JPL page](#) shows

Orbit Parameters [\[hide\]](#)

Osculating Orbital Elements

Epoch 2460000.5 (2023-Feb-25.0) TDB Reference: JPL 4 (heliocentric IAU76/J2000 ecliptic)			
Element	Value	Uncertainty (1-sigma)	Units
e	0.4193631702535146	.00016912	
a	1.527876315101061	.00040364	au
q	0.887141259845022	2.4097E-5	au
i	12.7953207242411	.0039894	deg
node	340.3518955773487	4.3707E-5	deg
peri	128.9238727187089	.0014603	deg
M	208.7433306971853	.084956	deg
tp	2460290.329612984074	.27764	TDB
	2023-Dec-11.82961298		
period	689.8119676652498	.27336	d
	1.888602238645448	7.4842e-4	y
n	0.5218813486499264	.00020681	deg/d
Q	2.168611370357099	.00057291	au

This would translate into an entry in the CometDataExtras.txt file of

C/2022 EB 60000 0.887141259845022 0.419363170253514 12.7953207242411 128.9238727187089 340.3518955773487 20230225.0

16 Troubleshooting

Displays update slowly – Two factors determine the speed at which the display are updated. The first is the speed of your computer's CPU. The computations required to calculate the positions of the planets, comets, and deep space object are mathematically **Very Intensive**. The fast and more powerful the computer your is, the faster the displays will update. The second main factor that determines the maximum update speed is the video card in your computer. Older video cards are not able to draw objects to the computer's monitor(s) as fast as newer video cards are.

You can help your computer update the displays faster by limiting the number of stars, deep space objects, and comets that are being displayed. See the [User Preferences](#) section for more details on this. Drawing Object Labels is also graphics processing intensive, and will slow the refresh times.

Comet Positions aren't exactly correct – Comet are very small objects compared to planets and stars, so their orbits are highly influenced by the gravitational pull of other bodies as they orbit the Sun. Their paths drift significantly from orbit-to-orbit around the Sun. As their orbits drift, the orbital parameters that define their paths becomes outdated and invalid. This has the effect of making the data parameters that defines them a perishable item.

Given that, comet orbital values should Not be considered 'permanent', and at some point need to be updated. A general rule of thumb is that a comet's orbital parameters are accurate for one to two passes of perihelion. Any longer than that, and the accuracy of the comet's positional calculations quickly degrades.

For more information on updating comet data, read the [CometData.txt File Format section](#).

It should also be noted that Comet Magnitudes are very difficult to calculate exactly. The irregular shapes, and variations in the material that make up comets, make it hard to know the exact apparent magnitude that a comet will be. Hubble-II does its best to give a reasonable indication of how bright a comet might appear, but it is only an approximation.

Comets Seem Limited on Solar System Display – If you are seeing comets being drawn only for a small area in the center of the Solar System display, say for example only comets within the orbit of Jupiter are shown, this is likely due to the [Comet Magnitude Limit](#). The farther comets are from the Sun (and from the Earth) the dimmer they appear in the sky, and thus the magnitude limit may be set too low. Try increasing it and a larger diameter field of comets will be shown.

Comets Seem to Pop in and Out of Existence on the graphical displays - Because a comet's magnitude changes with its closeness to the Sun and the Earth, its magnitude is constantly changing as its position changes. When a comet suddenly appears or disappears it's because its magnitude crossed the 'visibility threshold' that you have defined on the [Preferences screen](#).

'Find Objects' marks empty space on the displays – If you select an object with the 'Find Objects' feature, but the position that is marked on the display is not pointing to anything, the reason for this is that you have entered a '*Dimmest Visible Objects*' value that is brighter than the dim object you searched for. Lower the value on the [Preferences screen](#) and the object will appear.

17 Glossary

The following are common terms used in Astronomy, along with a brief explanation of their meaning.

17.1 Latitude

Latitude is the angle measured up and down from the Equator. North of the Equator are positive values, South are negative values.

17.2 Longitude

Longitude is the angle measured around the Earth from the Prime Meridian. West of the Prime Meridian are negative values and East are positive values.

17.3 Time Zone

A Time Zone is one of the 24 regions of the Earth, approximately coinciding with the meridians, at successive hours from the observatory at Greenwich England.

17.4 Greenwich Mean Time (GMT)

GMT is the basis for the measurement of time on Earth. [Local Time](#) is derived from GMT and your [Time Zone](#). A time zone of +6 means that your location is 6 hours behind the time at Greenwich, England.

17.5 Local Time

Local Time is the time with reference to your location on Earth based on your [Time Zone](#) and includes Daylight Savings Time when in effect.

17.6 Right Ascension

Right ascension is the angular distance of an object measured eastward along the celestial equator from the Sun, on March's Vernal Equinox (First Point of Aires), to the object in question above the earth.

17.7 Declination

Declination is the angle, measured in the equatorial system, perpendicular to the Equator North is *positive* and *South* is negative.

17.8 Altitude

Altitude is the angle up from the horizon. Negative altitude means that the object is below the horizon. 90 degrees means that the object is directly overhead.

17.9 Azimuth

Azimuth is the angle from the north point measured on the horizon. North is 0, East is 90, South is 180 and West is 270 degrees. This is the same measurement as made by a common compass.

17.10 Celestial Equator

This line indicates the great circle of the imaginary Celestial Sphere on the same plane as the equator of Earth. This plane of reference is the basis of the Equatorial Coordinate System. In other words, the Celestial Equator is an abstract projection of the Terrestrial Equator into outer space.

17.11 Galactic Plane

The Galactic Plane indicates the plane on which the majority of stars in our galaxy lie. This broad band of faint light across the night sky is often referred to as the 'Milky Way'.

17.12 Ecliptic Plane

The Ecliptic Plane indicates the imaginary plane containing the Earth's orbit around the sun.

17.13 Perihelion

Perihelion is the point in the orbit of a planet, asteroid, or comet at which it is closest to the sun.

17.14 Aphelion

Aphelion is the point in the orbit of a planet, asteroid, or comet at which it is farthest from the sun.

17.15 Astronomical Unit (AU)

An Astronomical Unit is the length of the semi-major axis of the Earth's orbit about the Sun. It is equal to approximately 149.6 Million Kilometers or 92.96 Million Miles.

17.16 Phase

Phase is the degree measure of how much of an object appears illuminated by the Sun as viewed from Earth. 0.0 means that the object is reflecting no light back to Earth, i.e. a New Moon. 180 means that the full disk of the object is reflecting light, i.e. a Full Moon.

17.17 Magnitude

Magnitude is the unit defined on a logarithmic scale which measures brightness. The more negative the value brighter the object.

i.e. An object whose magnitude is 1.0 is 10 times brighter as an object of magnitude 2.0.

17.18 Solar Day

A Solar Day is one revolution of the Earth, with reference to our Sun (instead of the Stars). It is approximately equal to 24 hours. This is what is commonly known as a 'Day'.

17.19 Sidereal Day

Sidereal Day is one revolution of the Earth, with reference to the background stars (instead of the Sun). It is approximately equal to 23 hours and 56 minutes.

17.20 Lunar Day

Lunar Day is one revolution of the Earth, with reference to the Moon (instead of the Sun). It is approximately equal to 24 hours and 50 minutes.

17.21 Lunar Month

Lunar Month is one orbit of the Moon around the Earth, with reference to the background stars. It is approximately equal to 29 days, 12 hours and 44 minutes.

17.22 Zodiac Constellations

Zodiac constellations are those constellations that lie along the [plane of the ecliptic](#). The Zodiac constellations are those that are commonly used in Astrology to mark a person's birth.

17.23 DSO

DSO stands for Deep Space Object. A Deep Space Object is any non-stellar object (not a star). Objects such as Galaxies, Nebulae, and Clusters represent the class of DSOs

17.24 SOHO

Solar and Heliospheric Observatory (**SOHO**) is a spacecraft built by a European industrial consortium that was launched on December 2, 1995 to study the Sun. **SOHO** has also discovered over 3,000 comets.