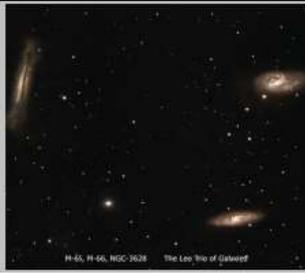
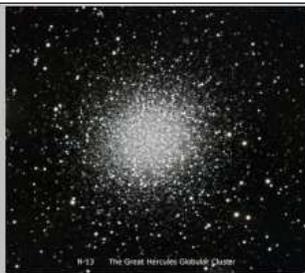


# 2021 Astronomy Desk Calendar Photos

 <p>M-42 - The Great Orion Nebula</p>	<p><b>Month:</b> January  <b>Object:</b> <a href="#">Orion Nebula</a>  <b>Constellation:</b> <a href="#">Orion</a>  <b>AKA:</b> M-42, NGC-1976  <b>Date(s):</b> 2019-01-25  <b>Classification:</b> <a href="#">Diffuse Nebula</a>  <b>Hardware:</b> C-11 Telescope  <b>Exposure Info:</b> 2hrs 39min</p>	<p>The Orion nebula is one of the brightest deep sky objects in the sky and can be seen with the naked eye. It is part of Orion's sword. The nebula is a huge gas cloud 1,344 light years from earth and is a stellar nursery where stars are born. The newly formed stars energize the gas surrounding them so that it emits light much like a neon light.</p>
 <p>M-65, M-66, NGC-3628 - The Leo Trio of Galaxies</p>	<p><b>Month:</b> February  <b>Object:</b> <a href="#">Leo Trio of Galaxies</a>  <b>Constellation:</b> <a href="#">Leo</a>  <b>AKA:</b> <a href="#">M-65</a>, <a href="#">M-66</a>, NGC-3628  <b>Date(s):</b> 2020-04-14, 15  <b>Classification:</b> <a href="#">Galaxy Group</a>  <b>Hardware:</b> C-11 Telescope  <b>Exposure Info:</b> 3hrs</p>	<p>These three neighboring galaxies are classic examples on how the similar objects can appear quite different depending on how you view them. They are all spiral galaxies (similar to our galaxy) but viewed at different angles. These trio of galaxies are approximately 30 million light years away.</p>
 <p>M-13 - The Great Hercules Globular Cluster</p>	<p><b>Month:</b> March  <b>Object:</b> <a href="#">The Great Hercules Cluster</a>  <b>Constellation:</b> <a href="#">Hercules</a>  <b>AKA:</b> M-13  <b>Date(s):</b> 2020-04-22  <b>Classification:</b> <a href="#">Globular Cluster</a>  <b>Hardware:</b> C-11 Telescope  <b>Exposure Info:</b> 1hr 12min</p>	<p>The most spectacular globular cluster in the visible in the northern hemisphere. M-13 is a sphere about 150 light years in diameter of hundreds of thousands of stars gravitationally bound to each other orbiting our galaxy at a distance of about 25,000 light years.</p>
 <p>M-78 - The Horsehead Nebula</p>	<p><b>Month:</b> April  <b>Object:</b> <a href="#">Blue Horsehead Nebula</a>  <b>Constellation:</b> <a href="#">Scorpius</a>  <b>AKA:</b> IC-4592  <b>Date(s):</b> 2020-05-21  <b>Classification:</b> <a href="#">Reflection Nebula</a>  <b>Hardware:</b> C-11 Telescope  <b>Exposure Info:</b> 2hrs 20min</p>	<p>This is a Reflection Nebula molecular cloud complex is composed of a lot of fine dust that would normally appear as a dark nebula, but the star that represents the eye of the horse head is causing the nebula to reflect in a blue hue as opposed to red with is characteristic of most emission nebula that are composed mostly of gas.</p>
 <p>B-72 - The Snake Nebula</p>	<p><b>Month:</b> May  <b>Object:</b> <a href="#">The Snake Nebula</a>  <b>Constellation:</b> <a href="#">Ophiuchus</a>  <b>AKA:</b> B-72  <b>Date(s):</b> 2020-04-25  <b>Classification:</b> <a href="#">Dark Nebula</a>  <b>Hardware:</b> C-11 Telescope  <b>Exposure Info:</b> 2hrs 5min</p>	<p>A classic example of a Dark Nebula that is a interstellar cloud composed mostly of dust and gas. The only reason why it is visible is because it is blocking out light from stars behind it in this rich star field. B-72 is located in our galaxy and is a few light years across and approximately 650 light years away.</p>
 <p>NGC-4631 (The Whale), NGC-4634 (The Hockey Stick) - Galaxy Pair</p>	<p><b>Month:</b> June  <b>Object:</b> <a href="#">Whale and Hockey Stick Galaxies</a>  <b>Constellation:</b> <a href="#">Canes Venatici</a>  <b>AKA:</b> NGC-4631, NGC-4656  <b>Date(s):</b> 2019-04-14  <b>Classification:</b> <a href="#">Interacting Galaxies</a>  <b>Hardware:</b> C-11 Telescope  <b>Exposure Info:</b> 2hrs 35min</p>	<p>These three galaxies are approximately 25 million light years away from us. The Whale galaxy has a small dwarf galaxy next to it, and the Hockey Stick galaxy is a distorted galaxy most likely due to it's gravitational interaction with the Whale galaxy.</p>

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 <p>IC 1274, IC 1275, NGC 4685 Emission Reflector/Long Duration Narrow Band</p>	<p><b>Month:</b> July  <b>Object:</b> <a href="#">NGC-6559 region</a>  <b>Constellation:</b> <a href="#">Sagittarius</a>  <b>AKA:</b> IC-1274, 1275, 4685, NGC-6559  <b>Date(s):</b> 2020-06-19  <b>Classification:</b> <a href="#">Stellar Nursery</a>  <b>Hardware:</b> C-11 Telescope  <b>Exposure Info:</b> 3hrs 50min</p>	<p>Another molecular cloud that is acting as a stellar nursery containing a lot of hot young stars. Emission nebula and dark nebula are visible in this patch of sky</p>
 <p>NGC 1499 - California Nebula</p>	<p><b>Month:</b> August  <b>Object:</b> <a href="#">California Nebula</a>  <b>Constellation:</b> <a href="#">Perseus</a>  <b>AKA:</b> NGC-1499  <b>Date(s):</b> 2019-08-31  <b>Classification:</b> <a href="#">Emission Nebula</a>  <b>Hardware:</b> C-11 Telescope  <b>Exposure Info:</b> 1hr 50min</p>	<p>At a distance of about 1,500 light years away this supernova remnant is part of the remains of an exploded star drifting through space. It is composed of mostly Hydrogen atoms (as are most nebula) and glows with a characteristic red color as many nebula do.</p>
 <p>M-5 (Pleiades) - Open Star Cluster</p>	<p><b>Month:</b> September  <b>Object:</b> <a href="#">The Pleiades</a>  <b>Constellation:</b> <a href="#">Taurus</a>  <b>AKA:</b> M-45  <b>Date(s):</b> 2019-09-27  <b>Classification:</b> Open Star Cluster  <b>Hardware:</b> C-11 Telescope  <b>Exposure Info:</b> 1hr 40min</p>	<p>At a distance of 444 light years away this cluster of newly formed hot blue stars contains over 1,000 members, but only about 14 stars can be seen with the naked eye if you have very good eyesight. This formation is also known as the “seven sisters”.</p>
 <p>M-74 (Phantom Galaxy) - Face on Spiral Galaxy</p>	<p><b>Month:</b> October  <b>Object:</b> <a href="#">Phantom Galaxy</a>  <b>Constellation:</b>  <b>AKA:</b> M-74, NGC-628  <b>Date(s):</b> 2019-10-26  <b>Classification:</b> <a href="#">Spiral Galaxy</a>  <b>Hardware:</b> C-11 Telescope  <b>Exposure Info:</b> 3hrs 10min</p>	<p>A face-on spiral galaxy located in the constellation Pisces. This galaxy is about the same size of our galaxy, the Milky Way galaxy, and is about 30 Million light years away and contains about 100 billion stars.</p>
 <p>6 Planets and One Dwarf Planet, in One Night</p> <p>Jupiter 7:00am, Saturn 8:00am, Mars 9:00am, Venus 10:00am, Mercury 11:00am, Pluto 12:00am</p> <p>2020-09-23</p>	<p><b>Month:</b> November  <b>Object(s):</b> <a href="#">Planets</a>  <b>Constellation:</b> Various  <b>Date(s):</b> 2020-09-23  <b>Classification:</b> <a href="#">Planets</a>  <b>Hardware:</b> C-11 Telescope  <b>Exposure Info:</b> Various</p>	<p>The planets are in continual motion in the sky. It is rare for all of the major planets to be visible on the same night sky. On September 23, 2020 I was able to image all of the major planets and Pluto. This montage is the result of that night.</p>
 <p>Ophiuchus Cloud Complex</p>	<p><b>Month:</b> December  <b>Object:</b> <a href="#">Ophiuchus Complex Region</a>  <b>Constellation:</b> <a href="#">Ophiuchus</a> &amp; <a href="#">Scorpius</a>  <b>AKA:</b> IC4604, 4603, NGC-6144, <a href="#">M-4</a>  <b>Date(s):</b> 2020-04-19  <b>Classification:</b> Various  <b>Hardware:</b> C-11 Telescope  <b>Exposure Info:</b> 2hrs</p>	<p>This is a mosaic composed of two images stitched together. Some astronomers call this the most colorful region in space. Dark Nebula, Emission Nebula, Reflection Nebula and Globular Clusters are all contained in this image. This is one of the closest star-forming regions to our solar system at a mere 360 light-years away.</p>

# 2021 Astronomy Desk Calendar Photos

## The Setup

All pictures in this calendar were taken by myself, most were taken with my Celestron 11" telescope (see setup below). Astronomical objects can be placed in two categories, Solar System and Deep Sky objects. Solar system objects include Planets, Comets, the Sun, and the Moon. Deep sky objects include galaxies, globular clusters, open clusters, and various nebula. The process of photographing Deep Sky Objects is quite different from Solar System objects



**Solar System Imaging** - Planets, Sun & Moon imaging is performed taking Video's of the subject (typically 2-3 minutes), then running special programs to scan through each frame of the video and picking the best ones from the video, then taking the selected set of frames and averaging them together for a single image. This technique is called Lucky Image Processing. Once the single image is produced special sharpening software is applied to pull show more details of the subject.

**Deep Sky Imaging** – Deep sky objects are very dim when compared to solar system objects. As a result the technique used to image deep sky objects is quite different. The typical process is to take a number of very long exposures that will be combined to create a single image. An typical deep sky photo may be composed of 20-50 exposures(called frames) that are each 5 minutes long combined to have a single image that represents 100 – 250 minutes of exposure (Integration Time). This process can span multiple nights since it is best to limit the imaging window to when the object is highest in the sky so there is less atmosphere for the light to travel through. Typically I prefer to keep my imaging restricted to objects that are at least 45 degrees from the horizon. These long exposures make tracking the object to an extremely high degree of accuracy critical. To ensure proper tracking a smaller telescope (called a guide scope) is mounted off the main scope both scopes have their own dedicated camera. The image obtained from the guide scope is feed into a special program that selects a single star in the image and makes appropriate adjustments to the tracking if the star location changes in the image. The guide scope image is updated every few seconds to make adjustments that might be needed to keep the scope on target. Meanwhile, the image from the main scope is sent to separate software responsible for recording and storing the long exposure images that will be combined at a later time.

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## Where images are taken

**Planetary imaging** is quite flexible in that dark skies are not very important since there is generally an over abundance of photons coming from the planet, moon, etc. Atmospheric turbulence play a key role in planetary imaging, so Jet Stream flow, other sources of atmospheric turbulence such as and heat radiating objects (ie pavement, roof tops, ect) are to be considered when finding a location for planetary imaging to obtain the best results. Most planetary imaging is performed in my yard.

**Deep Space objects** benefit greatly from dark skies, so ideally one would be in the middle of nowhere with no lights around during a new moon when imaging. Many of the images taken were taken out in the Superstitions at a location called the [Massacre Ground Trailhead](#), a location away from many of the city lights but still in reasonable driving distance. Imaging can be done in the city, but special filters are required to try to minimize the impact of city lighting. Unfortunately these filters are not perfect, and will cut out some of the light from the deep sky object, as a result more images(integration time) will be needed to get the same result as images taken with a darker sky. While dark skies are desirable, imaging from the back yard is convenient, and easily done, so many images are captured from my back yard.

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