Highlights of the October Sky...

- - - 2nd - - -

New Moon @ 2:49 pm EDT

- - - 5th - - -

DUSK: A waxing crescent Moon will be about 4° to the left of Venus low in the southwestern sky.

- - - 7th - - -

DUSK: The crescent Moon sits about 2° to the left of Antares in Scorpius in the south-southwest.

- - - 10th - - -

First Quarter Moon @ 2:55 pm EDT

- - - 12th - - -

Comet Tsuchinshan-ATLAS (C/2023 A3) is closest to Earth.

- - - 14th - - -

PM: A waxing gibbous Moon is about 3½° to the lower left of Saturn.

- - - 17th - - -

Full Moon @ 7:26 am EDT

- - - 19th - - -

PM: A waning gibbous Moon trails the Pleiades by 4°.

- - - 20th - - -

PM: The Moon is about 5° to the upper left of Jupiter in Taurus.

- - - 21st - - -

AM: The Orionid meteor shower peaks at 2am, but moonlight will hamper viewing.

- - - 23rd - - -

AM: The Moon forms a triangle with Castor and Pollux in Gemini. Mars is below the trio.

- - - 24th - - -

Last Quarter Moon @ 4:03 am EDT

- - - 25th - - -

DUSK: Venus is 3½° to the upper right of Antares in the southwest.

- - - 26th - - -

AM: A waning crescent Moon is about 3° to the lower right of Regulus in Leo.

Prime Focus

A Publication of the Kalamazoo Astronomical Society

★ ★ ★ October 2024 ★ ★ ★

This Month's KAS Events

General Meeting: Friday, October 4 @ 7:00 pm

Kalamazoo Area Math & Science Center • See Page 20 for Details

Observing Session: Saturday, October 12 @ 7:00 pm

Kalamazoo Nature Center • Visit Observing Page for Details

***Comet Watch*: October 14 - October 18 @ 7:00 pm**

Richland Township Park • See Page 6 for Details

Observing Session: Saturday, October 26 @ 7:00 pm

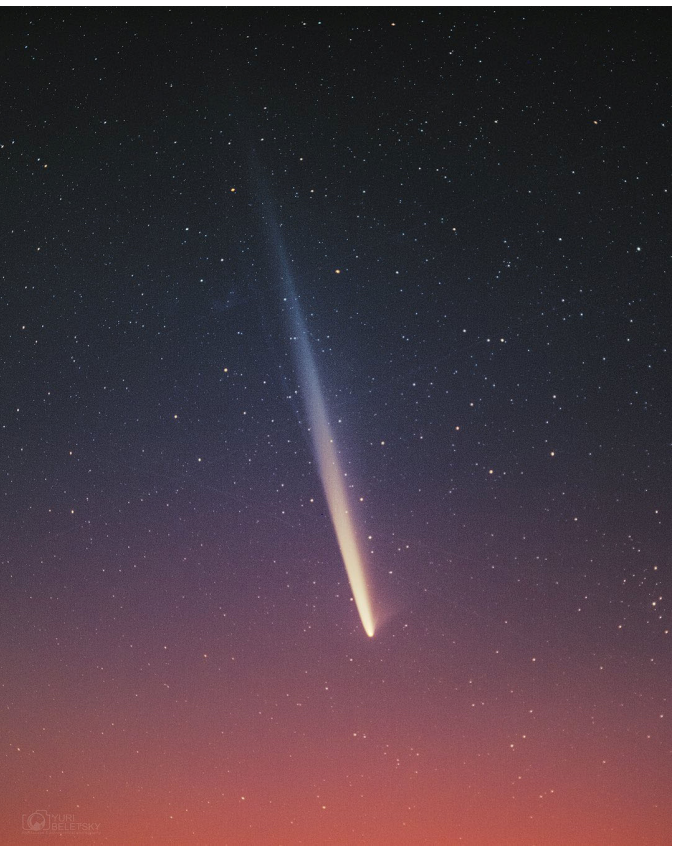
Kalamazoo Nature Center • Visit Observing Page for Details

Inside the Newsletter. . .

Observations by Richard S. Bell

A comet is coming, and we need your help! The Purple Mountain Observatory in China discovered the icy interloper from the distant Oort Cloud on January 9, 2023, and the Asteroid Terrestrial-impact Last Alert System (ATLAS) in South Africa independently found it on February 22, 2023. The name Tsuchinshan, pronounced *choo-cheen-SHAHN* in Mandarin Chinese, translates to "Purple Mountain," hence the designation C/2023 A3 (Tsuchinshan-ATLAS) for the new comet. The "C" indicates that it is a non-periodic comet with an orbital period longer than 200 years, and many only pass by the Sun once. The "A3" denotes that it was the third comet discovered in January 2023.

As I write this, observers in the Northern Hemisphere should be able to see the comet low in the east at dawn, but the remnants of Hurricane Helene are obstructing our view in West Michigan. It looks like we'll have to wait for the comet to transition into the evening sky. Our first chance will likely be on October 12th, when the comet comes closest to Earth. We just so happen to have a Public Observing Session on that date! If the predictions hold, it will be magnitude -2. That means it might be possible to spot it with binoculars or a telescope in the daytime sky. Be sure to **use extreme caution**! Shield the Sun behind the corner of a roof so its light doesn't accidentally enter your field of view.



I'm planning to head to the lakeshore on October 13th to grab a few photos. Maybe I'll see you there!

Assuming the comet doesn't disintegrate (like ISON did in 2013), I definitely hope to see you at Richland Township Park between October 14th and 18th for *CometWatch*. Richland Township Park offers a fairly unobstructed view of the western horizon. We intend to establish our setup in the park's rear, near the Little League baseball fields. *CometWatch* is a week-long event to increase the chance of clear skies on *at least* one day!

If this comet does manage to stay in one piece, it's going to generate A LOT of publicity and excitement from the public. That should bring huge crowds to our event, just like Comet Hale-Bopp did in 1997. That was a very special time to be a member of the Kalamazoo Astronomical Society, and I hope Comet Tsuchinshan-ATLAS helps to replicate those good times. We're counting on members like you to share views of the comet through a variety of binoculars and telescopes.

Yuri Beletsky, an astronomer and nightscape photographer, captured the image of Comet Tsuchinshan-ATLAS above. He took it from the Carnegie Las Campanas Observatory in the Atacama Desert, Chile, on the morning of September 27th. He cropped the image to highlight the structure of the tails. His gear included a Nikon D810a camera with a 135mm lens. He shot and stacked twelve 20-second subframes. Let's hope the best is yet to come! This should be a memorable month.

September Meeting Minutes

President Richard Bell called the Kalamazoo Astronomical Society's general meeting to order on Friday, September 6th, at 7:06 pm EDT. About 33 members and guests were in attendance at the Kalamazoo Area Math & Science Center (KAMSC), while at least another 34 joined us virtually on Zoom.

After welcoming everyone back from our meeting hiatus over the summer, Richard launched into his President's Report. A group of cub scouts and their families plan to attend the observing session on September 21st, so additional assistance may be required.

Richard provided an update on Comet Tsuchinshan-ATLAS (C/2023 A3). It could reach magnitude 2 or 3 at dawn in late September. The comet then transitions into the evening sky in mid-October, where it could reach or exceed -1 magnitude.

As a result, we plan to hold a week-long *CometWatch* event at Richland Township Park from October 14th to the 18th. If the comet performs as predicted, it will generate a tremendous amount of publicity. We could have crowds comparable to what we experienced when Comet Hale-Bopp was at its best in 1997.

We will set up telescopes equipped for solar viewing and pass out KAS literature during CraneFest on October 12th and 13th, from 12pm to 5pm. The Air Zoo has also invited us to provide an activity during their 45th anniversary celebration on November 16th, from 10am to 2pm. Volunteers are needed for both activities.

We invite members to participate in "Astronomy Open House" by giving a 10 to 20 minute talk at the November General Meeting. Please contact Richard if you're interested in presenting something. Speakers and/or topics for general meetings in 2025 are also welcome.

Phyllis Lubbert passed out a survey for the 3rd annual Winter Solstice Party. It had choices for appetizers, entrées, desserts, and beverages. Westwood United Methodist Church will host the party on Saturday, December 7th.

Finally, we are selling the 55" Roku TV originally purchased for the Remote Viewing Sessions for $200. The TV has been sitting in KAMSC's presentation center for five years, and it's time to unload it. The TV is in like-new condition and only used a handful of times.

Our guest speaker for the meeting was Chuck Allen, who recently became President of the Astronomical League again. This was Chuck's second talk for the KAS. The first was on Zoom in 2020. The title of this presentation was *Perspectives on Distance*.

The world altitude record (or the farthest humans have ever traveled from Earth), set by Apollo 13 on April 14, 1970, is 248,655 miles. On that day, the Moon was at apogee (its most distant from Earth). The Soviet mission Voskhod 2 held the previous record. Its single-day mission reached a maximum altitude of 295 miles on March 18, 1965. (The figures provided by Chuck during his talk differed slightly.)

Every 17 years during a perihelic opposition of Mars, Earth and Mars are only 35 million miles apart. Because Mars has an orbital velocity of 53,979 mph, it is not possible to send a spacecraft directly to the Red Planet. Instead, spacecraft must perform a Hohmann transfer orbit. Utilizing Earth's orbital velocity, a spacecraft launches itself towards a future Mars location. This saves a tremendous amount of fuel but takes more time.

Voyager 1 is the most distant manmade object from Earth. Launched in September 1977, it is currently more than 15.3 billion miles away, traveling at a speed of 38,210 mph. If *Voyager 1* were traveling in the direction of the nearest star, Proxima Centauri, 4.25 light-years away, it would take 75,000 years to get there.

When you try to look toward the center of the Milky Way on a summer night, the Scutum-Centaurus arm blocks your view. The nearest portion of the arm is about 10,000 light-years or 60 quadrillion miles away. That's 20 million times the distance to Neptune.

To put that into perspective, imagine Neptune's orbit as the diameter of a 50¢ coin. On this scale, the Milky Way would be the size of North America and 250 miles thick. The Alpha Centauri system would be about 400 feet away.

The Milky Way is a member of the Local Group of Galaxies. Two other major galaxies in the group include the Andromeda Galaxy (M31) and the Triangulum Galaxy (M33). Chuck shared a bowl containing about 1 million beads. He inquired about the number of bowls required in this scale model to reach the Andromeda Galaxy. He didn't give an

exact number, but the proper number of bowls would reach Neptune's orbit.

Chuck then shared a model he made that showed the relative distances and diameters of galaxy clusters around the Local Group, including the Virgo Cluster. This group of 2000 galaxies is 65.23 million light-years away.

The Local Group, Virgo, and many other galaxy clusters are part of the Laniakea Supercluster of Galaxies, which contains at least 100,000 galaxies and is about 520 million light-years across. The Boötes, Capricornus, and Sculptor Voids surround Laniakea. These are vast regions almost devoid of matter.

Zooming out further reveals the Large-Scale Structure of the Universe, also known as the Cosmic Web. Superclusters of galaxies connected in long filaments and walls, surrounded by enormous voids of space. J. Richard Gott, a longtime friend of Chuck's from Princeton University, first proposed this structure in 1987.

One of the nearest quasars that amateur astronomers can observe through a telescope is 12.9-magnitude 3C 273, found 2.43 billion light-years (Gly) away in Virgo.

PG 1634+706 is also within reach of amateurs with large telescopes. This 14.5-magnitude quasar is 9.6 Gly away in Draco. That works out to 5.6 septillion miles, 2 trillion times the distance to Neptune, or 200 million times the distance to Proxima Centauri. Thanks to the expansion of space, PG 1634+706 is actually 12.9 Gly distant.

Amateurs with access to 20-inch plus Dobsonian telescopes can observe APM 08279+5255, a 15.2-magnitude quasar located 12.05 Gly away in the constellation Lynx. Due to space expansion, this active galaxy is actually at a distance of 23.6 Gly.

To date, the galaxy JADES-GS-z14-0 is the most distant object ever seen. The James Webb Space Telescope discovered this galaxy, located in the constellation Fornax, and announced its discovery on May 31, 2024. We see it as it appeared 13.43 years ago, or about 290 million years after the Big Bang. It is now at a distance of 33.89 Gly.

Chuck explained the concept of expanding space with an analogy. A young girl needs to swim 10 feet to reach her father, who is standing in the middle of the pool. However, the pool is able to magically expand in all directions. She now needs to swim a total of 100 feet to reach her father. The side of the pool from which she left is now 300 feet away.

If we lived in a static universe, the distance we could see would simply be a function of time; i.e., light from a galaxy that traveled for 13.43 billion years would be 13.43 Gly away.

The first stars formed about 13.5 billion years ago, but what if they formed right at the Big Bang, 13.787 billion years ago? Today, those stars would be 46 Gly away. The edge of the observable universe is known as the Cosmic Particle Horizon.

Chuck also explained that it would be possible to see a supernova 16 Gly away. Observing anything further away than that is impossible because the expansion of the universe would exceed the speed of light. We refer to this as the Cosmic Event Horizon. Therefore, 96.7% of the galaxies we can currently see are unreachable.

The actual size of the universe depends on its geometry. All results point toward a flat universe. That means the universe is infinite. However, if current studies are wrong and the universe is closed and thus finite, it would still be at least 250 times the size of the Cosmic Particle Horizon. Other studies say it would be 300 sextillion or even $10^{40,000}$ times larger!

During the break, we celebrated KAS treasurer Don Stilwell's 75th birthday. His wife, daughter, and grandson brought cake and refreshments. Those that attended the meeting at KAMSC also enjoyed Chuck's 9-case display containing 100 chemical elements on the periodic table.

In observing reports, Jack was up at 5am on the weekend before the meeting and saw Jupiter and Mars in the eastern sky. One of our guests in attendance, Gary M. Ross from the Grand Rapids club, noted that Jupiter's south equatorial belt is now narrower in latitude than the north equatorial belt. Gary also noted how much lighter the Great Red Spot has become over the years.

Pete Mumbower reported on the great Northern Lights display during the peak of the Perseid meteor shower on August 11th/12th.

In astronomical news, the Catalina

Sky Survey discovered an asteroid, designated 2024 RW_1, on September 4th. It was quickly determined that this 1-meter -size object would burn up in the atmosphere over the Philippines the following day. Several people took images and videos of it (see the example above). This is the ninth impact event that was successfully predicted.

NASA's Perseverance rover on Mars discovered "leopard spots" on a reddish rock nicknamed "Cheyava Falls" in Jezero Crater in July 2024. Scientists think the spots may indicate that, billions of years ago, the chemical reactions in this rock could have supported microbial life; other explanations are being considered.

The James Clerk Maxwell Telescope (JCMT) in Hawaii announced the detection of phosphine in Venus' atmosphere in 2020. This led to speculation that microbial life was floating in the clouds of our sister planet. The JCMT has made newer discoveries of phosphine and now ammonia. Ammonia is another possible biosignature.

Pete also reported that newer StarLink satellites are brighter than previous models since they orbit Earth at a lower altitude. This has caused much concern in the astronomical community.

Boeing's Starliner capsule was due to return to Earth with two passengers from the International Space Station today. However, NASA has decided to return the astronauts to Earth in March and return the capsule alone. The astronaut's 8-day mission has now turned into an 8-month extended stay.

After reviewing upcoming events, the meeting concluded at 8:54 pm.

The featured talk can be viewed in its entirety on our YouTube Channel.

Board Meeting Minutes

The KAS Board met on September 8th, 2024, at Sunnyside Church. Richard Bell called the meeting to order at 5:08 pm EDT. Other board members present were Scott MacFarlane, Jack Price, Don Stillwell, Philip Wareham, and Dave Woolf. The board approved the meeting agenda, and Don then proceeded with the treasurer's report.

The total account balance for June was $43,148.41, for July it was $43,292.13, and for August it was $42,975.43. As of the end of August, there was $3,027.10 in the Owl Maintenance Fund and $997.61 in the Remote Telescope Fund. Richard asked if the Owl and Remote Telescope maintenance accounts are really necessary. We discussed how having a separate fund for the Remote Telescope helps track the money raised by its users.

The Register Reports for June through August were pretty sparse since we haven't been doing much spending over the summer. Sales from our online SkyShop store have dramatically decreased now that the eclipse has passed. Don noted that we received a full refund ($150) for the pavilion rental for the picnic at Texas Drive Park.

We then reviewed KAS activities up until the next board meeting in November. A group of Cub Scouts plans to attend the Public Observing Session on September 21st, so we may need a few extra telescopes on the field. We will center the general meeting on October 4th around the traditional *Astrophotography Night*. Keeping with tradition, Pete Mumbower offered to supply donuts and apple cider during the snack break.

During the observing session on October 12th, a bright comet may be visible. This may also bring a larger-than-average-sized crowd. The observing session season concludes on October 26th. The November 1st meeting will be the return of "Astronomy Open House." Three members will have the opportunity to give a 10- to 20-minute astronomical presentation of their choosing. Kirk Korista has already volunteered to be one of the presenters.

Jim Kurtz installed the new all-sky camera in Arizona. Richard got a good start on getting it set up before we shut the Remote Telescope down for the monsoon season.

Once Mike Patton returns to Arizona Sky Village in November, we will sell the current pair of CCD cameras and replace them with newer CMOS sensor cameras. The cost of the new cameras will be, at most, $10,000, and Richard thinks we can get around $5,000.00 for each of the old ones. We will first offer them to our members before putting them up for sale on Astromart and Cloudy Nights. We will likely hold a fundraiser to raise additional capital for the new cameras.

Dave Garten recently installed metal braces on the four corners of Owl Observatory. This will help prevent damage to the building from Nature Center mowers. There is still some water damage on the southwest corner of the roof. We would like to get that repaired before this upcoming winter. Jack reported that the observatory alarm is again functional.

Phyllis Lubbert is organizing this year's Winter Solstice Party. It will be held at Westwood United Methodist Church on Saturday, December 7th. The main course will be a choice of pork loin or chicken breast. The board agreed (or at least didn't argue) with Richard that it's time to sell the club's 55" Roku HDTV. We decided on a price of $200. It will first be offered to members, then listed on Craigslist if needed.

Comet C/2023 A3 (Tsuchinshan-ATLAS) may become visible to the unaided eye in mid-October. To take advantage of the tremendous publicity and attention it will likely receive, we hope to hold a week-long *CometWatch* event at Richland Township Park. Richard will contact Richland Township officials to see if this is feasible.

The Kiwanis Youth Conservation Area near Bellevue will host CraneFest on October 12th and 13th, from 12pm to 5pm. Jack reported that we had adequate volunteers for both days, but additional support would be welcome. We will offer solar viewing (if skies are clear) and hand out KAS literature.

The Air Zoo will be celebrating its 45th anniversary on Saturday, November 16th. They invited us to provide some sort of activity from 10am to 2pm. Two volunteers are needed.

Finally, Richard announced the schedule for Online Viewing Sessions for the 2024/2025 season. Dates are **11/23** (11/30) / **12/21** (12/28) / **1/18** (1/25) / **2/22** (3/1). Cloud dates are in parenthesis.

The board meeting concluded at 6:05 pm. We scheduled the next meeting for Sunday, November 10th, at 5:00 pm at Sunnyside.


CometWatch
October 14th to 18th | 7pm - 9pm
Will Comet Tsuchinshan-ATLAS be the "celestial event of the decade?" Join us and find out!
Members needed to bring binoculars and telescopes to share.
Richland Township Park
6996 N. 32nd St. • Richland, MI

PHOTOGRAPHING a Bright Comet

by **Richard S. Bell**

Astrophotography is a niche hobby. Those of us who pursue it spend the majority of our time imaging deep-sky objects. We set up our equatorial mounts and place telescopes of various shapes and sizes atop them. Most people will never become interested in deep-sky astrophotography, but there are some uncommon but spectacular astronomical phenomena that a larger group of people like to snap pictures of when they come along. These include solar and lunar eclipses, auroras, and bright comets.

Photographing a rare naked-eye comet can be one of the most rewarding experiences. The beauty of these celestial visitors, often adorned with glowing tails, captivates both die-hard amateur astronomers and the general public alike. Whether you're a seasoned photographer or a novice, capturing a comet requires some preparation, technique, and a bit of luck. Here, I present a detailed guide that I hope will help you get stunning comet photographs.

Understand the Comet's Characteristics

Before you start photographing, it's essential to understand the comet you want to capture. Each comet is unique, with different brightness levels, sizes, and tail lengths. Research your target comet's current visibility, expected trajectory, and optimal viewing times. Websites like NASA, Space-Weather, and dedicated astronomy forums like Cloudy Nights provide real-time information on comet visibility.

Choose the Right Equipment

DSLR or Mirrorless Camera: For still comet photography, either a digital single-lens reflex (DSLR) or digital single-lens mirrorless (DSLM, or simply "mirrorless") camera with manual settings is ideal. Either type of camera has interchangeable lenses and offers better control over exposure and focus than a point-and-shoot camera.

There's no difference between the two in terms of quality, but mirrorless cameras are better for videography. Manufacturers are putting their latest sensor and processor technology into mirrorless cameras. The selection of DSLR cameras is rapidly decreasing, but they are more affordable—especially at entry-level prices. However, if you're looking for a long-term investment, mirrorless cameras are the future.

Sensor Size & Resolution: Full-frame sensors typically perform better in low light, but crop sensors (or APS-C sensors) can also work well, especially with the right techniques. Lower megapixel sensors (i.e., 20 to 25 MP) have better sensitivity for low-light photography and less noise. Higher resolution sensors (i.e., 40 or above) are better for landscape or studio photography, conditions where you have an abundance of light. A satisfactory compromise for general astrophotography is in the 30 to 35 MP range.

A Nikon Z6 mirrorless camera on a Sky-Watcher StarAdventurer 2i star tracker was used to capture an image of Comet C/2020 F3 (NEOWISE) from Door County, Wisconsin, after sunset on the shore of Lake Michigan in July 2020. The image above was taken with a Nikon D850 camera and Sigma Art 35mm lens. Image courtesy of Marybeth Kiczenski, Shelby Diamondstar Photography (shelbydiamondstar.com).

Nikon Z5 | Canon EOS RP | Sony α7 III | Lumix S5IIX | Nikon Zf | Sigma fp L | Canon EOS R5

Recommended Full-Frame Mirrorless Cameras:
(* Popular for their lowlight video capability.)

- ~ $1000: Nikon Z5, Canon EOS RP
- ~ $1500: Nikon Z6, Canon EOS R8, Sony α7 III
- ~ $2000: Nikon Zf, Canon EOS R6, Sony α7 IV, Sony ZV-E1*, Panasonic Lumix S5IIX*, Sigma fp L*
- ~ $3000: Sony α 7S III*, Nikon Z8, Canon EOS R5

Recommended Older DSLR Cameras:

- Nikon D750, D850, D810
- Canon 6D and 5D (Mark III or IV)

Smartphones: If you do not want or cannot afford a DSLR or mirrorless camera, you can use a smartphone. There are many limitations, such as the inability to zoom into your subject. Smartphones with fixed lenses use a digital zoom, but the image quality drops dramatically.

Smartphones are best if they can take images in RAW format. For example, Apple iPhone Pro (12 or later) has this feature. Be sure to purchase a smartphone tripod adapter for a standard camera tripod. You can find these for less than $10. Most exposures required to capture sharp comet images will take at least one second. Even that's too long for hand-held photography.

Ensure that you have set your smartphone camera to night mode. This will allow you to take exposures up to 30 seconds. Finally, if your smartphone has different magnification lenses, be sure to stick with a 1x lens. That's the best one for low-light photography. The others use lower-quality sensors.

Wide-Angle Lens: A lens with a focal length between 14mm and 35mm is perfect for capturing the full extent of a comet's tail, especially in conjunction with the night sky. Comet Hyakutake in 1996 had a very long tail, and only wide-angle lenses could reveal its extent. In 2007, Comet McNaught had a very broad, curved tail that subtended several degrees in the sky. A 20mm lens captured some of the best shots I saw online of that comet. For Tsuchinshan-ATLAS, I think a 50mm lens would be best to capture both the sky around the comet and objects of interest in the foreground.

Telephoto Lens: For detailed shots of the comet itself, a telephoto lens (100mm or more) is beneficial. Telephoto lenses proved to be the most effective for capturing detailed shots of Comet NEOWISE in 2020. Based on the images I've seen online so far, this appears to be the case with Tsuchinshan-ATLAS as well. My guess is that 200mm will be the maximum you'll want to use on this comet, with **85mm, 105mm, or 135mm being the best focal lengths overall**. In that case, you'll either want to mount your camera piggyback on an equatorially-mounted telescope or invest in a portable star tracker (more on the latter shortly).

In either case, I recommend using prime (fixed) wide-angle or telephoto lenses as opposed to zoom lenses. Prime lenses will produce more pinpoint stars. Stars are the most stringent test for any kind of optical instrument. If you have a lens with image stabilization or vibration reduction, be sure to turn it off! When using a tripod, the stabilizer might actually create blur.

***Camera Tripod*:** The tripod should be sturdy and lightweight, with the ability to pan the vertical and horizontal axes with little difficulty. The purpose of the tripod is to hold the camera steady during "long" exposure times. The word long is a relative term, meaning anything slower than 1/60th of a second. The camera has a 1/4-inch x 20 screw slot on the bottom, while the tripod has a screw on the top. Just mate the two together, and you'll have a solid foundation for taking steady comet pictures. Tripods from both Manfrotto and Oben are of excellent quality.

***Star Tracking Mounts*:** These ultra-convenient tracking platforms have surged in popularity since Vixen released the Polarie Star Tracker in 2012. Several companies have introduced their own versions in years since, so there's sure to be one to suit your needs and budget. Some are compact enough to fit in carry-on luggage or travel to exotic locations—places that an ordinary telescope mount could never go! The new NOMAD star tracker from Move Shoot Move starts at $210 and holds 7.7 lbs. Despite selling itself as a star tracker, Sky-Watcher's Star Adventurer GTi is actually a small German equatorial mount with Go-To capability. The GTi has an 11 lb. instrument capacity, which is enough for small refractors. The kit version that includes a tripod is currently on sale for $619.

Remote Shutter Release: A remote switch sends a signal to the camera to open the shutter instead of pressing the camera's shutter release button. It allows you to open the camera's shutter for an extended period of time. This is a must for images that require long exposure times. The alternative to not using a remote switch is to push the shutter release button down yourself. That's not a good idea when the shutter speed dial is set to "B." Any movement of the camera during this period will result in fuzzy or out-of-focus photographs.

Intervalometer (Interval Timer): An intervalometer is a camera controller that signals the camera to take a series of images after a set interval. These are essential if you want to create timelapse videos of the comet or take several images in succession and stack them. Canon's TC-80NC version is quite costly at $168. Cheaper Chinese clones are available, but be sure to check reviews. You get what you pay for! Some cameras now have an intervalometer built into their firmware.

Extra Batteries and Memory Cards: Don't travel far from home and run out of power or storage. Pack at least one extra battery for your camera, especially mirrorless cameras. They're power hogs. You could also pack an extra memory card, but a 256GB card costs $25 to $35. That'll be more than enough storage for still images. It would probably be smart to carry an extra card if you plan to shoot a lot of videos of the comet, I suppose.

Find the Best Location

Most bright comets are only visible low in the east horizon before sunrise or low in the west after sunset (including Tsuchinshan-ATLAS). Any location should have an unobstructed view of one of those directions. For those of us in West Michigan, Lake Michigan's shore is ideal for a comet low on the western horizon. If that's not possible for you, find a spot with a high elevation.

Dark Skies: Light pollution significantly hampers your ability to see and photograph celestial objects. Find a location as far from city lights as possible, ideally in a national park or rural area. A wonderful spot in Michigan's Upper Peninsula would be Brockway Mountain Lookout near Copper Harbor.

Clear Weather: Check weather forecasts for clear skies. Cloud cover can easily obscure your view of the comet, making it essential to plan your shoot accordingly. My personal favorite website for checking cloud cover is the GOES-East Satellite page. Other websites, like Ventusky and Windy, allow you to check on all other types of weather conditions.

Comet Photography Checklist:

1. Make sure your tripod or mount is reasonably level.

2. Camera Settings:
   a. Set the image quality to **RAW**.
   b. Set your camera to the Bulb (B) or Manual (M) setting.
   c. Set the white balance to daylight. Some photographers recommend a setting in the 4500 to 5500 K range.
   d. Start with an ISO of 800 to 1600. Adjust according to the comet's brightness and ambient light. Don't be afraid to experiment with higher ISO settings.
   e. I recommend turning your camera's long-exposure noise reduction on. If you take a 20-second exposure, your camera will automatically take a 20-second dark frame and subtract it from your image. If you plan to create a time-lapse movie of the comet or stack a large number of images later, turn or leave it off. In these cases, leaving it on will really slow you down. Some photographers argue that in-camera noise reduction is no longer necessary with newer cameras, but it is with older ones. There are also plenty of specialized noise reduction software options available (i.e., Topaz Photo AI and NoiseXTerminator).
   f. Use the widest aperture your lens allows (e.g., f/1.4 – f/2.8) to gather as much light as possible.

3. Use manual focus. Autofocus doesn't work very well in low-light conditions. If a bright star or the comet itself are visible on the preview screen, focus on them. While observing a bright star, it can be challenging to determine the camera's focus, but fainter stars typically become visible only when the focus is precisely correct. This is known as focus peaking.

4. Frame your shot. If possible, use the live preview or take a quick exposure at a high ISO setting to check the scene's composition.

5. Start with a shutter speed of 15 to 30 seconds. Longer exposures may result in star trails due to Earth's rotation, while shorter ones may not capture enough light. To avoid trailed stars, use the 300 Rule:

$$E\ (\text{sec.}) = 300/F_{Lens}$$

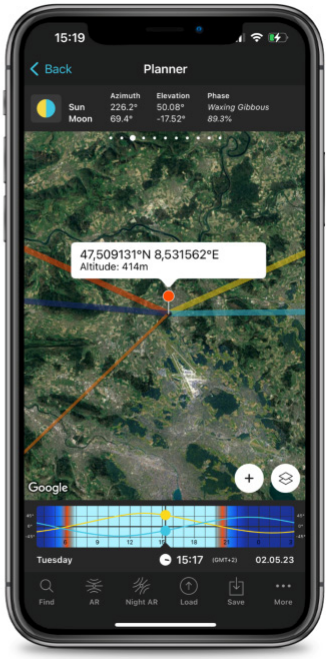
   E represents exposure in seconds, and F_{Lens} represents your lens's focal length. Formerly known as the 500 Rule, new high-resolution cameras required an adjustment. For 40 to 60 MP cameras, it's best to use 200 (i.e., 200/ F_{Lens}). For older, lower-resolution cameras, use 500. With 300 being the average, of course. Apps like PhotoPills have a built-in calculator for this (tap on "Spot Stars" to find it).

6. Expose to the Right! This means increasing the exposure so that the histogram is closer to the right-hand side of the graph. The increased exposure means that more light, or signal, hits the camera's sensor during the exposure, reducing the noise levels in the image. For nightscape photography, it's actually better to overexpose your image if you can, but avoid going too far to the right! Don't just rely on the preview image on your camera. Look at the histogram!

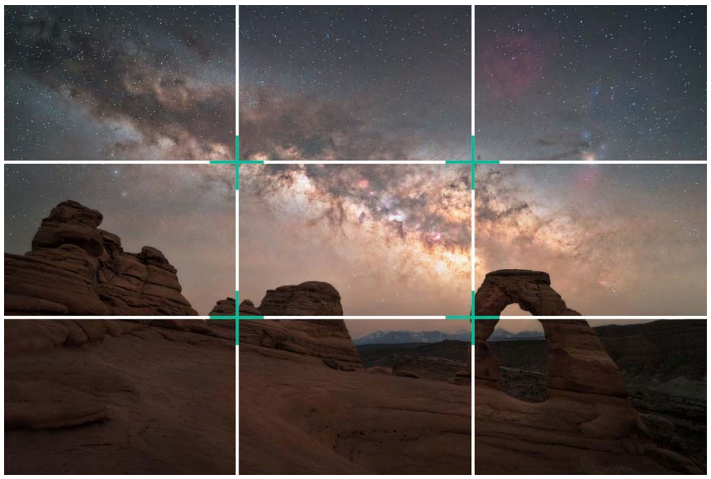
Composition Techniques

Foreground Interest: Incorporate elements like trees, mountains, or buildings to give your images depth and context. This can lead to stunning landscapes when combined with the comet. It's easier to include an intriguing foreground when the comet is low in the sky.

If you want to compose an image with a specific location or subject in the foreground, use an app like PhotoPills, PlanIt, or The Photographer's Ephemeris. These will help you to determine where objects like constellations, planets, etc. will be located at different dates and times.



Rule of Thirds: To ensure a balanced composition, position the comet according to the rule of thirds. This involves placing the comet off-center, allowing for a more dynamic image.



Using the rule of thirds for astrophotography will result in balanced yet powerful compositions.

Take Test Shots: Before the comet becomes fully visible, take a few test shots to check your settings. Adjust exposure, ISO, and composition as necessary.

Capture the Moment: Once the comet is visible, start taking a series of photos. Vary your settings slightly with each shot to ensure you get at least a few perfect images.

The photographer points at Comet Tsuchinshan-ATLAS on the morning of Sept. 29th from Rafaela, Provincia de Santa Fe, Argentina. He used a Canon EOS R7 camera and a Sigma 105mm f/1.4 lens. Credit: Eduardo Schaberger Poupeau

Post-Processing

Software: Use post-processing software, such as Adobe Lightroom or Photoshop. Adjust exposure, contrast, and clarity to bring out details in your comet photographs.

Stacking Techniques: For better results, consider stacking multiple images. This technique helps reduce noise and enhances the visibility of faint details. Adobe Photoshop can perform stacking, but there are free alternatives such as DeepSkyStacker, Siril, and Sequator.

Share Your Work: Once you've captured stunning comet images, share them! Join astrophotography communities online, enter contests, or simply post on social media. Sharing your work can inspire others and connect you with fellow enthusiasts.

Conclusion

Photographing a comet is a blend of science, art, and patience. By preparing, choosing the right equipment, and employing effective techniques, you can create breathtaking images of these celestial wonders. With a bit of luck and practice, you'll be able to capture a comet in all its glory, turning your nighttime adventure into a lasting memory. Clear skies and happy shooting!

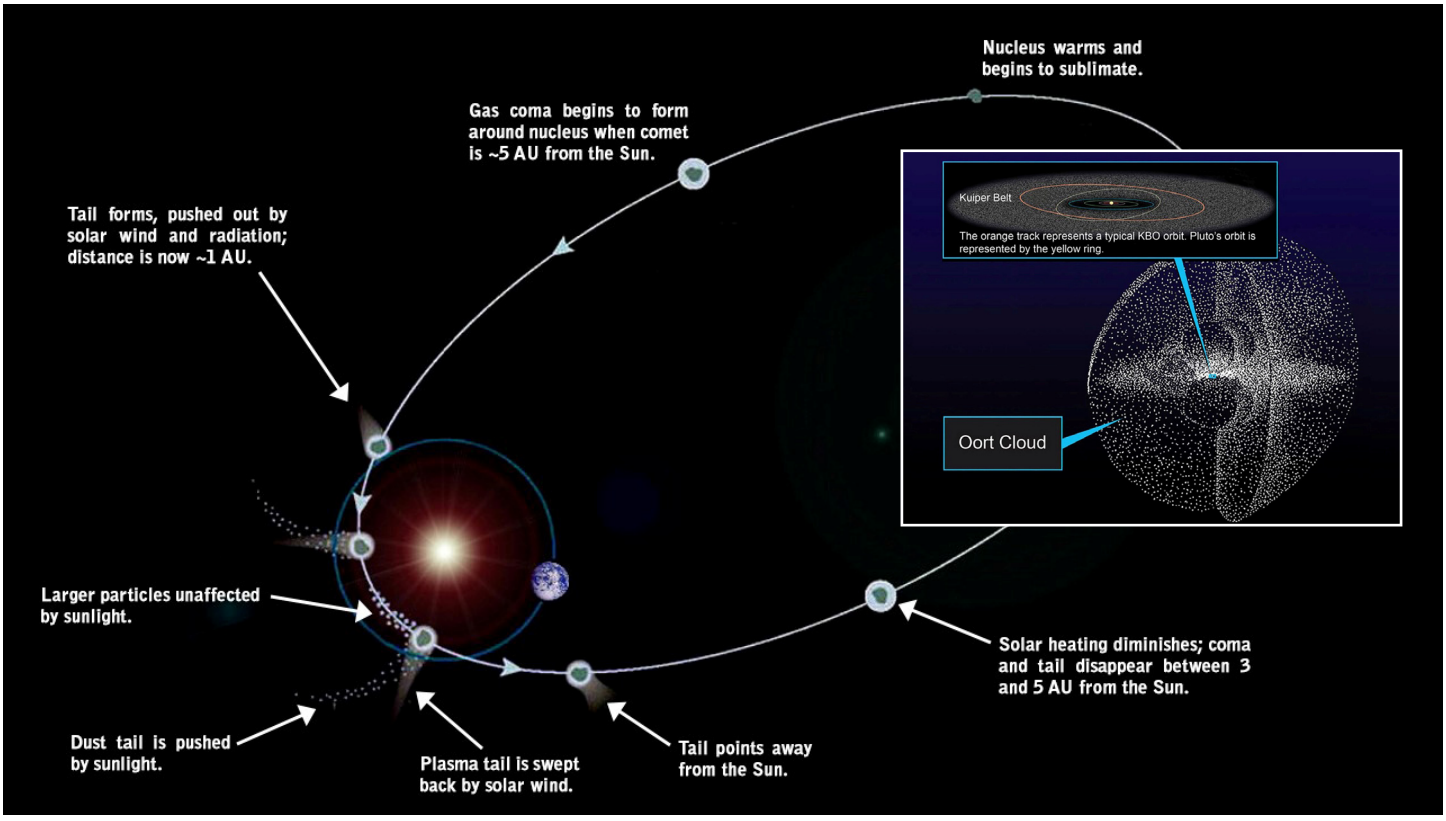
The Secret Lives of Comets

by Mike Sinclair

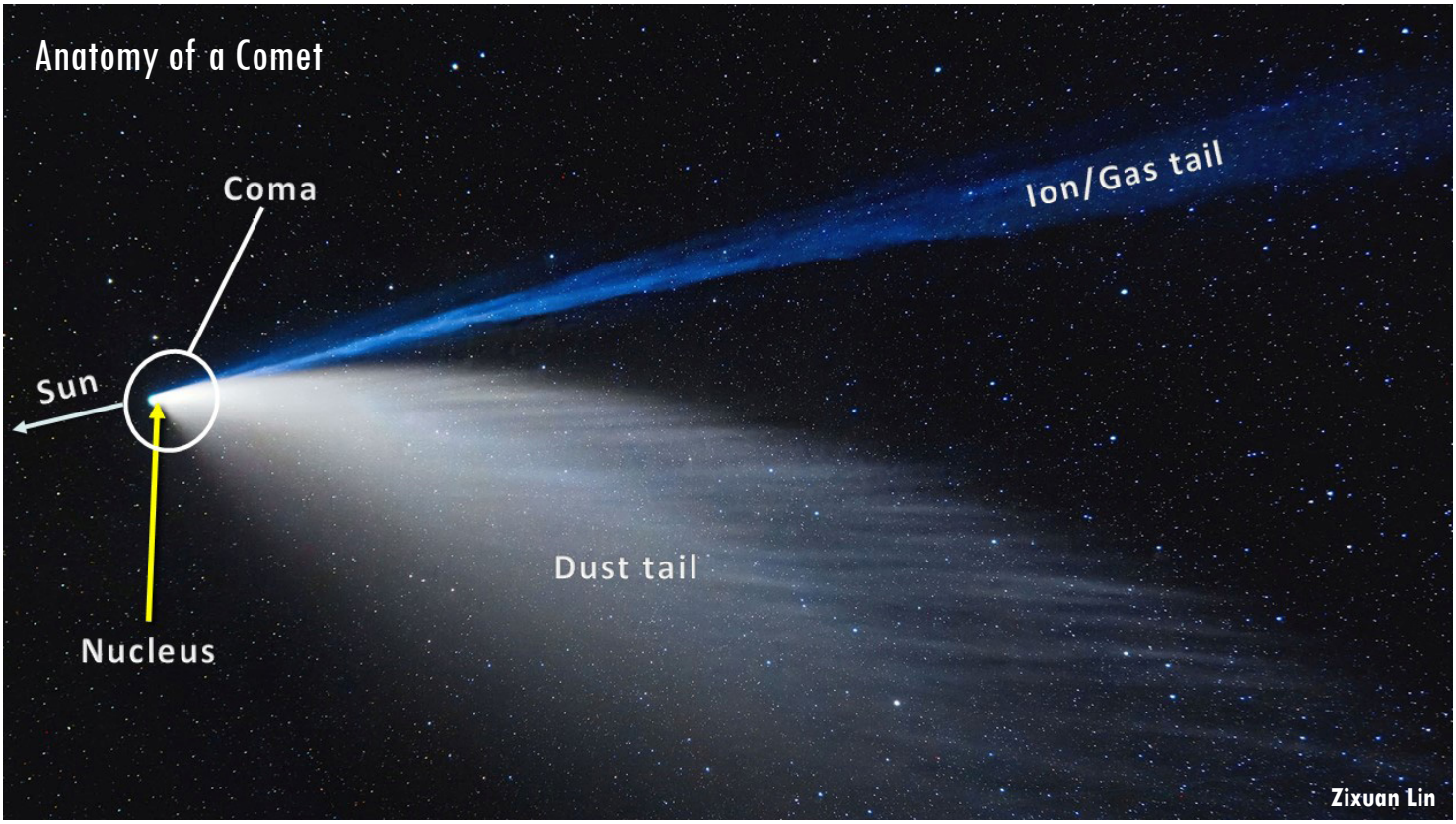
A small, dark mass lethargically winds its way among the outer reaches of the solar system. After eons of unhurried drift, it begins to slowly, imperceptibly, fall toward the faint star that bends nearby spacetime to its will. A comet is about to make a grand entrance.

Comets are often described as a dirty snowball slowly coasting around the Sun. With a typical "albedo" or reflectiveness of around 0.05 (with an albedo of 1.0 being perfectly reflective and 0.0 being perfectly dark), the nucleus of a comet can be more accurately described as an extremely sooty snowball or an ice-filled hunk of coal. The nucleus of a comet is composed of just about everything found in the solar system. Hydrogen, oxygen, carbon, nitrogen, methane, ammonia, carbon dioxide, water, and traces of helium, iron, potassium, calcium, and nickel are all present in the typical comet. As a result, a comet is nothing more than an amalgamation of the early materials of the solar system's orts and leavings.

The shape of a comet, though simple at first, develops a beautifully complex and dynamic appearance as it approaches the Sun. The typical comet starts out as a simple nucleus, which coasts relatively unmolested through the outer planets. As it falls past Jupiter's orbit, the Sun's increasing heat and the pressure of the solar wind on the cometary core begin to heat up both the surface and interior of the nucleus. Eventually, hot spots develop on the surface of the nucleus, and jets extrude gaseous material from under an insulating dust layer. As this material sprays outward, the solar wind forces it into a semi-spherical shell, or "coma," around the nucleus. The solar wind pushes outward from the Sun, forming a tail, as it ejects more and more material from the nucleus.



The comet's momentum and the mass of the dust particles may combine to form two distinct tails: an ion tail, streaked with irregular wisps and pointing directly away from the Sun, and a dust tail, smooth and featureless, pointing back in the direction the comet has traveled. Even though the total mass of a comet's tail is typically less than that of several large trash cans, they can extend outward to a length of over 100 million miles! The comets' tails are



visible due to the highly reflective dust, gas, and ice they expel.

Over the course of one orbit, a comet loses about 0.1 percent of its mass. Thus, the typical lifespan of a comet is around 1,000 orbits before the cometary remnants scatter themselves along the comet's original orbit. Earth may pass through such a remnant field, causing the periodic meteor showers we experience.

Rosetta, built by the European Space Agency, became the first spacecraft to orbit a comet, 67P/Churyumov-Gerasimenko, on September 10, 2014. This false-color four-image mosaic comprises images taken from a distance of 28.7 km on February 3, 2015. The mosaic measures 4.2 × 4.6 km. The mission ended on September 30, 2016, when it landed on the comet's surface.

Comets have the most eccentric or elongated orbits of any object in the solar system, and they appear to work their way in from the outermost reaches of our solar system. The Oort cloud is the birthplace of comets, where the remnant particles of dust and gas left over from the formation of the solar system slowly orbit the Sun. We cannot directly observe the Oort cloud at a distance of 20,000 to 100,000 AU from the Sun. However, these particles eventually collide, forming larger masses that gravitationally attract towards the solar system's edges.

As they slowly float in, they form a second region known as the Kuiper belt, located from the edge of Pluto's orbit to around 10,000 AU out from the Sun. When enough of these small masses mix together to form a reasonably large mass, the inexorable pull of the Sun draws these newly formed comets into the gravitational well of the inner solar system. And voila, a new comet is on its way! Normally, about one naked-eye comet appears every year, and about one fairly bright one appears every decade.

Given enough time, a comet will slip into the inner solar system, where the solar wind assists in creating the well-known and loved "sword in the heavens." Despite the dread and fear early civilizations once felt at the arrival of these celestial icebergs, the beauty and majesty of their ethereal entrances still captivate us.

Mike Sinclair has been a KAS member since 1992 and served as president from 1996 to 2001. He teaches physics, astronomy, geology, and math at the Kalamazoo Area Math & Science Center.

Great Comets
of the Past 30 Years

by **Richard S. Bell**

Search online for a list of currently visible comets, and you're sure to find at least a half-dozen. Most are exceedingly faint and require a large-aperture telescope to view. Even then, they will be nothing more than a nondescript "hairy star." On average, a *Great Comet*, one that is exceptionally bright, becomes easily visible to the unaided eye once every ten years. In the past thirty years, four comets have fit this category and put on grand shows for the citizens of planet Earth.

Comet Hyakutake and its magnificently long tail. Yuji Hyakutake discovered his comet using a giant pair of pedestal-mounted 25×150 Fujinon binoculars at a rural mountaintop site about 9.3 miles (15 km) from his home to get a better view of the eastern horizon. Image Credit: D. Dierick

On January 31, 1996, Yuji Hyakutake discovered **Comet Hyakutake** (C/1996 B2). On March 25th, it passed just 0.1 AU (9.3 million miles) from Earth, reached a maximum brightness of 0-magnitude, and had a noticeably blue-green color. The average tail length was 35°, but some observers at very dark sites reported an 80° tail! Hyakutake's rapid movement across the night sky during its closest approach was detectable against the stars in just a few minutes, covering the diameter of a full Moon every 30 minutes. Its coma appeared to be approximately 1.5° to 2° across, roughly 4 times the Moon's angular diameter.

Comet C/1995 O1 (Hale-Bopp) as seen on April 4, 1997. Credit: E. Kolmhofer, H. Raab; Johannes-Kepler-Observatory in Linz, Austria.

Comet Hale-Bopp (C/1995 O1) was one for the record books. On July 23, 1995, Alan Hale and Thomas Bopp discovered it from different locations in the southwestern United States. At that time, it was 7.2 AU from the Sun (between the orbits of Jupiter and Saturn) and 10.5 magnitude. Amateur astronomers had never discovered a comet at such a great distance from the Sun. Its relatively high magnitude at that distance meant the comet was larger than most. Indeed, most comets are no more than a mile or two in diameter. Astronomers estimated that Hale-Bopp was 25 to 50 miles (40 to 80 km) in diameter.

The prediction was that the comet would put on a grand show in late March and early April 1997, assuming it didn't fizzle out like so many had done before. This gave astronomy clubs around the world a chance to plan their comet-watching events well in advance. That, along with the media attention, brought hundreds to thousands of visitors to viewing sessions. Hale-Bopp is likely the most-viewed comet in history.

It reached perihelion on April 1, 1997, with a maximum magnitude of -1.8, brighter than any star in the night sky except Sirius. Its two tails were easy to see in most urban areas. From dark locations, the dust tail stretched 40° to 45° across the sky. It was visible to the unaided eye for a record 18.5 months, twice as long as the previous record holder, the Great Comet of 1811.

Image of the striking Comet McNaught over the Pacific Ocean as viewed from the ESO Paranal Observatory. To give you an idea of how large the comet appeared in the sky, the Moon is the bright object above the horizon to the right. Credit: Sebastian Deiries

The Southern Hemisphere took its turn with two Great Comets in 2007 and 2011. British-Australian astronomer Robert McNaught discovered C/2006 P1 using the 0.5-meter Uppsala Southern Schmidt Telescope at Siding Spring Observatory in New South Wales, Australia, on August 6, 2006, at a distance of about 3 AU from the Sun. Reaching an estimated peak magnitude of −5.5 on January 13 and 14, 2007, it was the brightest comet in over 40 years and the second-brightest since 1935.

It was briefly visible to the unaided eye in broad daylight from the Northern Hemisphere around the time of perihelion (January 12th), but persistently cloudy January skies made observations impossible for many. After passing the Sun, **Comet McNaught** became an incredible sight to skywatchers in the Southern Hemisphere. Its long, curved dust tail was simply jaw-dropping.

Australian amateur astronomer and comet hunter Terry Lovejoy used an 8-inch Schmidt-Cassegrain telescope and CCD camera to discover the last Great Comet on November 27, 2011. This was his third comet discovery and was designated C/2011 W3 (Lovejoy) after being confirmed. Based on its orbit, it was discovered to be a Kreutz Sungrazer.

Kreutz Sungrazers are a family of sungrazing comets, meaning they have orbits that bring them very close to the Sun. They are likely fragments from the breakup of a single giant comet many centuries ago, and their name comes from 19th-century German astronomer Heinrich Kreutz, who studied them in detail. Kreutz fragments pass by the Sun and disintegrate almost every day; the Solar and Heliospheric Observatory (SOHO) has witnessed the fate of thousands of them. Most measure less than a few meters across and are too small to see.

Comet Lovejoy reached perihelion on December 16, 2011, passing a mere 87,000 miles (140,000 km) above the Sun's surface. It reached a maximum apparent magnitude between -3 and -4. The first unaided eye sighting of it occurred about 10 hours after perihelion, when it faded slightly to -1-magnitude. Most skywatchers saw it for the first time on December 21st/22nd, when it had faded to 4th magnitude. It had a long, straight dust tail, about 40° to 45° long.

NASA astronaut Dan Burbank captured this image of Comet Lovejoy (C/2011 W3) onboard the International Space Station on December 22, 2011.

Notable mentions over the past thirty years include 17P/Holmes in 2007, C/2011 L4 (Pan-STARRS) in 2011, and C/2020 F3 (NEOWISE) in 2020. While they were all fine comets, none obtained the status of a Great Comet. Will Comet C/2023 A3 (Tsuchinshan-ATLAS) become the next Great Comet? Your guess is as good as mine!

Comet Cookbook

Some of the original material that formed the solar system is present in comets. Orbiting far from the Sun, this primordial material has survived in an unaltered state for billions of years.

Gravitational forces draw a comet nucleus into the inner solar system, where it begins to heat up. Its volatile materials boil off to form the head and tail(s) that have amazed, baffled, and frightened people throughout history. The small solid nucleus, only 10 km or less in diameter, produces this tremendous light show. Think of it as a very dirty iceberg! In 1986, Japanese, Soviet, and European spacecraft flew by Halley's Comet, confirming this view.

You can make an accurate model of a comet nucleus easily and inexpensively. Unfortunately, doing it neatly is difficult.

Here is what you need:

- Dry ice (5 lbs.) is available from ice companies or ice cream parlors; CAUTION: Dry ice is -79° C (-110° F). Any more than brief exposure will cause "burns." When handling it, be cautious.
- Water (around half a gallon) in pitcher
- Ammonia (a few drops or sprays of window cleaner);
- Dirt (fine-grained, one handful)
- Corn Starch, or Worcester Sauce (a couple of pinches or drops)
- Trash Bags (2)
- Large Bowl or Small Pot
- Waterproof Gloves (the better insulated, the warmer your hands will remain)
- Cloth Towel
- Paper or cloth towels
- Hammer
- Mixing spoon or stick.

These ingredients are either actual components or useful analogies. The dry ice is frozen carbon dioxide. Water, ammonia, organic (carbon-based) molecules, and silicates are all present on comet nuclei. Spectral measurements of comet tails and the collection of tiny particles by very high-flying research aircraft have identified them.

Here is the recipe:

Line the bowl with a trash bag. Place the other trash bag on the floor. Pour about a pint of water into the bowl. Add the corn starch or Worcester sauce, ammonia, and some of the dirt; mix a bit.

Put on the gloves. Wrap the dry ice in a cloth towel; place it over the trash bag on the floor. Use the hammer to grind up the dry ice into a powder. Gradually pour the dry ice powder into the water, mixing as you pour. A significant amount of vapor will be formed. The dry ice, water, and other ingredients should form a thickening slush. Keep stirring for a few seconds as it thickens.

Now, use the trash bag to lift the slush away from the sides of the bowl and use your gloved hands to pack it into a ball. Continue packing and forming until the ball solidifies into a large lump.

Peel back the trash bag. Scatter some dirt over the lump. Pour some of the remaining water over the lump, turning it as you do so, so that a layer of water ice forms over the entire lump.

Observe your miniature comet nucleus's behavior. If the water ice coating is intact, you can handle it without gloves. If a spot feels sticky, apply water to it. It hisses and pops as carbon dioxide sublimes (goes from the solid state directly into a gas), forcing its way through weak spots in the water ice crust. On real nuclei, this results in slight jetting forces that can cause the nucleus to spin, slightly alter its orbit, or split apart (or "calve").

Note: Get three or four pounds of dry ice for each nucleus you plan to make. You can purchase it the afternoon or evening prior to the demonstration and store it in a freezer or ice chest. Place an inch or so of newspaper below the dry ice to prevent cracking of the surface on which the dry ice rests. Check the demonstration to determine how much water to use.

It's fun, it's a mess, and it's one of the most memorable and scientifically accurate demonstrations in astronomy!

Catch Andromeda Rising!

by **Dave Prosper & Kat Troche**

If you're thinking of a galaxy, the image in your head is probably the Andromeda Galaxy! Studies of this massive neighboring galaxy, also called M31, have played an incredibly important role in shaping modern astronomy. The Andromeda Galaxy is also a beautiful sight, which is a bonus for stargazers.

Spot the Andromeda Galaxy! M31's more common name comes from its parent constellation, which becomes prominent as autumn arrives in the Northern Hemisphere. Surprising amounts of detail can be observed with unaided eyes when seen from dark sky sites. Hints of it can even be made out from light polluted areas. Use the Great Square of Pegasus or the Cassiopeia constellation as guides to find it. Credit: Stellarium Web .

Have you heard that all the stars you see at night are part of our Milky Way galaxy? While that is mostly true, one star-like object located near the border between the constellations of Andromeda and Cassiopeia appears fuzzy to unaided eyes. That's because it's not a star, but the Andromeda Galaxy, its trillion stars appearing to our eyes as a 3.4 magnitude patch of haze. Why so dim? Distance! It's outside our galaxy, around 2.5 million light-years distant - so far away that the light you see left M31's stars when our earliest ancestors figured out stone tools. Binoculars show more detail: M31's bright core stands out, along with a bit of its wispy, saucer-shaped disc. Telescopes bring out greater detail but often can't view the entire galaxy at once. Depending on the quality of your skies and your magnification, you may be able to make out individual globular clusters, structure, and at least two of its orbiting dwarf galaxies: M110 and M32. Light pollution and thin clouds, smoke, or haze will severely hamper observing fainter detail, as they will for any "faint fuzzy." Surprisingly, persistent stargazers can still spot M31's core from areas of moderate light pollution as long as skies are otherwise clear.

Generated version of the Andromeda Galaxy and its companion galaxies M32 and M110. Credit: Stellarium Web

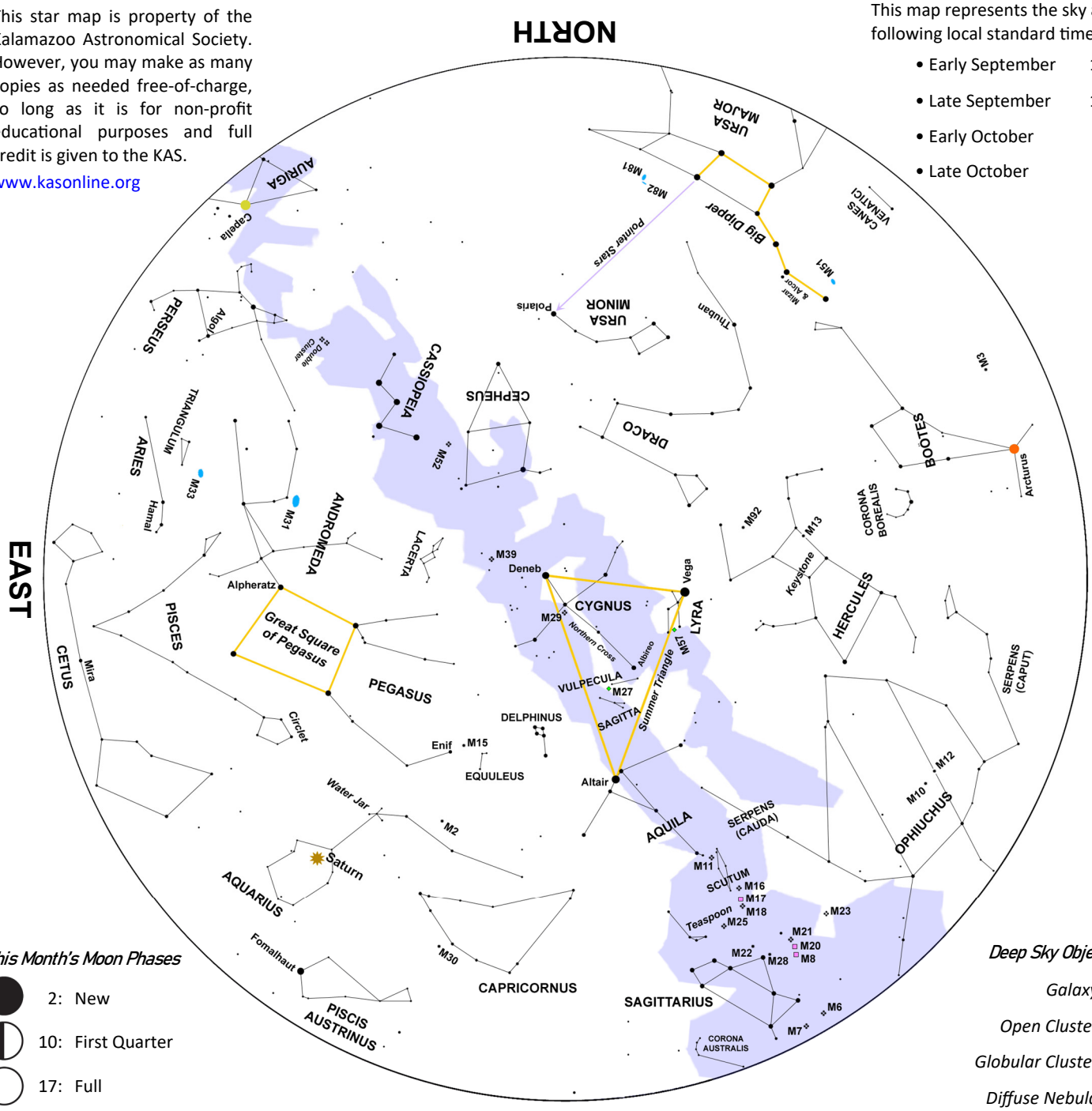
Studies of the Andromeda Galaxy greatly shaped modern astronomy. A hundred years ago, the idea that there were other galaxies beside our own was not widely accepted, and so M31 was called the "Andromeda Nebula." Increasingly detailed observations of M31 caused astronomers to question its place in our universe – was it its own "island universe" and not part of our Milky Way? Harlow Shapley and Heber Curtis engaged in the "Great Debate" of 1920 over its nature. Curtis argued forcefully from his observations of dimmer than expected nova, dust lanes, and other oddities that the "nebula" was in fact an entirely different galaxy from our own. A few years later, Edwin Hubble, building on Henrietta Leavitt's work on Cepheid variable stars as a "standard candle" for distance measurement, concluded that M31 was indeed another galaxy after he observed Cepheids in photos of Andromeda and estimated M31's distance as far outside our galaxy's boundaries. As a result, the Andromeda Nebula became known as the Andromeda Galaxy.

These discoveries inspire astronomers to this day, who continue to observe M31 and many other galaxies for hints about the nature of our universe. One of the Hubble Space Telescope's longest-running observing campaigns was a study of M31: the Panchromatic Hubble Andromeda Treasury (PHAT). Dig into NASA's latest discoveries about the Andromeda Galaxy on their Messier 31 page.

October Night Sky

This map represents the sky at the following local standard times:

- Early September 11 pm
- Late September 10 pm
- Early October 9 pm
- Late October Dusk



This Month's Moon Phases

- 2: New
- 10: First Quarter
- 17: Full
- 24: Last Quarter

Deep Sky Object Key

- *Galaxy*
- *Open Cluster*
- *Globular Cluster*
- *Diffuse Nebula*
- *Planetary Nebula*

Grab your binoculars shortly after dusk on October 5th, and look low in the west-southwest. A waxing crescent Moon will be 4° to the lower left of Venus. Conjunctions like this are always spectacular, so hope for clear skies!

Comet Tsuchinshan-ATLAS (C/2023 A3), discovered in early 2023, may be one of the highlights of the year (or even decade). The comet will be hidden in the Sun's glare until October 11th. Find yourself a spot with an unobstructed view of the western horizon (the lakeshore would be ideal). The comet will be ~5° above the horizon about 20 to 30 minutes after sunset. Hopefully it will be visible with the unaided eye, but be sure to bring binoculars in either case.

Comet A3 makes its closest approach to Earth (43.9 million miles) on October 12th and will be 13° above the western horizon 30 minutes after sunset. The comet's dust tail should extend over 10° to the northeast.

The comet climbs more than 5° per day but gradually fades as it recedes from the Sun. Light from the Moon will make it difficult to see with the unaided eye until the 20th, but it should be easy to see in binoculars.

General Meeting Preview

Astrophotography Night

KAS shutterbugs show off their wares.

The tradition continues! The Kalamazoo Astronomical Society dedicates its general meeting every October to astrophotography, the art of photographing the night sky. Over the years, KAS shutterbugs have traveled to exotic places, ascended to dizzying heights, or just hung out in their backyards and other locations across southwest Michigan, working the graveyard shift with their impressive array of camera gear. Now they are ready to show their artistic wares. Don't miss one of our most enjoyable meetings of the year!

Friday, October 4th @ 7:00 pm EDT

Kalamazoo Area Math & Science Center

Use Dutton St. Entrance • Locked by 7:10 pm

Also held on Zoom • Click to Register