New Jersey ASTRONOMICAL Association

The Journal

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Contributors Needed

The NJAA Journal is soliciting contributions for future issues. Click here if you would like to submit an article to The Journal. Any submission is welcome and will be reviewed for publication. This is a great opportunity for younger members to see their work published in a periodical.

We Value Your Feedback

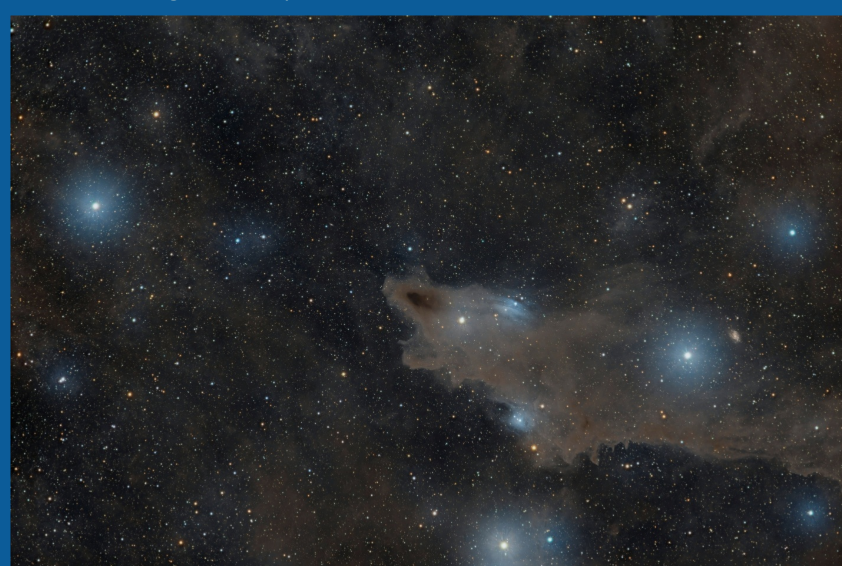
We hope you're enjoying The Journal, but tell us what you think. Suggestions are welcomed at this email address: Membership@njaa.org.

Hunting the Dark Shark

By Melanie Vayda

When a fellow member of NJAA offered me a chance to buy their ticket to this year's sold out Black Forest Star Party, I jumped at the chance. I wanted to select a target that took advantage of the dark skies available at Cherry Springs State Park. This wasn't my first time making the trek to Cherry Springs, but it was the first time I had the good sense to photograph something that would benefit from the low light pollution – the Dark Shark Nebula (LDN 1235).

I started experimenting with astrophotography in 2021, but I've been developing my astrophotography techniques at a much faster pace since joining NJAA and the astrophotography group in the spring of 2023. Like most of us in the astrophotography group, I'm typically shooting targets through light polluted central NJ skies while cursing at my neighbors' flood lights. Imaging at Cherry Springs' Overnight Astronomy Observation Field gives you the unique opportunity to image in an International Dark Sky Park, in a field that does not permit white light of any kind.



The Dark Shark is one of the many objects in Lynds' Catalogue of Dark Nebulae (LDN). Dark nebulae are dense clouds of gas and dust that obscure the light from background stars. However, some sections are more like a reflection nebula, lit by nearby stars. *(Continued)*

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LDN 1235 is about 650 light years from earth and 15 light years long. If we could see this nebula with the naked eye, the head of the shark would appear slightly smaller than the moon.

As dusk was approaching on Thursday night, I began preparing. I'm currently using a ZWO AM5 mount, ZWO ASI2600MC Pro camera, and my original starter telescope from 2021 – the Astrotech AT60ED. This little doublet has served me well considering its simple optics and affordable price. It will be replaced soon, though; I'm currently on the hunt for my goldilocks scope.

I was able to soak this target for three straight nights – another thing I don't typically do! I'm usually too excited to be patient, but I try to remind myself that *more* is better than *faster.* I ultimately collected about 20 hours of integration time.

As full dark settled over the park, a red glow could be seen emanating from the various imaging rigs. Night vision kicked in. I could see my own shadow cast by the light of the milky way - a surreal moment that reminded me why I love this hobby. I then enjoyed my favorite part – a night under the stars with good company and conversation.

My Journey to the Bubble Nebula

By Daniel Silber

Hello fellow astronomy enthusiasts!

Less than a year ago, I only saw pictures of the Bubble Nebula. Now that doesn't mean I just started my interest in amateur astronomy, not by far, but that's the point. You're always discovering new things with this hobby. I'm Daniel Silber, I go by Dan too and my family calls me Danny. I first acquired an interest in astronomy when I was about 10 years old (I'm retired now), so that gives you an idea how long this hobby has interested me. Suffice to say it's been a long time.

You may wonder if you can see the Bubble Nebula with a telescope. I don't know, certainly you could probably see the star that formed the Bubble with a large amateur telescope, but most often it's too dim to detect the nebulosity just by looking through a small telescope. That's one reason I never bothered trying to observe it, I knew it was very faint. That's where astrophotography comes in. I love astrophotography because it enables me to discover for myself many objects out there in the night sky that otherwise I would never have a good look at.

Here's some information about the Bubble Nebula from Wikipedia:

"**NGC 7635**, also known as the **Bubble Nebula**, **Sharpless 162**, or **Caldwell 11**, is an H II region emission nebula in the constellation Cassiopeia. It lies close to the open cluster Messier 52. *(Continued)*

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The "bubble" is created by the stellar wind from a massive hot, 8.7 magnitude young central star, SAO 20575 (BD+60°2522). The nebula is near a giant molecular cloud which contains the expansion of the bubble nebula while itself being excited by the hot central star, causing it to glow. It was discovered in November 1787 by William Herschel. The star BD+60°2522 is thought to have a mass of about 44 $M_{\odot}$."

What is "about 44 $M_{\odot}$" supposed to mean? Here you go: "The expression "44 $M_{\odot}$" refers to the mass of an object with approximately 44 times the mass of the Sun. The symbol $M_{\odot}$ represents a solar mass, which is a standard unit of mass used in astronomy."

So much information is available on the internet, how can anyone get bored? Anyway, I decided to photograph this thing; so I started out with a 4-inch refractor and a go-to mount. I just entered the name of the object in my hand controller and *voilà*; I was pointing at it. But I did not see it until I started taking long exposures, like 120-second exposures, that were the minimum saturation needed by the imaging software I was using to display. By the way, it takes many digital images of the same object, superimposed on each other to make a discernible image of most faint objects. This is called stacking. This is necessary when photographing faint objects with a digital camera because the camera introduces digital "noise" (light and dark specks) at random locations in each image. Stacking the images "averages out" the noise and, at the same time, reinforces the faint image of the desired celestial target, thereby increasing the signal-to-noise ratio. The result is below:

Of course, after I started taking pictures and processing them, I wanted to know where my object was on a star chart! With today's telescopes, you don't even need to know exactly where things are on a star chart or where to point the telescope, that's all done by go-to or push-to electronics that come with most modern telescopes. So, I used a free application, called *Stellarium* (You can download it; just google it).

Stellarium is a planetarium simulator for your computer. It works great! Searching *(Continued)*

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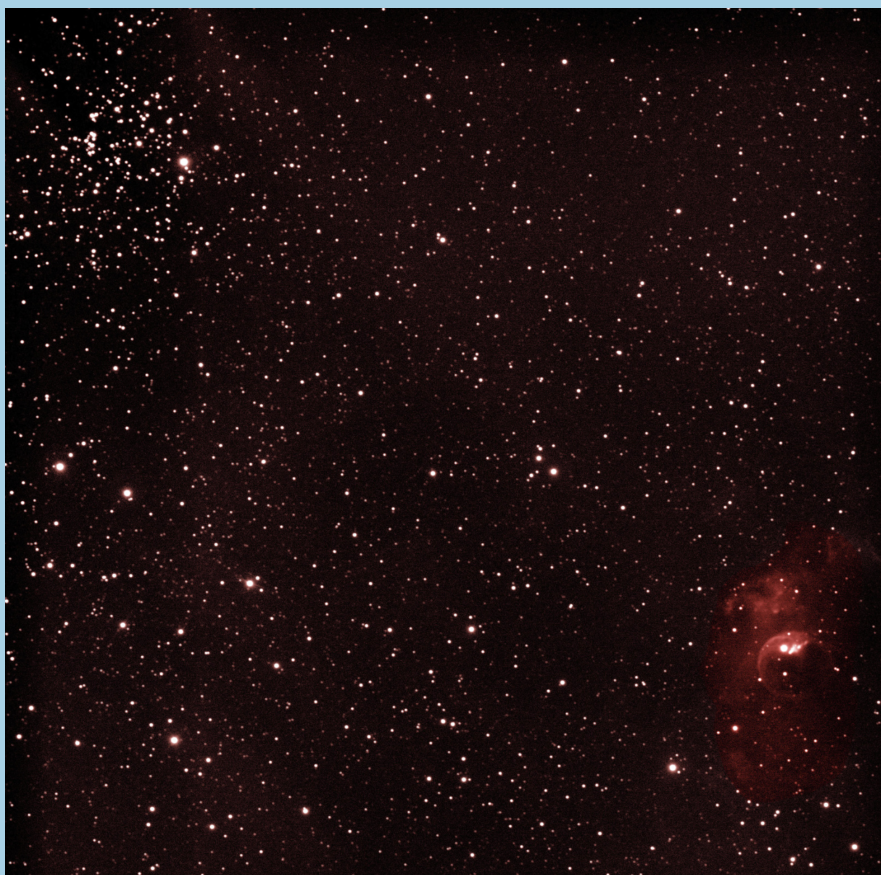
in the area of Cassiopeia, I noticed another object nearby, called M52 (that is, Messier 52), also known as the Salt and Pepper star cluster). So I decided to try to get both objects in one picture. Sure enough, I was able to do so:



BTW, you don't have to photograph these objects yourself in the night sky to appreciate them, you can view thousands of other people's images on a website called Astrobin.com. I host some of mine at this URL.

https://app.astrobin.com/u/powdermillphotography

There are a ton of resources for learning how to observe and photograph the night sky. When you know more about the objects you are observing or photographing, that makes doing so much more interesting. Otherwise, it's just light in the sky on a dark night. When you know something about the distances, the size of these things, how they got to be the way they are, and how old they are, then those lights and images have meaning. It's hard to wrap your head around how big space is, you have to use your imagination!

Imaging of Supernova SN 2025rbs in Galaxy NGC 7331

By Isbel Gonzalez

Summary

On August 23, 2025, I captured an image of supernova SN 2025rbs, discovered on July 14, 2025 in the spiral galaxy NGC 7331 in the constellation Pegasus. NGC 7331 is often referred to as the "twin of the Milky Way" due to its structure and size. It lies at a distance of approximately 40 million light years.

For this observation, I used a Celestron C14 Schmidt-Cassegrain telescope paired with a ZWO ASI071MC astrophotography camera. A total of two hours of exposure time was accumulated, allowing for a detailed view of the galaxy and the bright supernova near its nucleus. The exposure time was divided into sub-exposures, which were later calibrated, aligned, and stacked. Dark, flat, and bias frames were applied. Color calibration and linear stretching were applied during post-processing.

The resulting image shows NGC 7331's well-defined spiral arms, dust lanes, and several companion galaxies in the background. Most notably, the supernova shines distinctly against the galactic core, a powerful *(Continued)*

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reminder of the immense stellar explosions that contribute to the chemical enrichment of the universe.

This observation highlights the potential for amateur astronomers to contribute meaningful documentation of transient celestial events. Recording such phenomena not only provides striking imagery but also preserves valuable data for the astronomical community.

The following sections summarize the details of the image capture process:

Coordinates & Offset

From discovery and follow-up reports, SN 2025rbs is located at RA (J2000) = 22h 37m 03.642s, Dec (J2000) = +34° 25′ 07.96″. It lies approximately 5″.2 west and 11″.2 north of the nucleus of NGC 7331.

Classification & Photometry

SN 2025rbs has been spectroscopically classified as a Type Ia supernova (z_host = 0.002722). The discovery magnitude in the GOTO L-band was reported as 17.07 ± 0.03 AB mag. At the time of discovery, the supernova was faint; it brightened rapidly over ensuing days, reaching estimates around mag 14.0 near peak in unfiltered or R-band equivalents. Some amateur observers noted the supernova near magnitude 13.8 in mid-July. Even by late August, it was reported to maintain ~14.4 mag.

Given the distance and a typical absolute magnitude for Type Ia supernovae (around –19.3 at peak), the observed apparent magnitudes are broadly consistent with expectations for a nearby Type Ia event.

Image Features & Context

In the final stacked image, I resolved the spiral arms, dust lanes, and faint companion galaxies in the field surrounding NGC 7331. The supernova appears as a bright point source against the luminous background of the galactic bulge, aided by the high S/N from the 2-hour integration. Its proximity to the nucleus required careful dynamic-range handling to avoid saturating the core while preserving the SN.

Discussion & Significance

- The proximity (~40 Mly) of SN 2025rbs makes it an excellent candidate for photometric and spectroscopic follow-up, potentially contributing to calibrations of the distance ladder via Type Ia supernovae.
- Given its location close to the nucleus, the background subtraction and isolation of the SN flux are nontrivial; precise photometry and color correction are critical for light-curve construction. *(Continued)*

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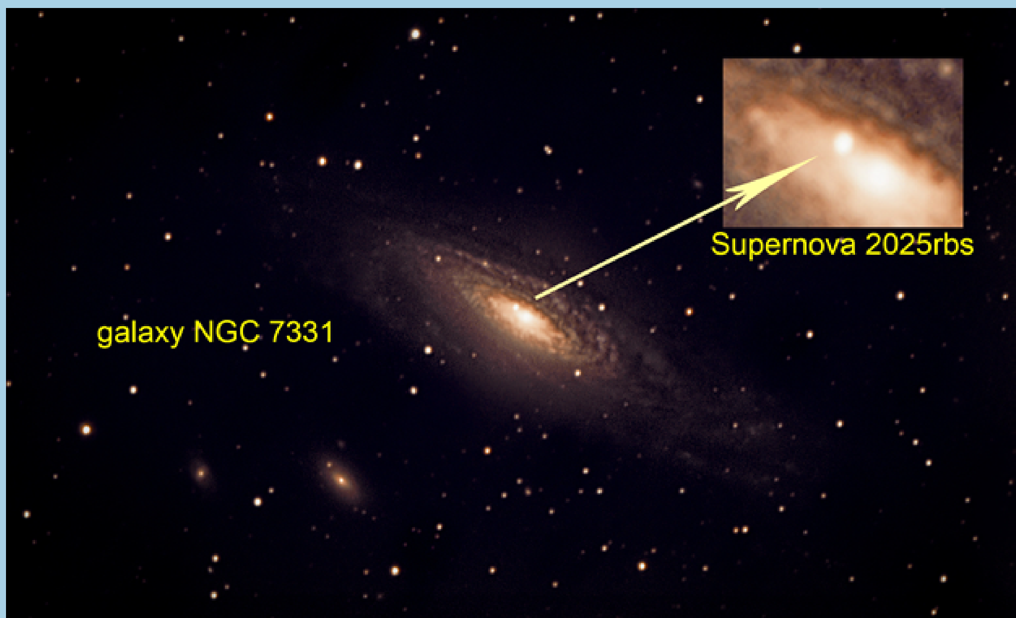
- The quality of the image demonstrates that advanced amateur setups, when carefully calibrated, can contribute valuable data to transient astronomy.
- Continued monitoring of SN 2025rbs over weeks to months is encouraged to chart its light curve decline and compare it with standard templates.



Video Documentation

Here is a link to a video explaining the entire capture process: https://www.youtube.com/watch?v=0tl-ui6BwBg

Photo of NGC 7331, SN 2025rbs, and Stephan's Quintet

By Michael Sweetman

I created the image below using photographs collected between start date and end date. On the right is galaxy NCG 7331. This is a spiral galaxy about 40 million light years away from earth. On July 14th, a supernova was observed in this galaxy. It is the blueish star just to the lower right of the galaxy core.

It is believed to a Type Ia supernova, which can occur in a binary star system, when at least one of the stars is a white dwarf. They have consistent peak brightness, which makes them a useful tool in the "Cosmic Distance Ladder" for determining distances to far off galaxies.

Also, in the left of picture is Stephan's quintet. It is an apparent cluster of galaxies. Four of these are interacting galaxies approximately 300 million light years away (the four red-shifted blurs, roughly aligned with the diagonal connecting the upper-right and lower-left corners of the *(Continued)*

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inset below), and one is visually superimposed, and about 40 million light years away (the more normal-colored galaxy near the top-center of the inset).

Capture details: 70 Lights @ 180 seconds, 20 Darks, 20 Flats, and 100 bias frames. Celestron AVX mount,

Celestron 8in SCT with flattener/reducer, ZWO ASI294mc pro camera, and ZWO ASI220mm mini guide camera on an off-axis guider. Captured night of August 4-5.

MacGyver Astronomy or Making Your Own Astronomical Focuser

by Richard Zepernick

With the advent of cheaply available micro computers that can control motors, read sensors. and do calculations, it is now possible to make your own focuser controllers, filter mechanisms and even entire telescope controllers.

I've made a telescope focuser using an Arduino Uno and a 12VDC motor. For those who don't know, the Arduino Uno is a single board microcomputer that has multiple real time digital and analog inputs and outputs and communicates to the outside world via a USB port. The Uno doesn't have an operating system like Windows or Linux, you just turned it on, and it runs its internal program over and over again. BTW, an Arduino Uno is what is controlling the drive on the 26" up in the dome.

The interface between the Arduino and the telescope is an ASCOM (Astronomy Common Object Model) driver. ASCOM sets standards between high-level astronomy apps (e.g.: the Sky, Stellarium, APT, and others) and the low-level world of the Arduino. This is basically the software that talks between the two worlds. Once you have a driver program that meets ASCOM standards, it means your little device should work with any astronomy program.

<u>General Workflow Overview</u>

<u>History</u>

What started my project is that I had a 12VDC manual focuser on my scope that I bought way back when from JMI (remember them?). This worked fine with the push buttons for manual focusing when you were at the scope, but I wanted to automate the process somewhat.

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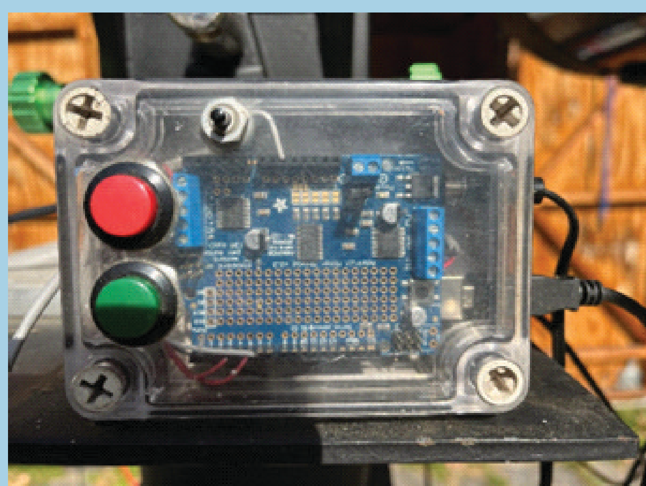
Enter the Arduino

I had really no idea of how to do this until I bumped into conversations on Cloudy Nights about telescope automation. These conversations referred to "Arduinos" and something called "ASCOM." Well, after a lot of reading and research, I decided that I should be able to do this. An Arduino could read digital inputs (i.e., push buttons), take commands via USB, and control the DC motor. This would replace the existing hand controller. With ASCOM, I could create an interface to the APT program I use. So, I bought an Arduino Uno to test it out and see how this would work.

The Arduino is programmed in a version of C, which I didn't know, so that was a learning curve in itself. Luckily, the device is virtually indestructible from coding errors. If it doesn't work, you power it off and start again.

The final hand controller came out as this:



The red button is "In" (that is, "Move the focuser inward."); green button is "Out". The little black button (above and to the right of the red button) sets a zero point (i.e., fully "In"). My program works by running the motor at a fixed speed and counting milliseconds. You start by setting the focuser all the way in and pressing the black button. This sets a zero point. Pressing the red button will do nothing, as the focuser can't go any more inward (i.e., it can't count below 0). The green button allows the focuser to go outward. I also set a software maximum so that the focuser can't get too far out. Now this is all fine for manual control by push button, but how about automatic…?

Enter ASCOM

The ASCOM website has a full software development kit you can download for free that allows you to create a standard compliant driver to allow your device to talk with other software. It has the basic templates and code module frameworks. There are templates for camera drivers, dome drivers, filter wheels and all other telescope accessories and these are available in either **C#.Net** or **VisualBasic.Net** (as of ASCOM Platform Version 6). I used VB.Net as I was fairly familiar with it. I won't go into the full details of writing the driver, but it basically comes down to information transfer. The calling program has a set of commands that it needs to be sent to your Arduino program (such as, desired position, immediate stop). In return, it expects feedback information *(Continued)*

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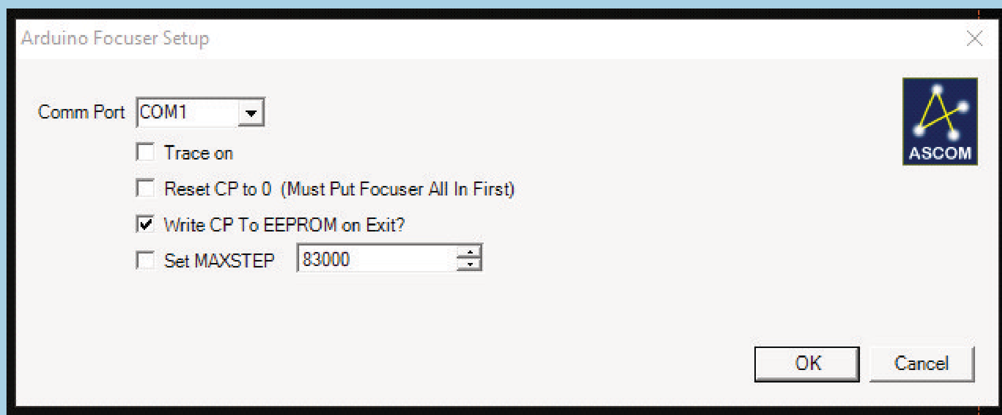
("focuser is moving" and "current position"), so that it knows what's going on. Once you've written and tested your drivers, ASCOM also includes programs that you can use to make your driver into an installable file so that it can be put into other computers. The driver interface for my focuser is shown below.



"Comm Port" tells the calling program where the Arduino is plugged in. "Trace On" is used to setup a log file in ASCOM to show the connection procedure which is useful to determine connection errors. "Reset CP to 0" sets the current position (CP) of the focuser to 0. "Write CP" writes the current position of the focuser to Arduino EEPROM when the focuser is disconnected and "Set MAXSTEP" is the maximum "out" the focuser is allowed to go.

<u>Result and Usage</u>

The driver installs like any other driver used. You tell the driver what COM port to talk to and the driver will do the handshaking and so forth between the calling program and the Arduino. I like using the program APT (short for AstroPhotography Tool) to run my sessions. Although not as sophisticated as NINA, it has a lot of features and only costs about $20. I tell APT to connect to my driver and I can then use the features in the program.

Once connected, I have GoTo ability and can use Auto Focus routines available in ATP. "Position" is the distance from the focuser's zero position to the position where the astronomical target is in focus, expressed as the working millisecond counter from the zero position to focus. When the program exits, the driver tells the Arduino to store the last focuser position in EEPROM so that we have a good starting point for the next time. Starting out at or near the correct focus saves time and is more accurate because fewer steps are required.

While not as accurate and repeatable as a stepper motor controller and with no true feedback, it does the job of focusing. It was also a helluva lot cheaper than stepper focusers and was challenging and fun to write and build.

NJAA Receives Life-Saving AED Donation from Rotary Club

by Brian Della Pesca

The New Jersey Astronomical Association (NJAA) extends its sincere thanks to the Rotary Club for their generous donation of an Automated External Defibrillator (AED) for the observatory.

This life-saving device and donation of Narcan inhalers from the Narcan program in New Jersey, will significantly enhance the safety of our members, guests, and visitors during public programs, star parties, and educational events, considering how often looking at the night sky can cause heart stopping moments, having an AED readily available provides peace of mind and ensures we are better prepared to respond in the event of a medical emergency.

We are deeply grateful to the Rotary Club for their continued commitment to community health and safety. Their support makes a meaningful difference and helps the NJAA maintain a welcoming and secure environment for everyone who shares in our passion for astronomy.

Thank you, Rotary Club, and especially Carol Gallo NHRC, for helping us look after our community—both on Earth and under the stars.

(L-R) Jim Roselli, Michael Sweetman, Bob Starcher, Andrea Sweetman, Stephen Blazier, Bruce Pierson, Brian Della Pesca, John Andrews, and Len Cacciatore.

For Beginners--

My Journey to the Milky Way

by Joe Link

It all started with a book, *The Giant Golden Book of Astronomy,* around 1955 when I was eight years old. I fell in love with that book and the wonderful illustrations of planets, constellations, comets and telescopes that took hold of my imagination and didn't let go.

My parents encouraged my interest in astronomy. They took me to Northwestern University in nearby Evanston, Illinois, to look at Mars through its observatory telescope. I still remember my amazement at how (Continued)

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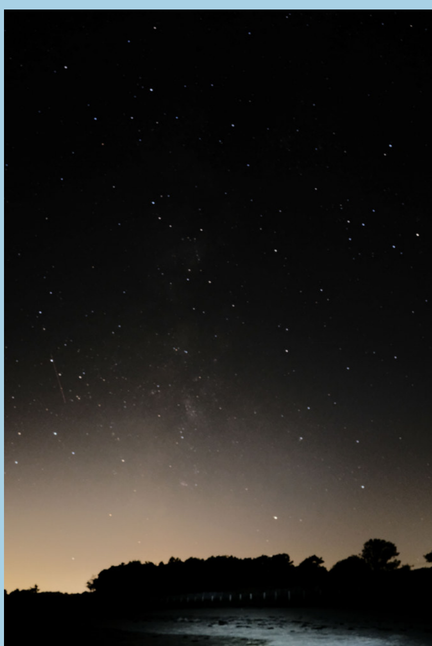
close the red planet looked. They also took me to Adler Planetarium in Chicago for star shows.

When I was 11, my father woke me in the middle of the night at our home north of Chicago to show me the Northern Lights. My mental image of the Aurora has faded, but the memory of how my father cared has stayed with me.

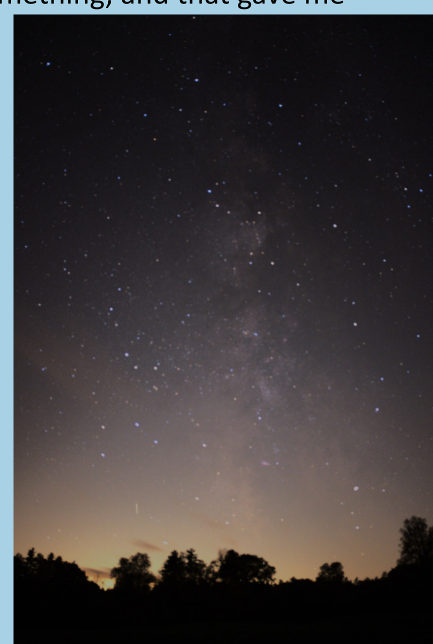
I remember being enthralled by the launch of Sputnik in 1957. I was especially attentive when Neil Armstrong set foot on the Moon in 1969. But after that, my interest in astronomy took a back seat to career building, life in brightly lit urban areas and the demands of raising four children. Even so, Carl Sagan kept me thinking about the wonders beyond what he called our "pale blue dot."



Fast forward to 2017 when a job change enabled me to work from home. As a photography buff, I wondered if I could capture an image of the Milky Way. After reading how to use a digital camera like mine, a stay in coastal Maine in October gave me an opportunity to try.

My wife Janet and I trekked to a dark stretch of beach between Ogunquit and Wells. I rarely felt so clueless standing on the beach with the temperature in the upper 30s while I tried to remember f-stops, ISO settings, manual focus techniques and exposure times. It was a disaster. I got nothing but frozen fingers while Janet retreated to the car. The photograph on the left is the result.

Several more attempts on subsequent nights went a little better. Still, my ISO was set way too low, and my shutter speeds were far too short. I also forgot to put my camera on manual focus. At least I could see something, and that gave me encouragement. The photograph on the right is an example.



It wasn't until four years later, when I fully retired, that I had another chance. Janet read about Cherry Springs State Park in central Pennsylvania and how it had some of the darkest skies in the East. We decided to give it a try, and this time, I read even more articles and watched additional YouTube videos.

The time came in June 2022 for our big trip. After two cloudy nights, the sky cleared somewhat on the third. We drove from our B&B to Cherry Springs and were treated to a dazzling array of stars directly overhead, but clouds hung over most of the Milky Way.

Discouraged, we finally gave up in the wee hours and drove back to our B&B. When we got out of the car, I looked up and was amazed to see that the clouds had parted, and the full Milky Way lay before me.

Here was my opportunity. I quickly set up my Fujifilm X100F, focused manually,

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set my ISO to 3200 and my shutter speed to 10 seconds, and captured a dozen RAW images and another dozen with the lens cap on to help reduce digital noise in later processing. I was so excited that I could hardly sleep because I knew I was getting it right this time.

Back home, I stacked my images using Sequator, a free application to combine images into a final TIFF file, and then processed the result using a decade-old copy of Photoshop Elements. I was blown away by how much detail I captured. Please see the photo below.

Wagner Farm Arboretum Astronomy Event April 24, 2026

by Bill Funcheon

The NASA Solar System Ambassador Program (SSA) and the New Jersey Astronomical Association (NJAA) will be holding a public Astronomy event on April 24, 2026, at the Wagner Farm Arboretum, located at 197 Mountain Avenue, Warren Township (Somerset County), New Jersey.

Hosted by NASA Solar System Ambassador (SSA) and longtime New Jersey Astronomical Association (NJAA) member, Bill Funcheon, a team of 25 NJAA club members will share their telescopes *(Continued)*

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and love of the night sky with the public. The moon, Venus and Jupiter, distant galaxies, star clusters, and deep sky objects.

A wide variety of astronomical instruments will be available, including binoculars, telescopes of many designs ranging from 3” up to 17”, advanced astrophotography equipment, and many Smart Telescopes (SeeStars, etc.).

Please join us for an informative and fun-filled night of wonder under the stars! The event starts at 7:30 PM and admission is free. For more information, see the Wagner Farm Arboretum website: https://www.wfafnj.org/events

Double Stars

by John Barbecane and Bob Starcher

Stargazing in New Jersey can be a challenge due to high levels of light pollution. On many nights, deep sky objects can be almost impossible to observe. Double Stars, on the other hand, offer several opportunities to observe interesting objects under such conditions. Many double stars are relatively easy to find with just the naked eye, making them perfect for outreach events and public nights at the observatory.

“Double Star” is a broad term which includes optical doubles, eclipsing binaries, visual binaries, and spectral binaries.

Optical doubles are stars that appear to be very close to one another, being nearly collocated along our line of sight; however, in reality, one star is typically much farther away than the other. Other than their common orientation with respect to us, these stars have no relationship to each other.

Eclipsing binaries, visual binaries, and spectral binaries are composed of two stars that are gravitationally connected to one another. Eclipsing Binaries are star systems that are oriented in a manner that allows one of the stars in the pair to eclipse the other when viewed from the Earth, resulting in periodic, short-term reductions in observed brightness. This requires the axis of revolution around which the pair orbits to be perpendicular to our line of site, which results in their mutual orbit to be viewed edge-on, similar to how the Needle Galaxy in Coma Berenices (NGC 4565, a.k.a. Caldwell 38) is viewed edge-on from Earth.

Visual binaries orbit an axis that is oriented in a direction that is not perpendicular to the line of site from Earth, similar to most spiral galaxies, for example, M31 (the Andromeda Galaxy), M51 (the Whirlpool Galaxy) and M81 (Bode’s Galaxy).

Spectral binaries are cases where two stars are so close together that they can’t be resolved into their constituent stars, even with the best telescopes. For this type of binary, a different approach is used that involves spectral observations of the two stars in the system. If the stars belong to different spectral classes, their spectra will have lines characteristic of their respective classes. Although superimposed, the two sets of characteristic spectral lines can be identified, indicating the presence of two stars.

Even if both stars are identical with respect to spectral class, it is still possible to detect two stars, if one is moving away from us and the other is moving toward us. This would be true for all pairs that do not have an axis of revolution that coincides with our line of sight. In most cases, because the axis of revolution is inclined with respect to our line, one of the stars is moving toward us and its spectrum is blue-shifted, due to the Doppler effect, while the other is moving away and its spectrum is red-shifted. The resulting shifts of characteristic spectral lines allow the individual spectra to be distinguished on the combined spectrum.

Presented here is a small sample of the different types of double stars easily found under light-polluted skies. These are all Winter/Fall doubles that can be resolved with telescopes as small as 4 inches in aperture.

The Winter Albireo

The Winter Albireo (unofficial name) is an optical double found in Canis Major. It is registered in the Bright Star Catalog as HR 2764 and consists of a gold-colored star, 145 G. Canis Majoris (a.k.a. HD 56577), which is about 1418 light years from Earth and has a magnitude of 5.0. In some sources (e.g., the star atlas that comes with Stellarium), HR2764 refers to 145 G. Canis Majoris and an adjacent dimmer blue star, HD 56578, which is 303 light years away and has a magnitude of 6.0. This optical double is sometimes known as the Albireo of Winter *(Continued)*

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due to the color-contrast similarity it has to the summertime star that marks the head of Cygnus the Swan. The stars composing the Winter Alberio are separated by 27 seconds of arc and have a combined magnitude of approximately 4.9.

Historical Note: The Yale Bright Star Catalog (YBSC, or simply BSC) includes approximately 9.000 stars of magnitude 6.5 or brighter. The "HR" in the brighter star's designation indicates that Professor Frank Schlesinger of Yale University, the BSC's initial author, had the foresight to continue use of designations from well-established star catalogs, in this case, the Harvard Revised Photometry Catalogue (HR), rather than introduce new catalog designations. The name of the brighter component (145 G. Canis Majoris or 145 G. Cma, using the standard 3-letter abbreviation for Canis Majoris) is taken from the late 19th-century Uranometria Argentina, compiled by Benjamin Apthorp Gould (from which the "G." in the star's designation derives). Each of the two component stars have their own respective "HD" number in the early 20th-century Henry Draper Catalogue, a spectral catalog of stars with brightness down to magnitude 9, compiled primarily by Annie Jump Cannon.

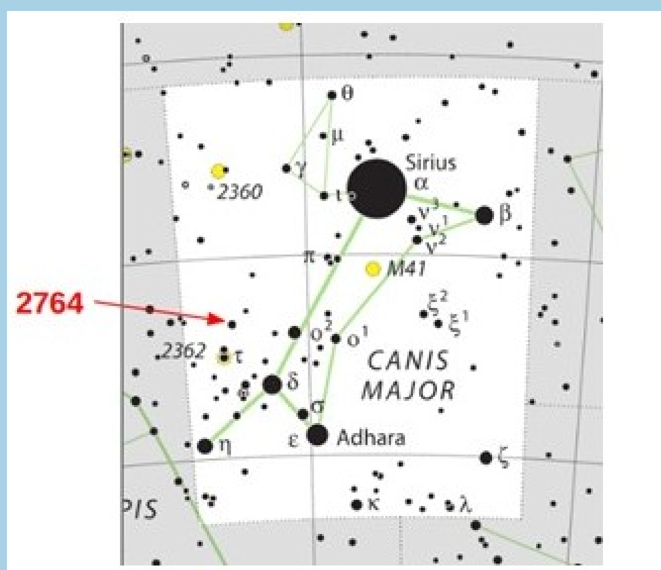

Figure 1: HR 2764 Location

Algol

Algol (Beta Persei, or Beta Per) is an Eclipsing Binary system found in Perseus. It is 93 light years from Earth and consists of a brighter, more massive, but smaller-diameter primary star, Beta^1 Per (called Aa1 in the Beta Persei literature), which orbits a common center of gravity shared with the dimmer, larger-diameter red-giant branch (RGB) star, Beta^2 Per (Aa2).

This binary system has special interest for those who study the effects of the components of binary systems upon one another. Since both stars in a binary system formed at the same time, we would expect the more massive member to be hotter, causing it to exhaust the hydrogen in its core quicker, and to leave the Main Sequence sooner than the less massive member. In the case of this pair, the fact that more massive star is still in the main-sequence phase of its life, while the less massive has advanced to the RGB, is known as the Algol Paradox. It has been explained by Roche-lobe overflow (RLOF), where the originally more massive member of a close binary pair exhausts the hydrogen in its core, causing core collapse and hydrogen shell burning, and begins expanding into a *(Continued)*

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red giant. When its radius reaches the distance to L1 (the Lagrange point between the pair of stars), matter (mostly hydrogen) from the atmosphere and surface of the expanding star enters the gravity well of the main-sequence component, ultimately finding its way to the latter's core. The mass transfer to the originally less massive star continues, making it progressively more massive and brighter. Meanwhile, this continuous contribution delays the exhaustion of hydrogen in its core. This same transfer mechanism is believed to be the cause of type 1a supernovae, when a low-to-intermediate-mass receiving star has already completed its life cycle and become an oxygen-carbon white dwarf and gains enough mass from its companion that it exceeds the Chandrsekhar Limit (about 1.44 solar masses).

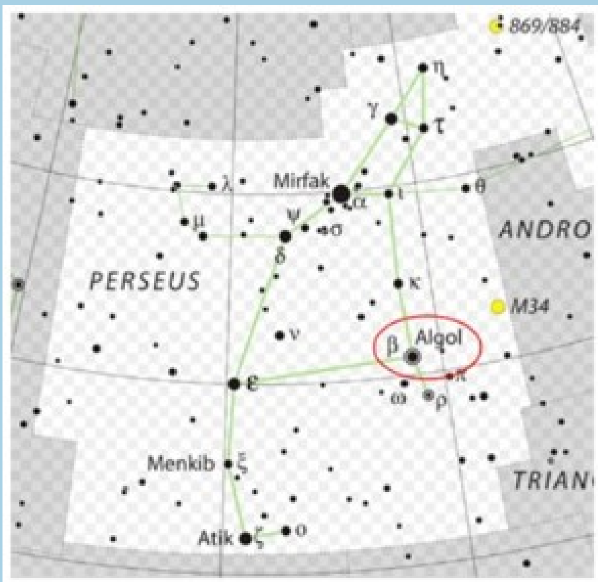

Figure 2: Algol's Location

Technically Algol is a three-star system, consisting of Aa1, Aa2, and Ab, but Ab has a different axis of revolution, which is oblique to our line of site, and therefore is not involved in the eclipse. Aa1 and Aa2 orbit their common center of gravity every 2.87 days.

Aa1 and Aa2 are too close to each other to be resolved with a telescope; less than just a tenth of an arcsecond apart. However, the variation in magnitude resulting from the eclipse can at times be observed over the course of a single night. This is because the transition from maximum magnitude to minimum magnitude occurs over a span of only about five hours. Figure 3 illustrates the eclipse. The minimum magnitude occurs when Aa1 is behind Aa2, called the primary eclipse. A smaller dip in magnitude, called the secondary eclipse, is seen as Aa1 passed in front Aa2.

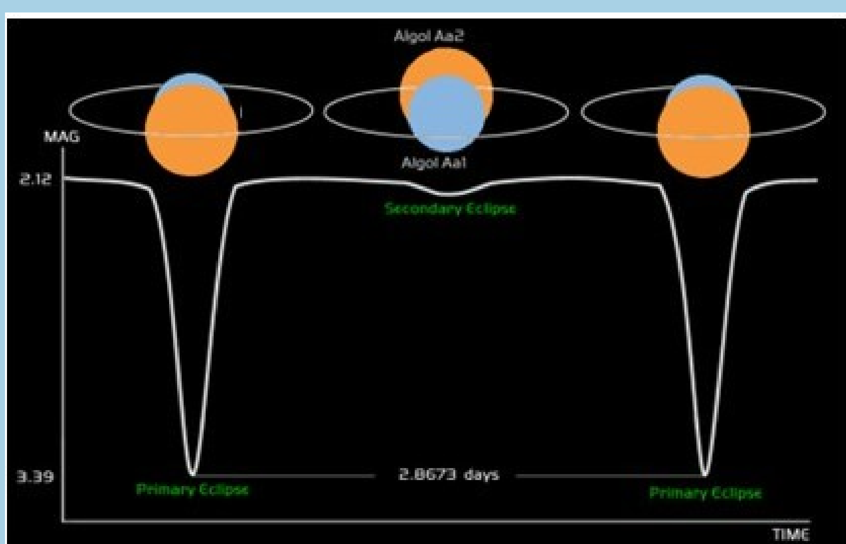

Figure 3: Eclipse Diagram

On the right night, one could observe Algol transition from its maximum magnitude of 2.1 to its minimum of 3.4 and back to maximum in about 10 hours. This would be a great project for time lapse photography. *(Continued)*

Continued from page 17)

A few upcoming opportunities where this may be observed in New Jersey are shown below:

- March 13, 11:07 PM
- March 16, 7:57 PM
- April 5, 10:42 PM

These times show where the primary eclipse, or minimum magnitude, occurs.

Algieba

Algieba (Gamma Leonis or Gamma Leo) is a visual binary (Gamma[1] and Gamma[2], or HR 4057 and HR 4058, respectively) found in Leo consisting of two bright gold-colored stars. The stars are separated by 4.6 arcseconds, have a combined magnitude of 2.2, and are 130 light years from Earth. The small separation should provide a good test of your telescope's resolving ability. A high magnification, at least 120X, will be needed to split the stars. Worthy of note, the primary star, Gamma[1] Leo, is host to an exoplanet.

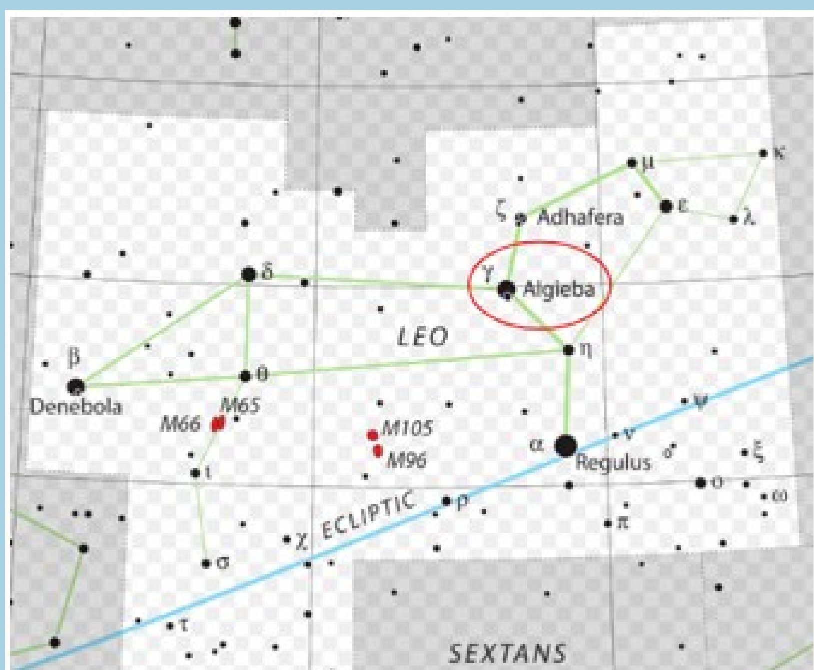

Figure 4: Algieba Location

Almach

Almach (Gamma Andromedae or Gamma And), also a visual binary, is found in Andromeda. The stars are separated by 10 seconds of arc, have a combined magnitude of 2.23, and are 393 light years from Earth. The pair consists of a bright, golden-yellow primary and a dimmer, sapphire-blue secondary.

This star system actually has four components, which includes the golden-yellow primary (Gamma[1] And), as well as Gamma[2], which consists of three stars, two of which, Gamma[2] Ba and Bb orbit a shared center of gravity, which in turn orbits a center of gravity that they share with Gamma[2] C. Finally, the common center of gravity of these three stars orbits a common center of gravity with Gamma[1]. Gamma[2] Ba and Bb are *(Continued)*

(Continued from page 18)

a spectroscopic binary and cannot be visually split. However, they are in a highly eccentric orbit with respect to Gamma^2 C, which has an 64-year period and can be optically distinguished from it. In 2019, the Gamma^2 B pair was separated from Gamma^2 C, by about 0.16 arcseconds, which under ideal conditions would have been distinguishable in NJAA's 26-inch telescope.

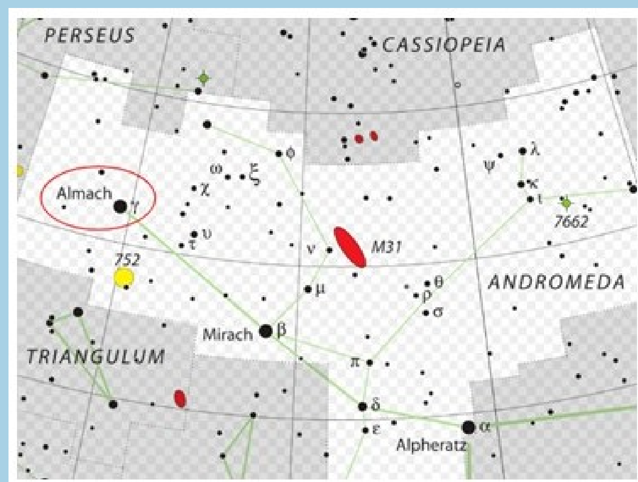

Figure 5: Almach Location

Resolution

The ability to split a double star is dependent on your telescope's resolution, which is based on aperture and measured in arcseconds. A discussion of resolution may be better suited for a separate write up. For the sake of this article, we have provided a table of resolutions for common telescope sizes as a reference.

Aperture		Resolution Angle
4"	102mm	1.14 arcsec
8"	203mm	0.57 arcsec
12"	305mm	0.38 arcsec
26"	660mm	0.18 arcsec

Table 1: Resolution

Consider these numbers as good estimates of what you would get for a given aperture assuming excellent seeing conditions. The table uses Dawes' Limit calculation shown below.

$$\text{Max Resolution (arcseconds)} = \frac{116}{\text{Aperture (mm)}}$$

Name	Designator (Stellarium)	Magnitude	Type	Separation (arcsec)	Const.	Distance (LY)	Magnification
Winter Alberio	HR 2764	4.9 (5.0 and 5.8)	Optical Double	27	Canis Major	1418 and 303	20X
Algol	HR 936	2.1 to 3.4	Eclipsing Binary	< 0.10	Perseus	93	-
Algeba	HR 4057	2	Visual Binary	4.6	Leo	130	120X
Almach	HR 603	2.23	Visual Binary	10	Andromeda	393	60X

Table 2: Summary of Double Stars Presented

A Brief Report on Measuring the Earth

By Eratosthenes

Alexandria, June 21, 240 BCE

Greetings from Alexandria.

On the summer solstice, I observed that in Syene the Sun stood directly overhead at noon, casting no shadow at all. At the same moment in Alexandria, my measuring stick did cast a shadow. I measured the angle of the shadow about 7.2 degrees, or 1/50 of a circle.

Here's the fun math: if you imagine the Earth as a circle, the Sun's rays are essentially parallel lines hitting the surface. The shadow in Alexandria forms a tiny angle at the surface, which corresponds to the angle at the center of the Earth between Alexandria and Syene. Using simple geometry, that angle tells us that the arc distance I measured is 1/50 of the full circumference of the Earth. Multiply the measured distance by 50, and there it is—the circumference of our planet!

Shadow angle in Alexandria: 7.2°

Fraction of full circle: $7.2 \div 360 = 1/50$

Distance between Syene and Alexandria: 5,000 stadia

Earth's circumference: $5{,}000 \times 50 = 250{,}000$ stadia

1 stadion = 157.5 meters

250000 x 157.5=39,375,000/1000=39,375Km

Actual Circumference =40075Km

No fancy instruments, no satellite just shadows, angles, and geometry that reaches straight to the center of the Earth.

Respectfully submitted,

Eratosthenes

Yelp review-Eratosthenes (c. 276–194 BCE) was a genius who loved figuring out how the world worked. He made one of the first maps of the known world, invented latitude and longitude, and even measured the tilt of the Earth's axis. He also created the "Sieve of Eratosthenes" to find prime numbers and ran the famous Library of Alexandria, collecting knowledge from all over. His ideas and discoveries shaped science, math, and geography for centuries—and he did it all with sticks, shadows, and brains!

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