vaonis

GUIDEBOOK

Exploring and capturing the Universe with Vespera smart telescope.

Vespera II / II X_edition - Vespera Pro

Version 1.1 - October 2025

Table of content

Introduction

The Rho Ophiuchi cloud complex.

A mega mosaic captured with Vespera. It notably features the supergiant red star Antares and the globular cluster M4.

About this guidebook

Welcome to Vaonis' universe.

This guidebook is designed to provide comprehensive documentation for you to make the most out of your Vespera smart telescope.

It includes detailed instructions to help you master the use of your smart telescope, as well as many practical tips and essential concepts for amateur astronomy.

Although this guide is dedicated to Vespera II / II X_edition and Vespera Pro, most of the information it contains also applies to Stellina, Vespera Classic, and Vespera Passenger.

As Vespera's features are continuously evolving, this guide may be updated regularly. Be sure to visit our website to download the latest version.

In addition to this guide, you will also find a wide range of online resources, including a knowledge base, troubleshooting assistance, and video tutorials.

USING THE GUIDEBOOK

This guide features a detailed table of contents, allowing you to jump directly to a specific chapter. Simply click on the page number in the table of contents to access the corresponding section.

Throughout the guide, you'll also find interactive links (in blue) that redirect you to other chapters offering more in-depth information when needed.

Additional online resources

VIDEO TUTORIALS

Explore Vaonis' YouTube channel for step-by-step tutorials covering key features of your smart telescope.
youtube.com/@vaonisdotcom

VAONIS COMMUNITY

Join the Facebook group **My Singularity by Vaonis** to get help, tips, and benefit from other users experiences.
facebook.com/groups/mysingularitybyvaonis

VAONIS BLOG

Visit our blog to read in-depth articles about specific Vespera features, stay up-to-date on product news and updates and discover what to observe in the night sky each month.
https://vaonis.com/blogs/travel-journal

KNOWLEDGE BASE

Search Vaonis support knowledge base for answers to more specific questions.
support.vaonis.com/portal/en/kb/faq

MANUALS AND DOCUMENTS

Access the technical documentation for all Vaonis products.
vaonis.com/pages/manuals-documents

FURTHER ASSISTANCE

If you encounter an issue that can't be resolved through the community or online resources, you can submit a ticket to customer support for further assistance.
support.vaonis.com/portal/en/newticket


Meet Vespera:
your smart telescope

How does a smart telescope work?

Smart telescopes are revolutionizing astronomy by making sky observation and astrophotography more accessible than ever. Unlike traditional telescopes that require complex setup, manual tracking, and technical skills, Vespera handles most of these steps automatically, allowing users of all experience levels to enjoy deep-sky exploration.

At the heart of this technology lies a powerful feature: **live image stacking**.

WHAT IS IMAGE STACKING?

When observing the night sky, especially deep-sky objects like galaxies and nebulae, capturing faint details is a major challenge. These objects emit very little light, and a single exposure—even with a sensitive sensor—often appears noisy or blurry, hiding much of the structure and beauty of the object.

To overcome this, Vespera captures **many short exposures** (10 seconds by default) of the same target over time. These individual images are then **"stacked"**—a process where they are aligned and combined in real time to produce a single, much cleaner image.

Each individual exposure contains real light from the celestial object (signal) as well as random noise. During the stacking process, the signal adds up (reinforcing the real object's light) while the noise averages out (since it's random and different in every frame).

The more exposures are stacked the cleaner and sharper the final image. This is the reason why the image quality increase with the observation duration. Vespera lets you see in real time how the image evolves.

- **Tracking and capturing:** Vespera automatically tracks your selected object as it moves across the sky and captures a series of short exposures.
- **Image alignment:** Since Earth's rotation slightly shifts the object's position in each frame, the Vespera software precisely aligns each image.
- **Stacking:** The aligned images are averaged together, reinforcing the real light from the object and reducing random noise.
- **Result:** The final image reveals much more details, contrast, and color than any single exposure could show. The more images are stacked (the longer the observation), the better the final image quality will be.

Handling your smart telescope

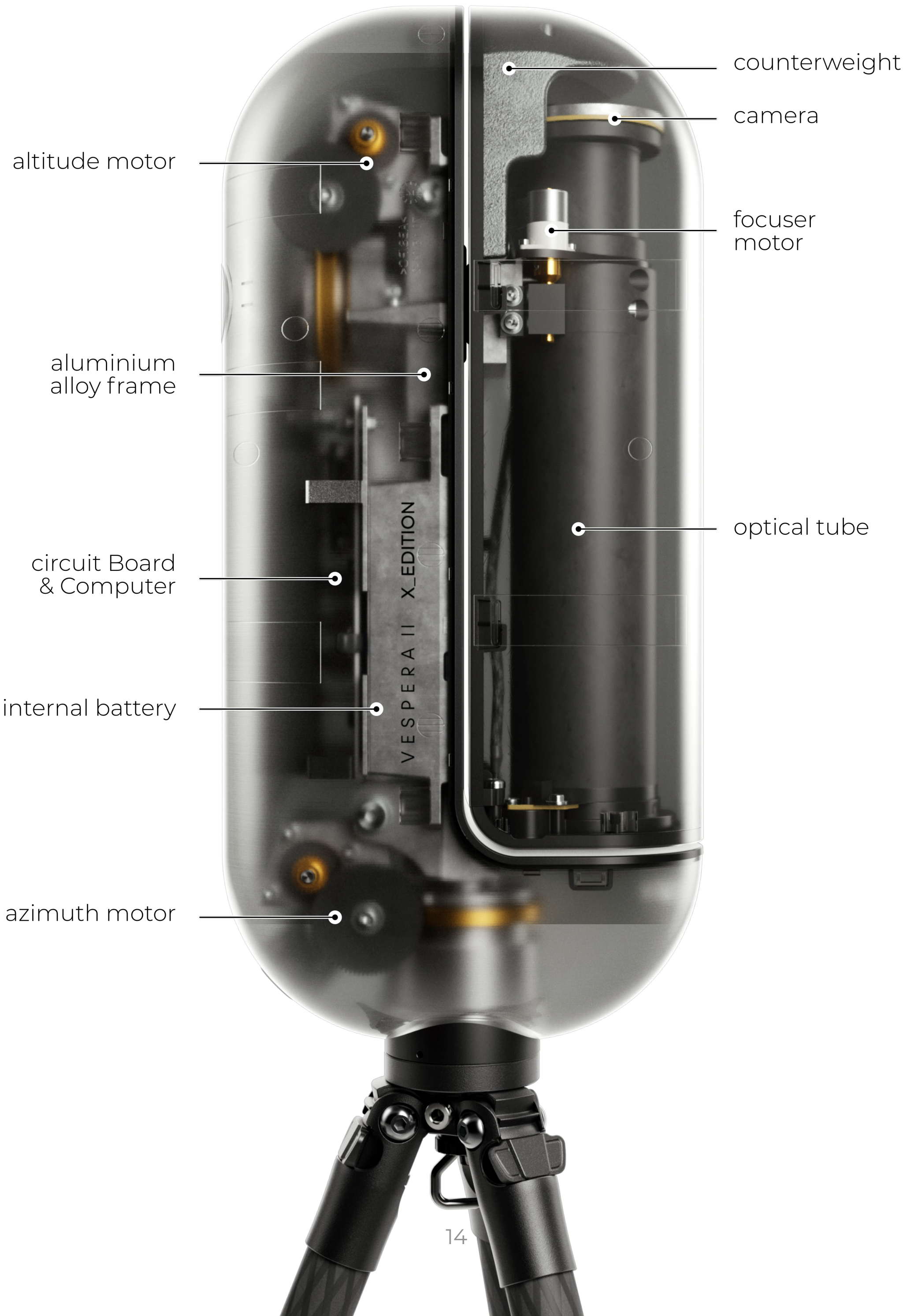
Vespera has been designed from the ground up with precision, sturdiness, and durability in mind. To meet these challenges, Vespera is built on a solid mechanical structure, with a motorization system combining metal gears and POM-C gears. This design minimizes backlash, preserves performance over time, and reduces motor noise.

- Vespera is designed for intensive use.
- Vespera can be safely transported without compromising performance and requires no special adjustments after being moved.
- Vespera features self-disengaging motors, allowing you to manually move the optical arm or rotate the telescope on its base without any risk of damage when the telescope is off.
- It is built for outdoor use, even in sub-zero temperatures or high humidity conditions.
- Your Vespera smart telescope comes with a 3-year warranty.

Product description

Detailed front view of the lens without the accessory port protective ring.

Inside Vespera



About the tripod

USING A VAONIS TRIPOD

Vaonis offers different tripods, depending on your telescope model or as optional accessories. Check our website to see the available models.

ATTACHING THE TRIPOD

Simply attach the tripod legs to its head, then securely screw the base of your Vespera onto the tripod. There should be no play or movement between the telescope and the tripod.

If your tripod comes with a bubble level plate, insert it between the telescope base and the tripod head before assembling both parts.

Watch our video tutorial for a comprehensive how to.

USING A THIRD PARTY TRIPOD

Vespera can also be used with tripods from other models.

The tripod must have a 3/8" thread, a standard size commonly used in photography.

The key factor when choosing a tripod is its stability and ability to absorb vibrations. Ensure the tripod can easily support at least 5 kg.

Powering your smart telescope

CHARGING THE VESPERA BATTERY

To charge Vespera, you'll need a USB Type-C charger and cable. These accessories are not included but you can use widely available options on the market. For example, a laptop or tablet charger works well. A smartphone charger is also compatible but due to its lower power output, charging will take longer.

RECOMMENDED EQUIPMENT

USB-C charger compatible with the Power Delivery standard (+ dual USB-C cable)

Power range: Minimum 30W, maximum 65W (supports 5V/9V/12V/15V/20V)

CHARGING TIME AND BATTERY PROTECTION

Charging time depends on both your telescope model and the power of the charger used. Vespera Pro, with its larger battery capacity, naturally takes longer to charge.

For optimal charging performance, we recommend using a charger rated at 50W or higher. Standard smartphone chargers might be too underpowered to deliver efficient charging for Vespera.

As a reference, charging a Vespera Pro with a 65W charger may take approximately 6 hours.

To ensure safety, preserve battery longevity, and comply with American and European regulations, **Charging may be paused or slowed down if the battery temperature exceeds certain thresholds, whether too hot or too cold**.

In such cases, Singularity will display an alert, and a temperature icon will appear next to the battery level indicator on the instrument screen.

You can continue using your smart telescope as usual. Charging will automatically resume normally once the battery returns to a safe temperature range.

BATTERY AUTONOMY

The battery life of Vespera II / II X_edition is approximately 4 hours, while Vespera Pro lasts around 11 hours.

Actual runtime may be impacted by the use of the anti-dew system and extremely low temperatures, which can significantly reduce battery performance. Frequently changing targets can also affect battery life, as the motors are used more intensively.

USING VESPERA WHILE PLUGGED INTO A POWER BANK.

You can keep Vespera plugged into a power bank while in use. However, since the telescope's body may rotate, ensure that the charging cable does not create tension or twisting on the USB connector, as this could hinder movement or cause damage.

EXTENDING THE AUTONOMY WITH A POWER BANK

If you need to conduct observations for longer than your smart telescope's battery life allows, you can connect an external battery.

Use a battery that has a USB-C output. For Vespera II / II X_edition, an external battery of 10,000 mAh—supplementing the internal battery—should enable a full night of observation. Vespera Pro's battery life is typically sufficient for an entire night.

Powering Vespera on and off

Vespera features a one-touch switch.

This touch switch is equipped with a safety feature to avoid unintentional activation or deactivation during handling and use.

TO TURN YOUR SMART TELESCOPE ON

- Press and hold the touch switch until the light ring pulses three times white, then immediately release your finger.
- If pressed for too long or too short, the telescope switches off.
- The light ring will then pulse in blue (Vespera II / II X_edition) or red (Vespera Pro) to indicate that the device is starting up.
- Once the light becomes steady, your telescope is ready for use.

TO TURN YOUR SMART TELESCOPE OFF

Follow the same procedure as for turning it on.

You can also remotely turn Vespera off from the Singularity app:

- Go to the **Instrument** screen.
- Tap the red **power** icon in the top-right corner of the screen.

TOUCH SWITCH PROTECTION

When handling the telescope—such as removing it from or storing it in a backpack—you might accidentally touch the switch. In such cases, the light ring will briefly illuminate in white and start pulsing.

Tip: Remove your hand before the three pulses finish to cancel the action.

If your telescope powers on but does not connect to the Singularity app within 5 minutes, it will automatically shut off to preserve battery life.

Adjusting the button light ring brightness

The light ring can be set to **three different brightness levels**. This allows you, for example, to reduce its luminosity once the telescope is set up, helping preserve your night vision and avoiding disturbance to nearby observers.

A fourth brightness level, raising the luminosity to maximum, is **automatically activated** when using the solar filter. This makes it easier to see the light ring's status in daylight conditions.

Note: Adjusting the brightness of the light ring has no impact on battery life.

To adjust the button brightness:

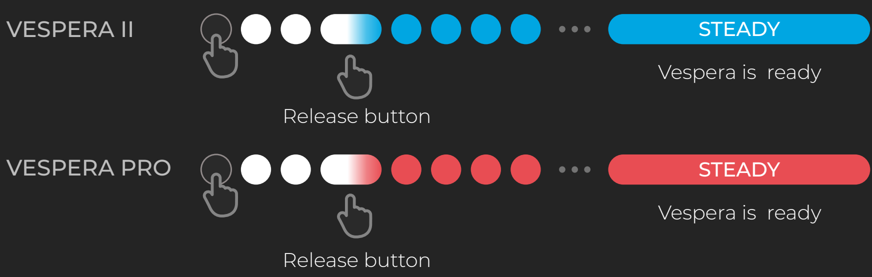
- In the **Singularity app**, connect to the telescope and go to the **Instrument screen** (Refer to the Singularity section).
- Select **Settings**.
- Scroll down to the **Button Brightness** section and choose the desired level (low, medium, high).

Vespera specification sheet

	VESPERA II / II X_EDIT.	VESPERA PRO
APERTURE	50 mm	50 mm
FOCAL LENGTH	250 mm	250 mm
OPTICAL DESIGN	quadruplet apo.	quadruplet apo.
F/D	5	5
UV/IR CUT FILTER BANDPASS	430 - 680 nm	430 - 680 nm
SENSOR TYPE	Sony IMX 585	Sony IMX 676
SENSOR DEFINITION	3840 x 2160 (8.3 MP)	3536 x 3536 (12.5 MP)
SENSOR FORMAT	1/1.2"	1/1.6''
SENSOR SIZE	11.2 x 6.3 mm	7.0 x 7.0 mm
PIXEL SIZE	2.9 µm	2 µm
NATIVE IMAGE DEFINITION	8.3 MP	12.5 MP
MAX. IMAGE DEF. WITH COVALENS	24 MP	50 MP
NATIVE FIELD OF VIEW	2.5°x1.4°	1.6°x1.6°
MAX. F.O.V. WITH COVALENS	4.33°x2.43°	3.2°x3.2°
SAMPLING	2.39 arc sec.	1.6 arc sec
INTERNAL STORAGE	25 GB	225 GB
BATTERY LIFE	4 hours	11 hours
EXTERNAL CONNECTOR	USB type C	USB type C
SIZE	48 x 20 x 9 cm	48 x 20 x 9 cm
WEIGHT	5 kg	5 kg

Vespera light ring status

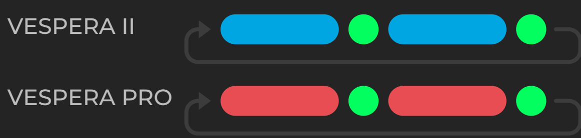
STARTUP SEQUENCE



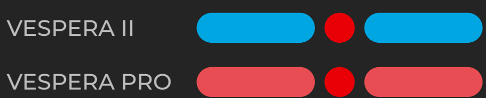
SHUT DOWN SEQUENCE

VESPERA OFF AND CHARGING

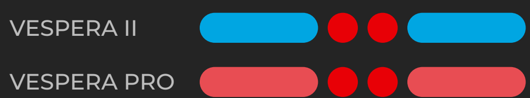
VESPERA ON AND CHARGING



LOW BATTERY (12% REMAINING)



LOW BATTERY (7% REMAINING)

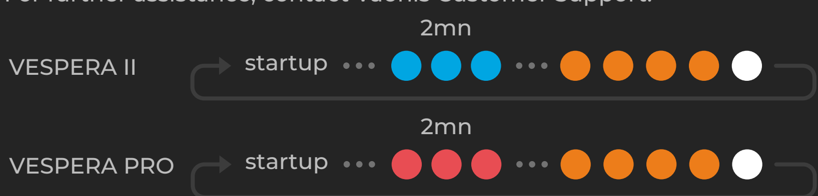


DURING UPDATE

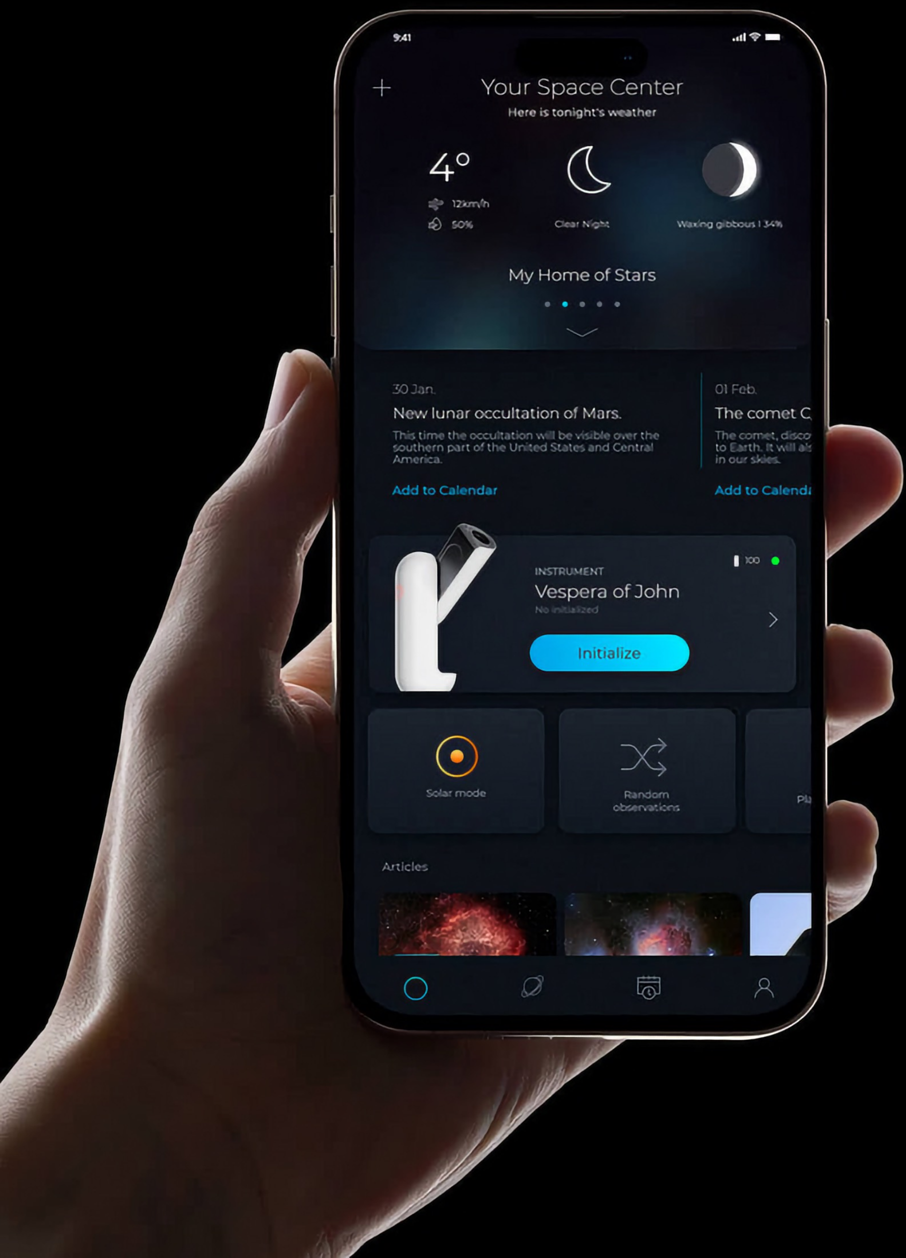
The following light status may appear during certain updates.
This is normal and does not require any specific attention.

INSTRUMENT UNABLE TO STARTUP

For further assistance, contact Vaonis Customer Support.



Singularity: your telescope control center



The "Singularity by Vaonis" app is essential for operating your smart telescope. With Singularity, you can:

- View live images captured by your telescope.
- Browse the catalog of observable objects and initiate observations.
- Save, share, and export the results of your observations.
- Adjust observation settings such as framing, exposure time, etc.
- Manage your smart telescope's configuration.
- Schedule automatic observation sessions.

Downloading and installing Singularity

The Singularity by Vaonis app is available exclusively for smartphones and tablets.

APPLE DEVICES

Require iOS 14 or later. Download the free app from the App Store.

ANDROID DEVICES

Require Android 8 or later. Download the free app from the Google Play Store.

Once downloaded, Singularity installs automatically.

Singularity: First-time setup

When you launch Singularity for the first time, you'll be prompted to create a Vaonis account. This is mandatory to access a 200 MB cloud storage capacity, which allows you to save images from your observations.

You can control your smart telescope using multiple devices (for example, a smartphone and a tablet) and switch between them seamlessly. By logging in with the same Vaonis account on each device, your image library, observatories, favorite objects in the catalog, and manual targets will all be synchronized.

You'll also be prompted to grant the following permissions to the app. Please enable them to ensure a seamless experience:

- Access to geolocation
- Access to the device photo library
- Access to the local network (iOS)
- Access to the device calendar (in order to add ephemeris events to it)

ACCESS AND EDIT YOUR ACCOUNT INFORMATION

- Navigate to the **Profile** tab.
- Open the menu in the top-right corner of the screen (refer to the **Profile** screen in the **Singularity Screens** section of this guide).
- Select **Edit Profile**.

ESSENTIAL SETTINGS

To enhance your smart telescope experience, we recommend ensuring that the following options are enabled:

- From the Profile screen menu (see above), select **Settings**.
- Enable all available options.

Connecting your smart telescope to Singularity

The connection between the app and your smart telescope is established via Wi-Fi. Vespera creates its own Wi-Fi network, which you need to join.

- Turn on Vespera and wait until the light ring displays a steady blue or red light (depending on your smart telescope model).
- Connect to Wi-Fi: On your smartphone or tablet, go to the Wi-Fi settings and search for Vespera's network. The network name begins with **vespera...**
- Once connected to the Wi-Fi, return to the Singularity app.
- From the Space Center within the app, you should have a confirmation that your instrument is properly connected.

CONNECTION TROUBLESHOOTING

- An active VPN, firewall, or antivirus on your smartphone or tablet may cause connection failures.
- On iOS, if you haven't granted Singularity access to the local network, your telescope won't be detected.
- Try connecting with another device that has Singularity installed to determine if the issue is with your smartphone.
- If Singularity doesn't detect the instrument while you're connected to its Wi-Fi: Disconnect from Vespera's Wi-Fi, then go to your Wi-Fi settings and choose to forget the network. Reconnect to Vespera's Wi-Fi, and when prompted, allow the connection in the pop-up window that may appear.

Updating Singularity and Vespera firmware

Vaonis regularly releases updates for both Singularity and your telescope's internal firmware, adding new features and enhancing your smart telescope experience. To stay informed, subscribe to the Vaonis newsletter and join the official Facebook group. You can also enable automatic updates on your smartphone or tablet.

CHECKING FOR SINGULARITY UPDATES

Go to your application store and search for the Singularity application. You'll be notified if an update is available.

UPDATING VESPERA'S FIRMWARE

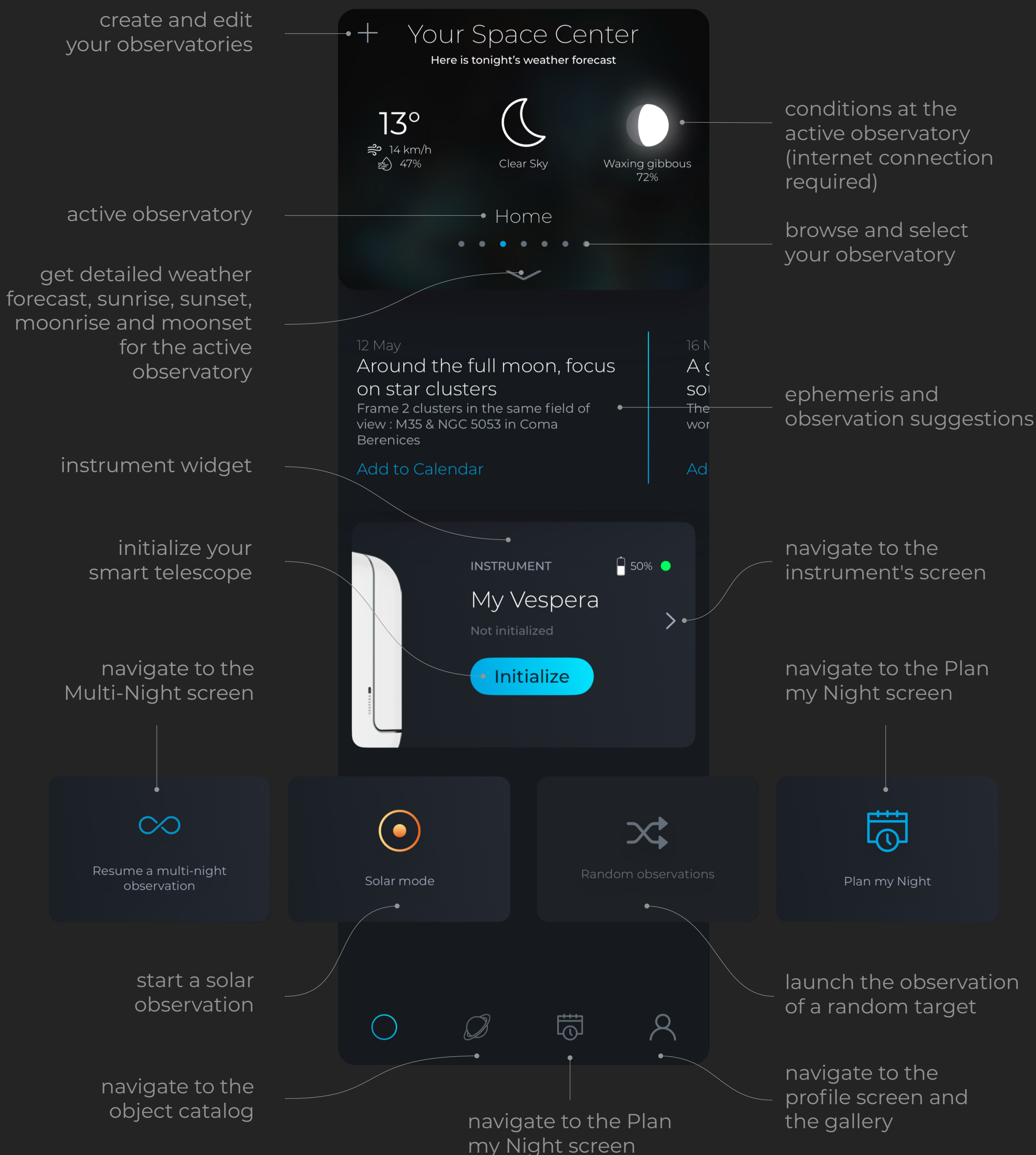
- Update the app: ensure you have the latest version of the **Singularity by Vaonis** app.
- Connect Singularity to your smart telescope (see the "Connecting Your Smart Telescope to Singularity" section).
- From the Space Center, check for a firmware update availability.
- Prepare your telescope: Vespera must be charged to at least 50%, or if plugged in, a minimum charge of 30% is required.
- Tap the update button and follow the on-screen instructions.

Do not turn your smart telescope off during the update process. Stay close to the instrument during this time to avoid wifi disconnections.

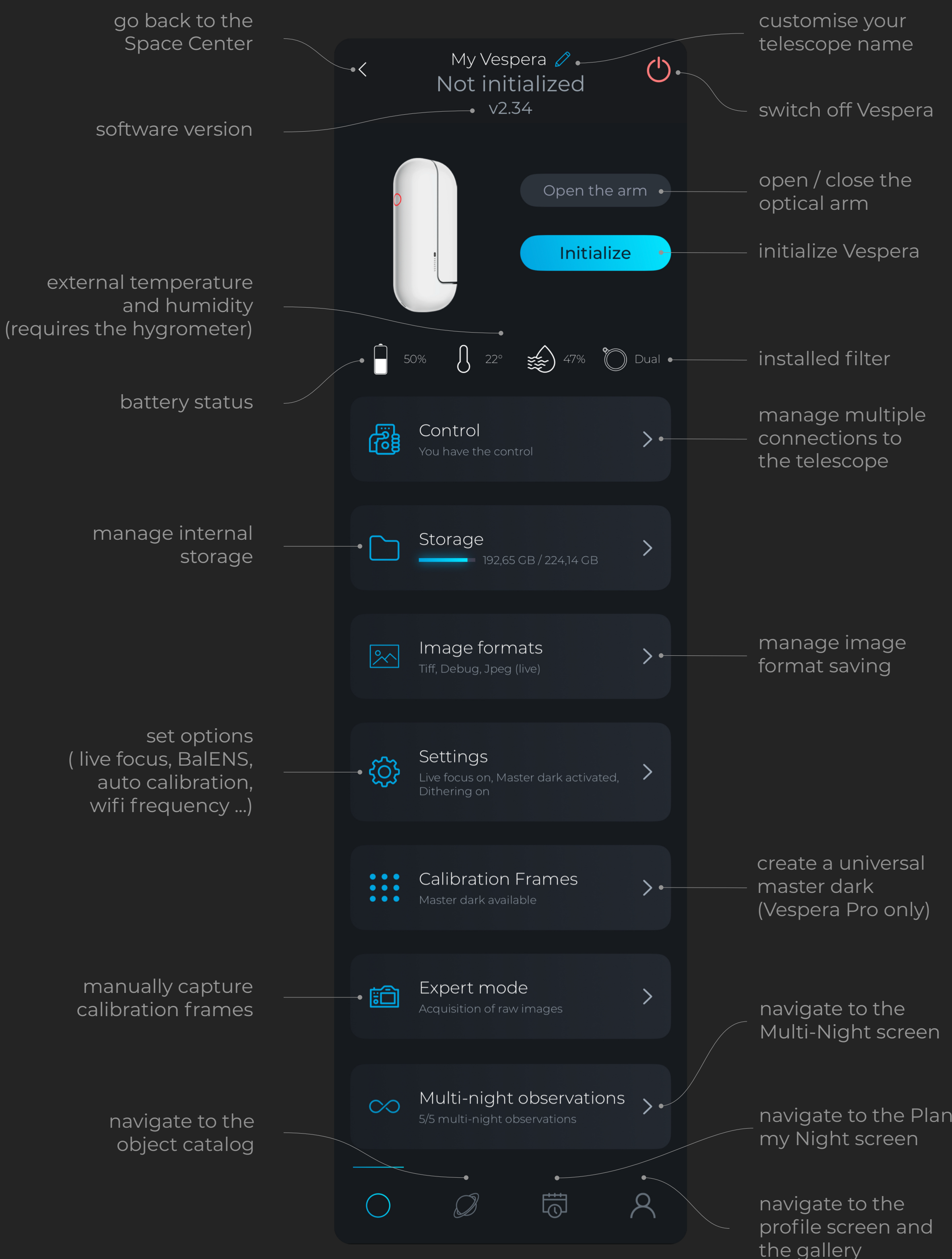
Singularity's main screens

Here are the main general screens of Singularity. Specific screens related to features such as Plan My Night, Multi-Night observations, and mosaic capture are covered in the chapters dedicated to those functions.

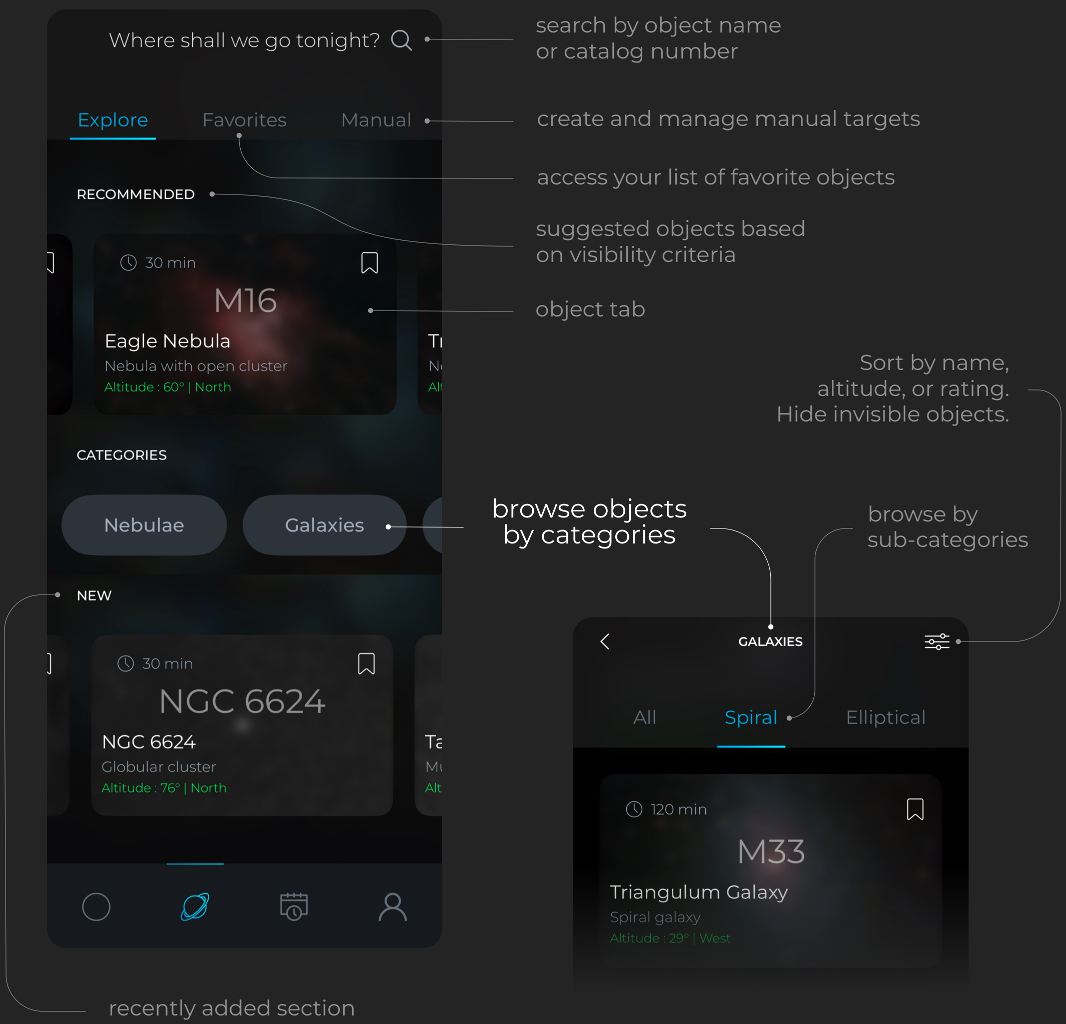
SPACE CENTER



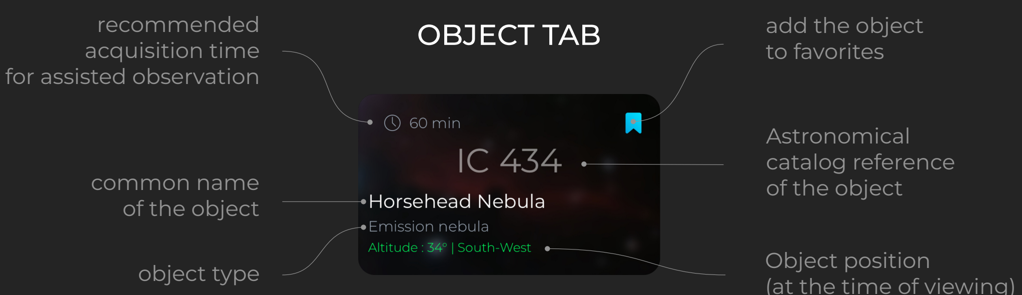
INSTRUMENT SCREEN



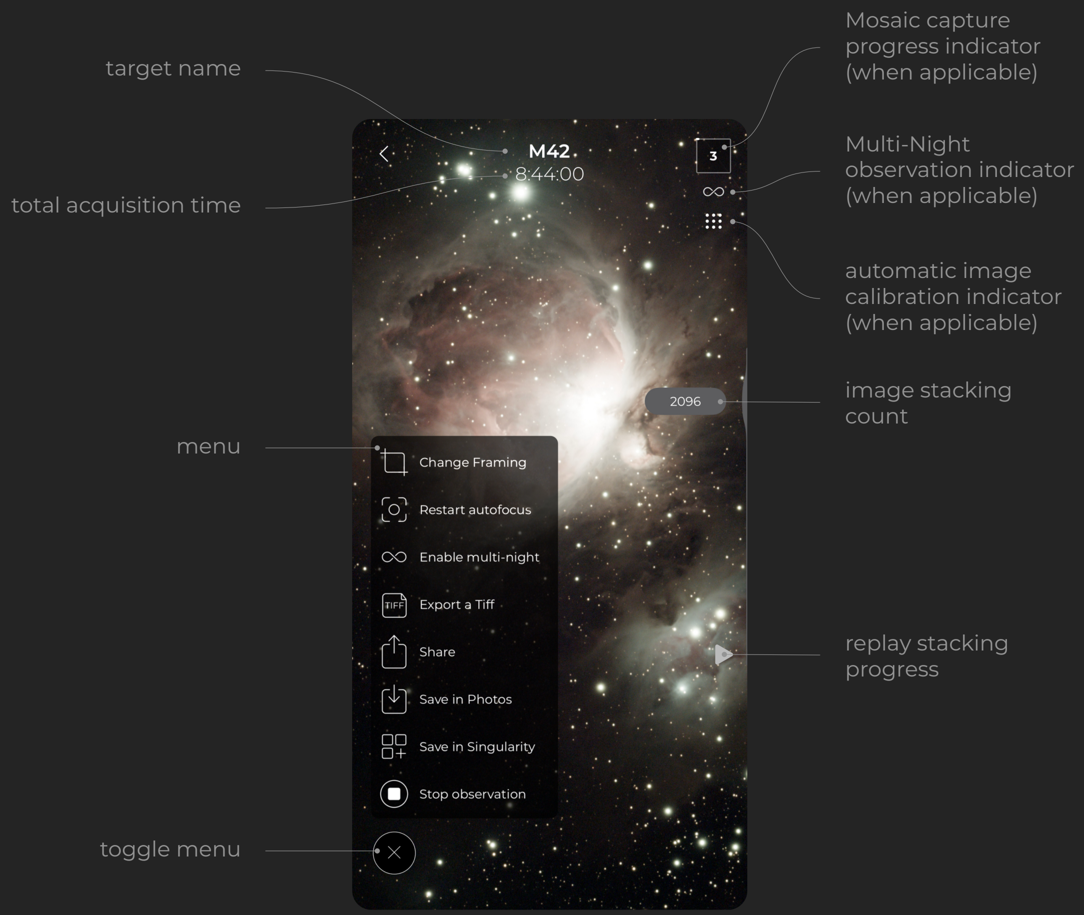
CATALOG SCREEN



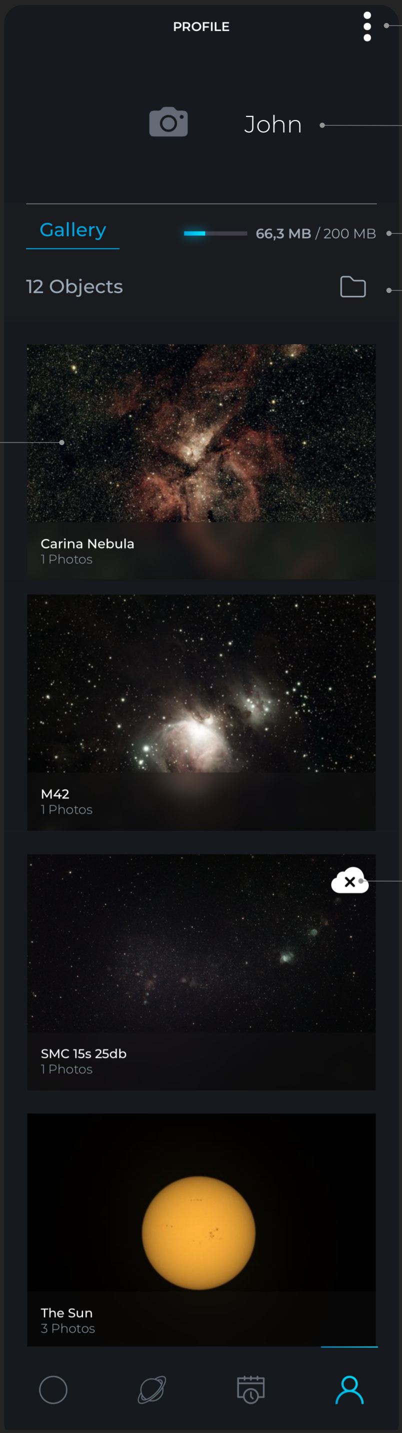
OBJECT TAB



OBSERVATION SCREEN



PROFILE & GALLERY SCREEN



profile and app settings menu

profile unique ID

gallery storage usage

Toggle image grouping by object

Tap a thumbnail to view images

Images not yet synced to your account

Preparing for observation

Key points for successful observations and optimum performances

A clear sky is essential for successful astronomical observations, as celestial light is incredibly faint. It's also crucial to avoid direct light sources, such as streetlights, which can seep into the telescope tube and overwhelm the starlight.

Here are the key factors that can impact the quality of your observations.

WEATHER CONDITIONS

CLOUD COVER

For the best results, choose nights with completely clear skies. While observations are possible when part of the sky is cloudy, keep in mind that celestial objects move throughout the night (see Chapter Understanding the night sky for more details).

During prolonged observations, clouds my drift in front of the target. When this happens, Vespera will pause the stacking process, halting the observation progress. The process will automatically resume once the target region clears. However, in case of prolonged or repeated cloud cover, Vespera may no longer be able to correctly point at the target, leading to a complete stop of the observation session.

Even if the cloud layer is thin enough for Vespera to continue capturing images, the quality of the observation may be degraded. High-altitude thin clouds, in particular, can be difficult to detect with the naked eye but still impact image clarity.

Additionally, clouds may interfere with the autofocus system, preventing proper focusing.

RAIN

Your smart telescope is safe in light rain as long as the optical arm remains closed. However, if the arm is open, water may enter the system. To prevent damage, it is recommended to stop observations and power off your telescope as soon as rain begins and shelter the instrument.
Do not expose your instrument to heavy rain.

WIND

A light breeze will not affect your observations, but stronger winds or gusts can cause vibrations or micro-movements in the optical arm.

If you notice elongated stars instead of perfectly round ones or if image capture slows down significantly (due to multiple frames being rejected for poor quality), wind is likely the cause. In such cases, it is best to halt the observation.

TEMPERATURE

In general, lower temperatures are beneficial for astronomical observations, as they contribute to a more stable atmosphere. Additionally, the sensor in your smart telescope performs better in cooler conditions.

Your Vespera is guaranteed to operate down to 0°C (32°F).

However, Vespera can also operate in subzero temperatures. Many users worldwide successfully observe at temperature as low as -10°C to -15°C.

In such conditions, extra precautions are necessary. Keep in mind that extreme cold can affect battery life. If you experience any abnormal performance, stop the observation and power off the telescope. Additionally, avoid immediately bringing your telescope into a heated environment after exposure to very low temperatures, as this may cause condensation to form on electronic components.

If there is a significant temperature difference between indoors and outdoors, allow your telescope to acclimatize outdoor for about one hour before starting your observations. This ensures optimal performance.

> **Note**: With Multi-Night Observation mode, you have the opportunity to resume an observation interrupted by temporary weather conditions. For more details, see the Multi-Night Observations section.

LIGHT POLLUTION

Urban lighting and, more generally, stray light sources can significantly degrade the quality of observations.

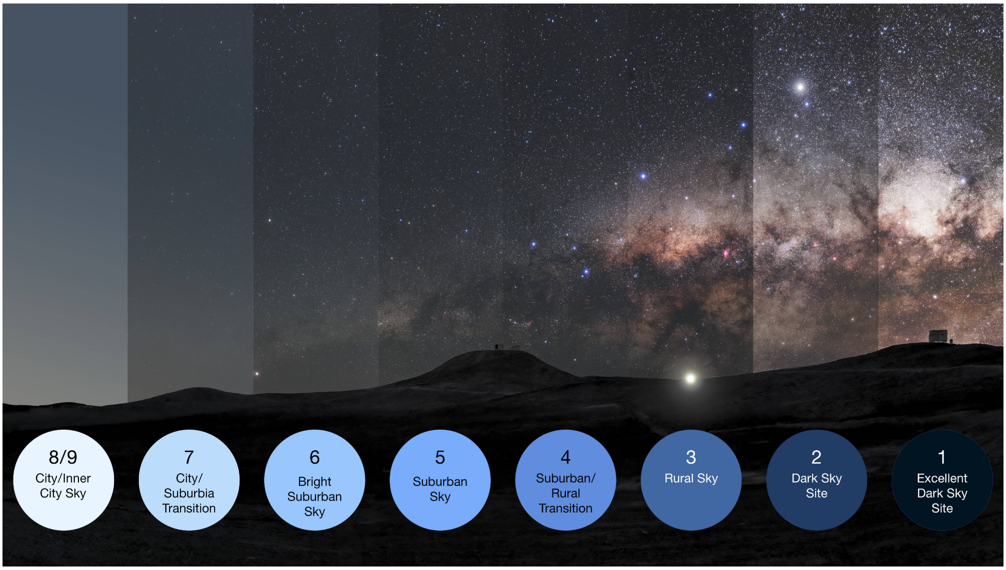
- Keep away from artificial light sources whenever possible.
- If observing from an urban area, try to avoid streetlights and opt for dimly lit locations, such as parks.
- For optimal conditions, seek a site away from city lights and orient your telescope away from the glow of distant towns.

ENHANCING URBAN OBSERVATIONS WITH FILTERS

Astronomical observations and even astrophotography are entirely possible in urban environments with the use of specialized filters. Vaonis offers an optional CLS (City Light Suppression) filter, along with a dual-band filter that reduces light pollution for specific celestial objects. For more details, refer to the dedicated chapter.

ESTIMATING SKY DARKNESS AND LIGHT POLLUTION

The Bortle scale is a 9-level rating system that measures the brightness of the night sky caused by light pollution. The scale ranges from class 1 for pristine dark skies to class 9 for a very bright sky in the center of large cities.



© European Southern Observatory / P. Horálek, M. Wallner
View source image online

SKY DARKNESS

Even after sunset, the sky remains bright due to the scattering of sunlight in the atmosphere. True darkness, essential for optimal stargazing, only occurs when the sun descends at least 18° below the horizon.

It's better to wait one hour or so after the sunset to start your observations and aim to complete your observations an hour or so before dawn.

During summer in the Northern Hemisphere, at certain latitudes, the sun never sets far enough below the horizon to achieve full darkness, making this period less ideal for astrophotography of nebulae and galaxies. In contrast, winter offers longer, darker nights, providing optimal observation conditions—assuming the sky is clear.

UNDERSTANDING TWILIGHT PHASES

- **Civil twilight:** The Sun is between 0° and 6° below the horizon. The sky remains bright enough for most outdoor activities without artificial light. Only the brightest celestial objects, such as Venus and Jupiter, are visible. **The sky is not dark enough for Vespera to initialize successfully**.
- **Nautical twilight:** The Sun is between 6° and 12° below the horizon. The horizon remains visible at sea, and more stars begin to appear. This is the phase when sailors traditionally took measurements with a sextant for navigation. **You can perform Vespera initialization**.
- **Astronomical twilight:** The Sun is between 12° and 18° below the horizon. The sky is dark enough for most astronomical observations, though a faint glow from the Sun may still linger. True night begins when the Sun is more than 18° below the horizon. **Conditions are then optimal for astrophotography.**

THE MOON PHASE

Starting from the first quarter, the Moon's brightness casts a glow across the sky, making deep-sky observations less ideal. To maximize visibility, it's best to plan your observations according to the lunar phase.

In the Singularity app, the Space Center welcome screen provides information on the Moon's phase, rise, and set times to help you schedule your sessions effectively.

- **New Moon:** The period around the new moon is ideal for all types of observations (except the Moon itself) and is particularly well-suited for deep-sky astrophotography.
- **First Quarter:** The Moon sets around midnight, leaving the second half of the night perfect for deep-sky observation.
- **Full Moon:** The sky can be very bright, making it difficult to observe nebulae and galaxies. However, star clusters remain easily visible since they are less affected by light pollution, making them a great alternative.
- **Last Quarter:** The Moon rises in the second half of the night, meaning the first half remains ideal for observations.

TRANSPARENCY

Even in the absence of clouds, the atmosphere can be loaded with particles (dust, sand, pollution, haze, smoke from forest fires...) that absorb part of the light coming from the stars. To optimize observation quality, it is wise to favor nights with great atmosphere transparency.

ASSESSING THE TRANSPARENCY OF THE SKY

- During the day, the horizon may seem hazy and long-distance visibility is limited, or you might notice a light halo around the sun. These are advance clues that sky transparency is poor.
- When the sunset is deep red, this indicates that the atmosphere is loaded with particles. This can happen when a high-pressure system stays over a region for a long time, which often causes particles to stagnate in the atmosphere. Most of the time, this is associated with high pollution levels in cities.
- After a period of rain or heavy showers, the sky is generally “washed out” and more transparent (once the cloud cover has gone of course).
- The number of stars you can see with the naked eye from your usual observation site (after acclimatizing your eye to darkness) is also a good indicator of the sky’s transparency.

TURBULENCE

The atmosphere consists of air masses with varying densities and temperatures that are constantly in motion—this phenomenon is known as atmospheric turbulence. It causes slight deviations in light rays, creating a “shimmering” effect in what we observe and is responsible for the twinkling of stars. Strong turbulence reduces the sharpness of observed stars and details, making it important to assess turbulence levels and choose the best nights for observation.

As a general rule, turbulence is more pronounced in hot weather due to faster-moving air masses, while colder temperatures often result in more stable conditions. On clear winter nights, observations may be of higher quality.

To evaluate turbulence with the naked eye, observe the stars in the sky. If they twinkle excessively, turbulence is strong. Conversely, if the twinkling is minimal, atmospheric turbulence is low, providing optimal conditions for observation.

OBSERVATION SITE

We have seen how atmospheric turbulence can cause problems for astronomical observations. Another type of turbulence is local turbulence which results from the day’s heat being released by certain surfaces during the night.
For example, cement and tar heat up when exposed to the sun. As night falls, the temperature drops and these surfaces become warmer than the surrounding air, producing localized turbulence.

it is best to avoid setting up Vespera on concrete or asphalt surfaces. Grass or dirt is more suitable.

Another factor that can enhance observation quality is the altitude of your observation site. At higher elevations, the atmosphere is generally clearer and more transparent, improving visibility.

TARGET POSITION

TARGETS NEAR THE HORIZON

When celestial objects are close to the horizon, their light must pass through a thicker layer of the atmosphere than when they are higher in the sky. This increased atmospheric interference can reduce image clarity.

For optimal observations, aim to observe objects when they are at least 20° above the horizon.

TARGETS NEAR THE ZENITH

Due to the way an altazimuth mount—such as the one used in Vespera—operates, tracking objects becomes more challenging as they pass near the zenith. This can lead to increased image rejection and slower acquisition, particularly when capturing mosaics. In some cases, image capture may even be interrupted.

For best results, prioritize observations when targets are below 75° in elevation.

LEARN MORE

In the Singularity app's object catalog, you can check the altitude of each target above the horizon at current time.

Keep in mind that celestial objects change position over time. To plan your observation session effectively, consider anticipating the target's trajectory throughout the night.

For more details on celestial reference points and measuring object altitude, refer to the chapter Understanding the Night Sky.

INSTRUMENT STABILITY

- After initialization, it is essential that the tripod does not move to ensure better tracking of the stars and sharper images (avoiding oval-shaped stars). Try not to place Vespera on loose soil, sand, or gravel.
- Even small vibrations that you produce while walking near the telescope can be transmitted through the ground and affect image quality. This is especially the case if you observe from a terrace, a balcony, a wooden floor or similar surface.

- Ensure that your tripod is stable. Avoid placing your smart telescope on a table or any surface where even minor bumps could cause vibrations.
- A shorter tripod is less prone to vibrations and reduces the impact of wind, as the instrument remains closer to the ground.

How to make the most of your stargazing night

With a smart telescope, you can explore the universe from the comfort of your couch. Simply set up Vespera on your terrace or in your backyard and control it remotely.

However, observing the night sky outdoors is a more immersive and deeply rewarding experience. Yet, spending long hours outside requires proper preparation.

Here are some tips to ensure both comfort and well-being during astronomical observations:

DRESS FOR THE CONDITIONS

Wear warm clothing, even in summer—nights can be colder than expected. Layering is best. Be sure to protect your feet, especially from ground moisture, as staying in one place for an extended period can make them more vulnerable to the cold. Wear mountain shoes and warm socks, for example.

PRESERVE YOUR NIGHT VISION

Use red LED flashlights instead of white light to avoid ruining your night vision.On your phone or tablet, enable night mode or dim the brightness. Allow 15-30 minutes for your eyes to fully adapt to darkness.

Singularity offers a night mode that turns the interface red. To activate it, go to the Profile tab then from the top right menu, activate the night mode option.

BRING A STAR MAP OR APP

A star chart, sky map app, or a printed guide can help navigate the night sky. Learning to identify key constellations beforehand makes the experience more enjoyable.

BRING FRIENDS

Observing with others can make the experience more fun and allows shared discoveries.

With Vespera, organizing group observation is easy. Up to eight smartphones or tablets can connect to the same telescope simultaneously, allowing everyone to enjoy the experience together.

BE RESPECTFUL

If observing with a group, avoid arriving at or leaving the observation site with your car’s headlights on, as this can ruin others' night vision and disrupt ongoing observations. Keep noise levels low to preserve the peaceful atmosphere.

Setting-up and initializing your smart telescope

Image calibration (Vespera Pro only)

Vespera Pro users can benefit from automatic image calibration to enhance image quality. This process significantly reduces noise in astronomical images, bringing out finer details for a clearer and more refined result.

Vaonis has developed an innovative technique: the Universal Master Dark. This single calibration model is applicable to all observation conditions and also incorporates offset or bias data. Once created, the Universal Master Dark can be used for all observations, eliminating the need to frequently capture new calibration images for each session.

If you plan to use automatic image calibration during your observations, you must first generate the Universal Master Dark.

GENERATING THE UNIVERSAL MASTER DARK

- This process can be done indoors and during the day.
- Ideally, perform this operation at a room temperature of around 20°C.
- The generation process takes approximately 30 minutes.
- Using the lens cap provided with your Vespera Pro is mandatory to initiate the procedure. The optical tube must be completely obstructed.
- The Universal Master Dark cannot be used with third-party astronomy image processing software.

Note: The Universal Master Dark only needs to be created once. However, it is recommended to regenerate it every 12 months or after a firmware update that improves the image calibration feature (refer to the update documentation for details).

TO GENERATE THE UNIVERSAL MASTER DARK...

- Connect Singularity to your telescope, then navigate to the instrument screen.
- Ensure the lens cover is in place then choose "calibration frames".
- Press "Generate" to initiate the Universal Master Dark creation process.
- Wait for the process to complete; this may take up to 30 minutes.
- The Universal Master Dark is now ready for use with your upcoming observations.

ENABLING AUTOMATIC IMAGE CALIBRATION

- Once activated, automatic calibration applies to standard observations, mosaic captures, Multi-Night observations, and automated observations conducted with **Plan My Night**.
- Automatic calibration affects the observation image displayed on your smartphone or tablet, JPEG images stored in Vespera's memory, and RAW TIFF images stored in Vespera's memory or exported during observation.
- Automatic calibration does not alter individual FITS images intended for manual stacking, as these must remain untouched.
- Automatic calibration does not impact the capture speed of your smart telescope.

TO ENABLE AUTOMATIC IMAGE CALIBRATION...

- Connect Singularity to your telescope, then navigate to the instrument screen.
- Choose "settings" from the menu.
- Enable "Use the Master Dark." It will then be applied to all your upcoming observations.

Vespera setting-up check list

Before starting the initialization of your smart telescope, check the following points to ensure a successful observation. You will find detailed instructions for the different steps in the following pages.

- Vespera's internal battery has sufficient charge.
- The Singularity app and Vespera's firmware are up to date.
- There is enough free space in the internal memory to save images.
- Weather conditions are suitable for astronomical observation with no rainfall expected. At least a significant portion of the sky is clear and free of clouds.
- No direct light sources (such as a streetlamp) are present in the immediate vicinity of the telescope, in the direction of the sky you intend to observe.
- Vespera's front lens is clean and free of any obstructions, even partial ones. There is no condensation and any lens caps or filter have been removed.
- Nothing obstructs the movement of the smart telescope.
- The telescope is perfectly leveled.
- The telescope is set up on a stable surface, with the tripod legs firmly tightened.
- The correct observatory is selected in the Singularity app, matching your actual observation site.
- When the Moon is very bright, make sure Vespera is positioned so that the arm will open on the opposite side of the sky.

Leveling the tripod

IMPORTANCE OF LEVELING AND STABILITY

Proper leveling of the telescope is crucial for fast targeting and precise tracking of celestial objects. It helps maintain perfectly round stars and reduces the number of rejected images during stacking due to insufficient quality.

Stability is equally important, as any movement of the tripod after initialization can compromise accurate pointing and tracking. If the tripod shifts for any reason during observation, you may need to relevel it and restart the initialization process.

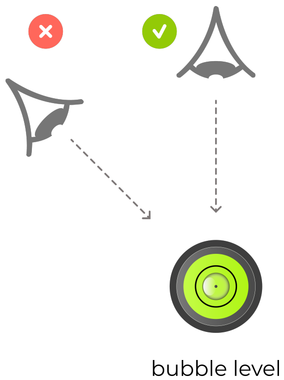
For optimal performance, the telescope's leveling tolerance should not exceed 1°.

LEVELING USING THE BUBBLE LEVEL

Your Vaonis tripod should come with a bubble level, which attaches between the tripod plate and Vespera's base.

If you're using a third-party tripod without a built-in bubble level, you can easily find this accessory in stores specializing in photography or astronomy equipment.

Adjust the height of each tripod leg to center the bubble precisely within the marked circle on the bubble level. To ensure an accurate reading, always check the bubble position from directly above rather than from the side.



LEVELING USING YOUR SMARTPHONE

Alternatively, you can also use the measurement app on your smartphone to level the telescope.

Once the telescope is securely attached to the tripod and positioned for observation, manually open the optical arm. Then, place the smartphone flat on the horizontal part of Vespera's housing (see photo).

Understanding and setting observatories

WHAT IS AN OBSERVATORY?

Observatories stand for your observation sites.

For your smart telescope to automatically locate any object in the night sky, it must have an accurate record of your observation site's geographic location.

This information is stored within the observatory settings.

Since you may observe from different locations, you can create an unlimited number of observatories, each corresponding to a specific site. Simply select the appropriate observatory before initializing your telescope.

Note: You don't need to create a new observatory if you move your observation location by a short distance. A margin of a few kilometers is tolerated.

Your list of observatories is linked to your Vaonis account. If you use multiple smartphones or tablets to control your telescope, the observatories will be synchronized across your devices.

The Space Center's weather widget provides real-time conditions along with sunrise, sunset, moonrise, and moonset times for the selected observatory. This allows you to plan ahead for any of your observation sites.

Important: If the selected observatory does not match your actual location, your telescope's initialization may fail, or it may struggle to locate and track celestial objects. If this happens, Singularity will display an error message.

CREATING A NEW OBSERVATORY

To add a new observatory:

- Tap the **+** icon at the top left of the Space Center screen.
- Select **Add a new observatory**.
- You can either use your smartphone's GPS to automatically detect your location, manually enter an address, or directly input your latitude and longitude coordinates.
- Give your observatory a name.

SELECTING AN OBSERVATORY

From the top section of the space center, swipe through the observatories' names to select the one corresponding to your current observation site.

EDITING AND DELETING OBSERVATORIES

- Tap the **+** icon at the top left of the Space Center screen to access the list.
- Tap **Modify**.
- Select the relevant observatory, then tap **Edit** to modify it or **Delete** to permanently remove it.

Initialization

WHY IS INITIALIZATION REQUIRED?

Depending on your location, date, and time of observation, the visible stars and constellations vary and continuously shift across the sky.

In these conditions, accurately pointing a telescope at a star—often invisible to the naked eye—and tracking its motion to capture sharp images is a true technical challenge. To achieve this, the telescope must be set up with precision, ensuring that both the date and location are accurately configured.

HOW DOES IT WORK ?

Vespera's initialization is fully automated and requires approximately five to 10 minutes.

It uses the coordinates from the selected observatory in the Singularity app and retrieves the time from your smartphone or tablet. Vespera then points to a region of the sky and attempts an astrometric calibration, also known as plate solving.

This process involves comparing the star field captured by the telescope with an internal database to identify the observed region of the sky. This ensures Vespera is precisely synchronized with the celestial sphere.

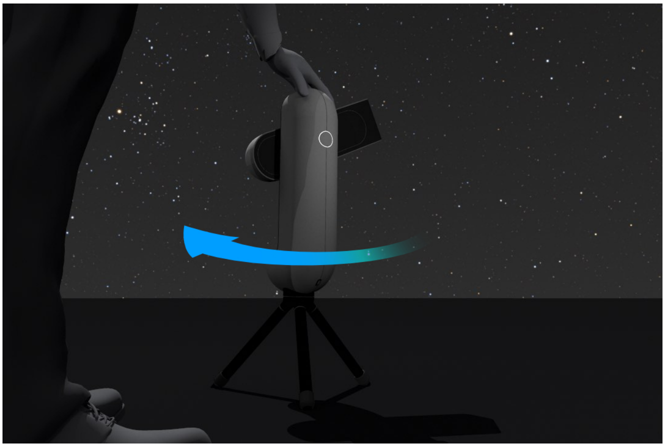
The initialization phase also includes automatic focusing.

RUNNING INITIALIZATION

To initialize Vespera, the sky must be dark enough and bright stars must be visible. This means it cannot be initialized immediately after sunset.

For more details, refer to the Sky Darkness chapter.

- Make sure you have completed all the steps in the Vespera setup checklist.
- From the Instrument section of the Space Center, tap **Initialize**.
- Vespera's optical arm will begin to open. Ensure it opens toward a clear area of the sky where stars are visible. If necessary, you can manually rotate the telescope clockwise on its base—even while the arm is moving—to find a better orientation (image below).



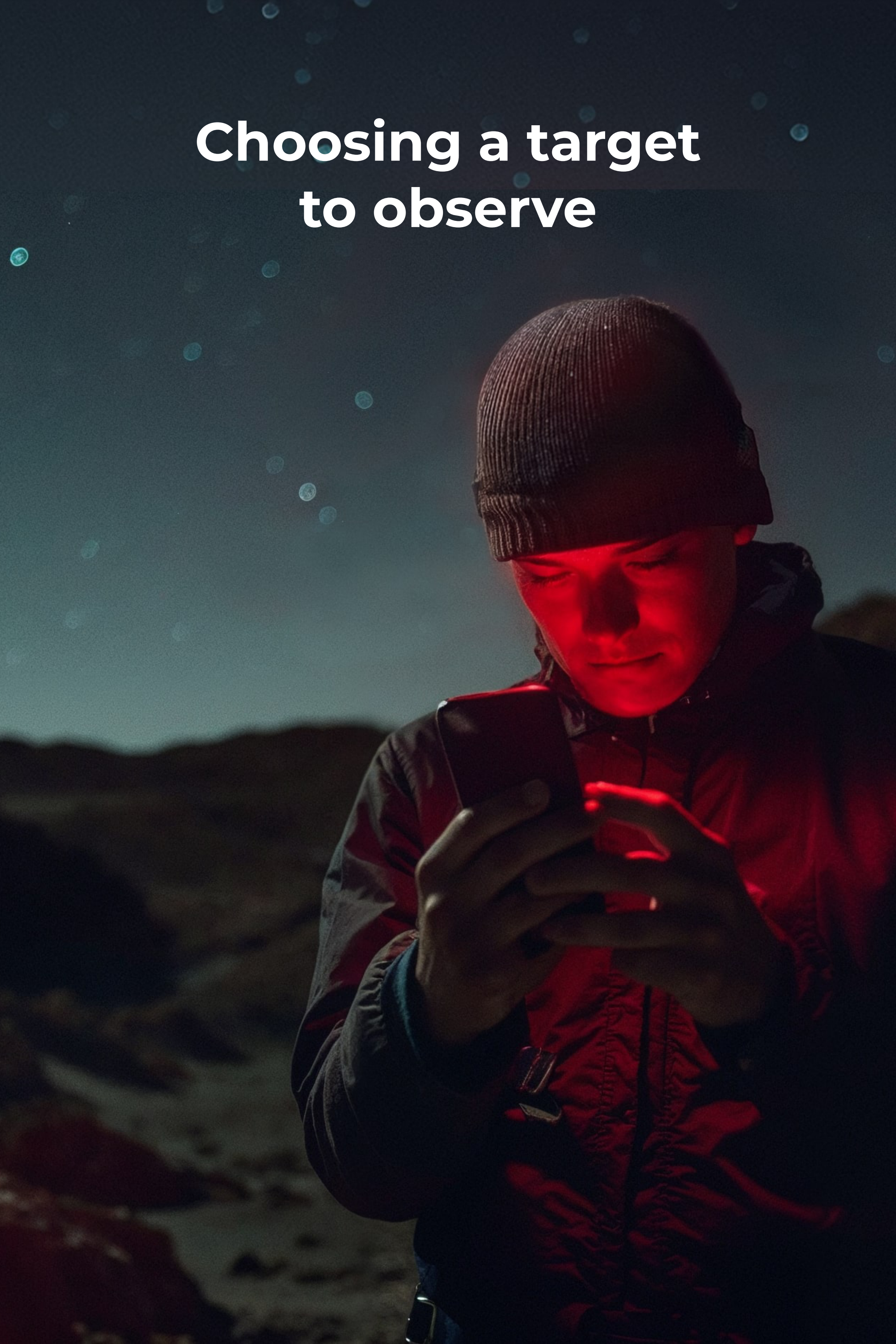
- Wait for the process to complete. In most cases, initialization is successful on the first try. If it fails, Vespera will automatically adjust its aim to another region of the sky and attempt again.
- If initialization continues to fail after two or three attempts, please refer to the troubleshooting section for further guidance.
- Once successful, Singularity will display a confirmation message and your smart telescope will be ready for use.

INITIALIZATION TROUBLESHOOTING

Here are a few reasons why initialization may fail. Refer to our online support for further help.

- It’s not dark enough yet.
- The observatory is not properly set.
- The telescope is not properly leveled.
- The target area is obscured by clouds.
- Trees, branches, or other obstacles block the telescope's field of view.
- In some cases, the dual-band filter may interfere with initialization.

Choosing a target to observe



Vespera gives you access to thousands of celestial objects. Some are more interesting than others, depending on your experience level, while others are only visible during certain times of the year.

To observe and capture a celestial object with Vespera, you must first perform one of the following actions :

- Select a target from the catalog.
- Create a manual target.
- Create a Plan my Night including one or several targets.

Deep sky vs. solar system objects

Astronomical observation is divided into three main categories of celestial objects, each requiring different observation techniques.

THE SUN AND THE MOON

These two celestial objects are either very close (the Moon) or both close and massive (the Sun), and they are also extremely bright. This makes them easy to observe with any type of instrument, including a smart telescope.

Observing the Sun requires special precautions and the use of a dedicated solar filter to avoid serious damage. (refer to Sun observation for more details.)

For both the Sun and the Moon, very short exposure times are sufficient. With Vespera, observation happens in real time—the telescope continuously transmits an updated image feed every few seconds.

THE SOLAR SYSTEM

This includes the planets from Mercury to Uranus, the dwarf planet Pluto, and comets.

Most of these celestial objects are quite bright (except for Pluto), and some—like the planets from Mercury to Saturn—are even visible to the naked eye. However, despite being relatively close to Earth, they appear very small. While their brightness makes them easy to capture, high magnification is needed to reveal fine details.

Vespera allows you to observe various planets, but keep in mind that smart telescopes, in general, are not specifically designed or optimized for planetary observation which typically requires a much longer focal length (the angular size of planets is very small.). That said, you can still observe Venus' phases, Jupiter's two main cloud bands along with its moons, and even catch a glimpse of Saturn's rings.

For these objects, observation is also done in real time, using short exposure times.

Learn more about observing planets in the related section.

DEEP SKY OBJECTS (DSO)

Unlike the Solar System, deep-sky objects are extremely distant, lying beyond the nearest stars. Within our galaxy, they include nebulae and star clusters, while beyond, they encompass other galaxies.

These objects are vast, spanning from dozens to thousands of light-years across, making them best observed at low magnification. However, due to their immense distance, they are also extremely faint. Observing them requires longer exposure time—several seconds per frame—and the stacking of numerous images captured over minutes or even hours to reveal their full detail. This technique, known as stacking, is a fundamental process in astrophotography.

With Vespera, deep-sky observations rely on stacking exposures (10 seconds by default). As each new frame is integrated, the image gradually improves in quality.

For a simple visual observation, just a few minutes are enough to clearly see the object. However, capturing high-quality images often requires several hours of accumulated exposure.

Key criteria for choosing the best targets

APPARENT MAGNITUDE

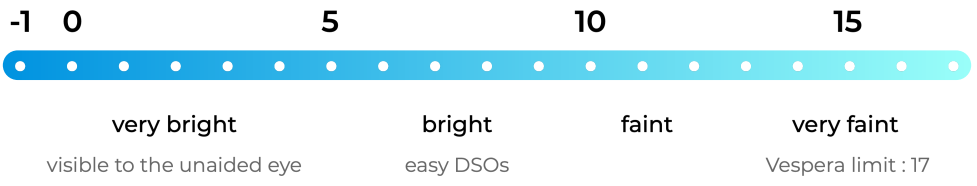
The apparent magnitude of a celestial object represents its brightness as perceived by an observer on Earth (unlike absolute magnitude, which measures an object's intrinsic brightness regardless of its distance from the observer). is a crucial factor in determining the difficulty of observing an object and the total exposure time required for astrophotography.

The brighter an object, the lower its magnitude value. Extremely bright objects like the Sun, Moon, Venus, and Jupiter even have negative magnitudes.

Conversely, fainter objects have higher magnitude values. The brightest stars in the night sky have magnitudes close to 0. Under ideal dark-sky conditions, the naked eye can detect stars with magnitudes up to 6, representing around 10,000 visible stars across the entire sky.

Deep-sky objects, with only a few exceptions visible to the naked eye, generally have higher magnitudes, which is why a telescope is essential for observing them.

MAGNITUDE SCALE



Vespera can capture celestial objects with magnitudes up to 16-17 (depending on your sky conditions). The higher the magnitude, the longer the observation time required for the object to become clearly visible.

You can check an object's magnitude in Singularity's catalog.

Brighter objects are easier to observe and often more visually striking. If you're just starting out, it's best to focus on objects with a magnitude below 10.

That said, many fainter objects are also worth observing but require more patience. In general, galaxies tend to be among the least luminous targets (with a few exceptions), while large nebulae are often brighter and easier to observe.

APPARENT SIZE

Apparent size (also referred to as apparent diameter for roughly circular objects) represents the angular size of a celestial object as seen from Earth. It depends on both the object's actual size and its distance from us.

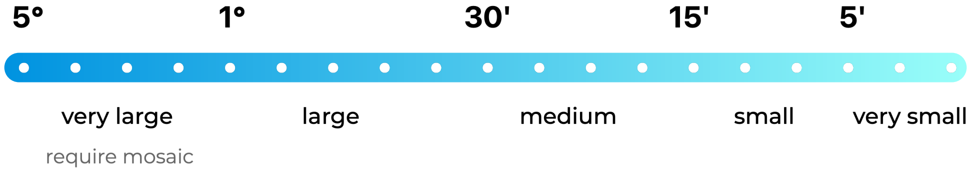
For example, two nebulae may have the same true size, but if one is much farther away than the other, it will appear smaller in the sky, hence a smaller angular size.

Since apparent size is an angle, it is measured in degrees (°), arcminutes (’), and arcseconds (”):

- 1° = 60’ (arcminutes)
- 1’ = 60” (arcseconds)
- 1° = 3600” (arcseconds)

Singularity’s catalog provides the apparent size of each object to help you choose your targets.

For reference: The Full Moon, considered a relatively large object, has an apparent diameter of about 0.5° (30').A few celestial objects appear even larger, such as the Andromeda Galaxy (M31), which spans over 3° at its longest axis—more than six times the size of the full Moon in the sky.



Apparent size is a key factor in determining how large an object will fit within the telescope's field of view. Celestial objects with a large apparent size are often the most striking to observe. However, many smaller objects remain fascinating targets, such as the Dumbbell Nebula (M27).

Most objects can fully fit within Vespera's field of view. For the largest ones, it is possible to capture their entire image using the mosaic mode (learn more by reading the dedicated chapter).

Here are the angular dimensions of some reference objects.

Veil Nebula	3° x 3.25°
Andromeda Galaxy	3.2° x 1°
Carina Nebula	2°
Orion Nebula	1°
full moon	30' (0.5°)

Trifid Nebula	20'
Whirlpool Galaxy	11.2' x 6.9'
Dumbbell Nebula	8' x 5.6'
Ring Nebula	3'
Jupiter (max.)	50'' (0.8')

POSITION IN THE SKY

Beyond an object's magnitude and apparent size, its observability is determined by its position in the sky.

Since the night sky's appearance changes depending on your location, date, and time, some objects may not be visible at certain moments. (For more details, see the chapter Understanding the Night Sky.)

TARGET'S ALTITUDE OVER TIME

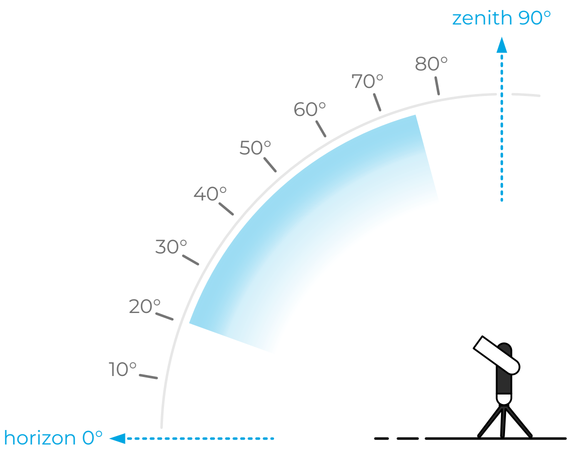
Keep in mind that your target's position will shift throughout the night. Ensure that it remains above the horizon for the entire duration of your observation, especially if you plan to capture long exposures for high-quality astrophotography.

The Singularity app's catalog displays an object's altitude above the horizon at the time of consultation. It's important to anticipate how its position will evolve. To do this, you can use a sky chart application.

If an object doesn't stay visible long enough for your planned acquisition time you can use Multi-Night observations to split the capture process over several nights.

OPTIMAL TARGET POSITION FOR OBSERVATION

- Celestial objects rising in the east will remain visible for a longer period than those in the west, which will soon set.
- Objects located near the celestial pole never set (except when observed from regions close to the equator) and can be observed throughout the night, regardless of the season.
- When observing near the horizon, the light from celestial objects must pass through a thicker layer of the atmosphere, which dims their brightness and creates less favorable conditions for observation. Additionally, atmospheric turbulence and light pollution tend to be more pronounced near the horizon. It is recommended to observe objects when they are at least 20° above the horizon.
- Finally, objects near the zenith (directly overhead) present tracking challenges, potentially leading to frequent image rejection or even the interruption of an observation, especially when using mosaic mode. For optimal tracking and imaging, it is advisable to observe objects positioned below 75° in altitude.



Altitude range for optimal observation

HORIZON CLEARANCE

Finally, consider any obstacles at your observation site, such as buildings, trees, or terrain. The azimuth indicator in the Singularity app catalog can help you to identify targets that are within the clear, unobstructed portion of the sky.

Choosing a target from the Singularity app catalog

ABOUT THE SINGULARITY APP CATALOG

- Singularity features a curated catalog of over 4,000 objects, each accompanied by educational content.
- In addition, an extended catalog provides direct access to tens of thousands of celestial objects.
- Finally, you can create your own custom targets by entering celestial coordinates, allowing you to observe any point in the night sky.

It is impossible to observe the entire night sky from a single location. The visibility of celestial objects depends on the season and the time of observation (see the chapter Understanding the Night Sky).

As a result, only a portion of Singularity's catalog is accessible at any given time. If you attempt to observe an object located below the horizon, Singularity will notify you that the observation is not possible.

CATALOG SECTIONS

The **Explore** screen of the catalog is divided into several sections, making it easier for you to browse the vast array of observable celestial objects.

RECOMMENDED

This section suggests a selection of particularly interesting objects to observe based on the time you access it. These objects are well-positioned in the sky and easy to observe.

CATEGORIES

This section provides a shortcut to explore the catalog's celestial objects by type. The list is sorted based on the selected sorting options (see below), so the objects appearing at the top may not always be currently observable.

The available categories are:

- **Nebulae**: Select this category to view a list of nebulae. You can further refine your choice by nebula type.
- **Galaxies**: Select this category to view a list of galaxies. You can then refine your selection by galaxy type.
- **Clusters**: Select this category to view a list of star clusters. You can further filter between open clusters and globular clusters.
- **Solar System**: Select this category to view a list of planets. The Moon is also included in this section.
- **Stars**: Select this category to access the list of stars available in the catalog.
- **Messier**: Select this category to view all objects from the Messier catalog. These are some of the easiest deep-sky objects to observe from the Northern Hemisphere (see Understanding the Night Sky for more details).
- **Constellations**: This category allows you to explore deep-sky objects in the catalog (regardless of their type) based on their constellation. You can browse the constellation list or search for a specific one. Select the desired constellation to view a list of the deep sky objects it contains.

NEW

Vaonis regularly adds new objects to the catalog and this section highlights the most recent additions.

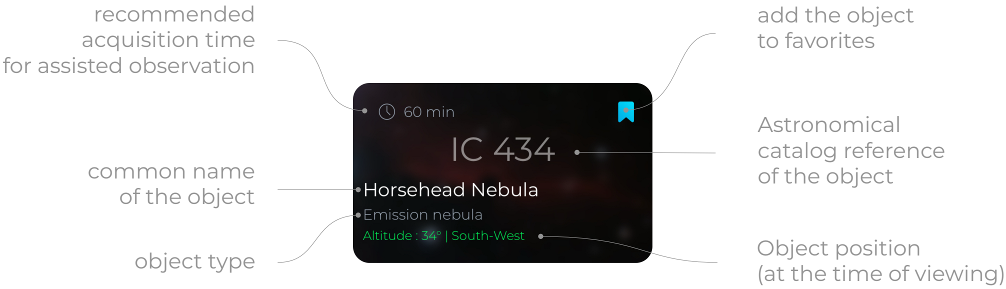
You can also contribute to expanding the Singularity catalog by suggesting objects you believe are of interest.

To submit a celestial object for the catalog:

- Go to the **Profile** tab.
- Open the menu in the top left corner of the screen.
- Select **Suggest an Object**.

OBJECT PRESENTATION IN LISTS

In addition to displaying object names, the lists provide key information to help you quickly assess their interest and suitability for observation.



ABOUT ESTIMATED ACQUISITION TIME

This is an estimated duration required to obtain a clear image of the object in assisted visual observation. It corresponds to the acquisition time displayed on the **Observation** screen (see the Managing observations section).

Extending the observation beyond the suggested time can improve image quality. For astrophotography, longer capture times are almost always necessary.

Observations using mosaic mode will also require extended acquisition times.

For more details on the recommended acquisition time based on your desired result, refer to the Recommended Acquisition Time chapter in the Observation section of this guide.

SEARCHING, FILTERING AND SORTING OBJECTS IN SINGULARITY'S CATALOG

FILTERING VISIBLE TARGETS

To filter out objects that are not currently visible, open the object catalog, tap the settings icon in the top right corner, and enable **Hide if below**

horizon. This will display only the objects that can be observed from your selected location at the current date and time.

OBJECT POSITION INDICATOR

For additional guidance, go to Singularity's **Profile** tab, open the menu in the top right corner, and select **Settings**. Enable **Display object position** to see detailed information for each object, including its altitude above the horizon and its azimuth (direction relative to north). These values are specific to your selected observatory location and the current date and time.

- If the object is well above the horizon, its status is shown in **green**.
- If it is close to the horizon (where observation conditions are less than ideal), or too high to ensure a efficient tracking, it appears in **orange**.
- If it is below the horizon and not visible, it is marked in **red**.

SORTING OBJECTS

From any object list in the catalog, tap the settings icon in the top right corner and choose one of the following sorting options:

- **Sort by Name**: Objects are arranged alphabetically based on their catalog designation (IC, NGC, Messier, etc.).
- **Sort by Grade**: Objects are sorted by their rating, which indicates their level of interest.
- **Sort by Altitude**: Objects are ranked by their current altitude above the horizon at the time of consultation. Higher objects in the sky appear higher in the list.

GETTING DETAILED INFORMATION ON OBJECTS

Activate the object of interest from the list to view detailed information. Scroll through the screen to see all available information sections.

Ask LumENS...

While observing an object from Singularity's curated catalog, the astro-companion LumENS is available to answer any questions you might have about the target you're observing.

To learn more on how to use LumENS, refer to the dedicated chapter.

STARTING THE OBSERVATION OF AN OBJECT

Once you have selected your target, choose one of the observation modes —Standard or Advanced—from its information screen. Refer to the Observation Modes chapter to learn more.

Observing a target that is not in the catalog

Despite the large number of celestial objects in the curated catalog, you may wish to observe a target that is not included.
To observe it, you can create a manual target. This allows you to:

- Create the new object from the extended catalog.
- Create a new object from astronomical coordinates. This option enables you to observe any point in the night sky.

The manual targets you create remain accessible at any time in the **Manual** tab of the Singularity catalog, as long as you don't delete them. They are also synchronized with your Vaonis account and therefore available on any devices you use to control your smart telescope.

Customizing Capture Settings

Manual targets offer additional customization options compared to catalog objects, such as adjusting the exposure time and camera gain.

You must activate Expert Mode to access the exposure and gain settings.

You can create a manual target for an object already present in the catalog if you wish to capture it with personalized settings.

CREATING A MANUAL TARGET

Important: You must activate **Expert Mode** to access the exposure and gain settings.

To activate expert mode:

- Navigate to the **profile** tab then from the top right menu, choose **Parameters**.
- Enable **Activate expert mode**.

To create your manual target: From the Singularity app's object catalog, select the **Manual** tab. You will then have two options to add a manual target:

- **Add a manual target by entering coordinates:** Choose this option to manually enter the celestial coordinates of right ascension and declination for your target.
- **Create a manual target by searching in our extensive catalog:** This option allows you to create a manual target from the extended catalog, which contains far more references than Singularity's standard catalog. The astronomical coordinates will be automatically filled in.

CONFIGURING YOUR MANUAL TARGET

OBJECT NAME

Assign a unique name to your target for easy identification. You might include the object's name along with specific capture settings you've customized.

OBJECT TYPE

The object type affects the real-time image processing applied by the app during observation (this does not affect raw images in TIFF or FITS format).

- **Nebula, Galaxy, and Cluster:** These categories apply different real-time processing techniques to the object for an optimal result.
- **Star:** Unlike the other options, this setting disables image stacking, providing a real-time) view—similar to how the app handles

observations of the Moon and planets. Choose this option if you want to observe without stacking.

EXPOSURE TIME

Set a custom exposure time for this manual target, between 1 second and 30 seconds. Default is 10 secondes
Check the observation guide for recommendations on exposure time settings.

GAIN

Specify the camera gain value for capturing this target, adjustable between 1 dB and 27 dB.
Default is 15 for Vespera II / II X_edition and 20 for Vespera Pro.

Check the observation guide for recommendations on gain settings.

POINTING TYPE

This setting determines how Vespera will point to the target:

- **Direct pointing** works for most cases.
- **Indirect pointing** is useful when the target is close to the moon while it is particularly bright (full moon) or near the horizon in twilight conditions. In this mode, Vespera first locks onto a nearby, well-positioned reference object before shifting to the target.
- If unsure, leave this option on **Automatic**.

RIGHT ASCENSION & DECLINATION

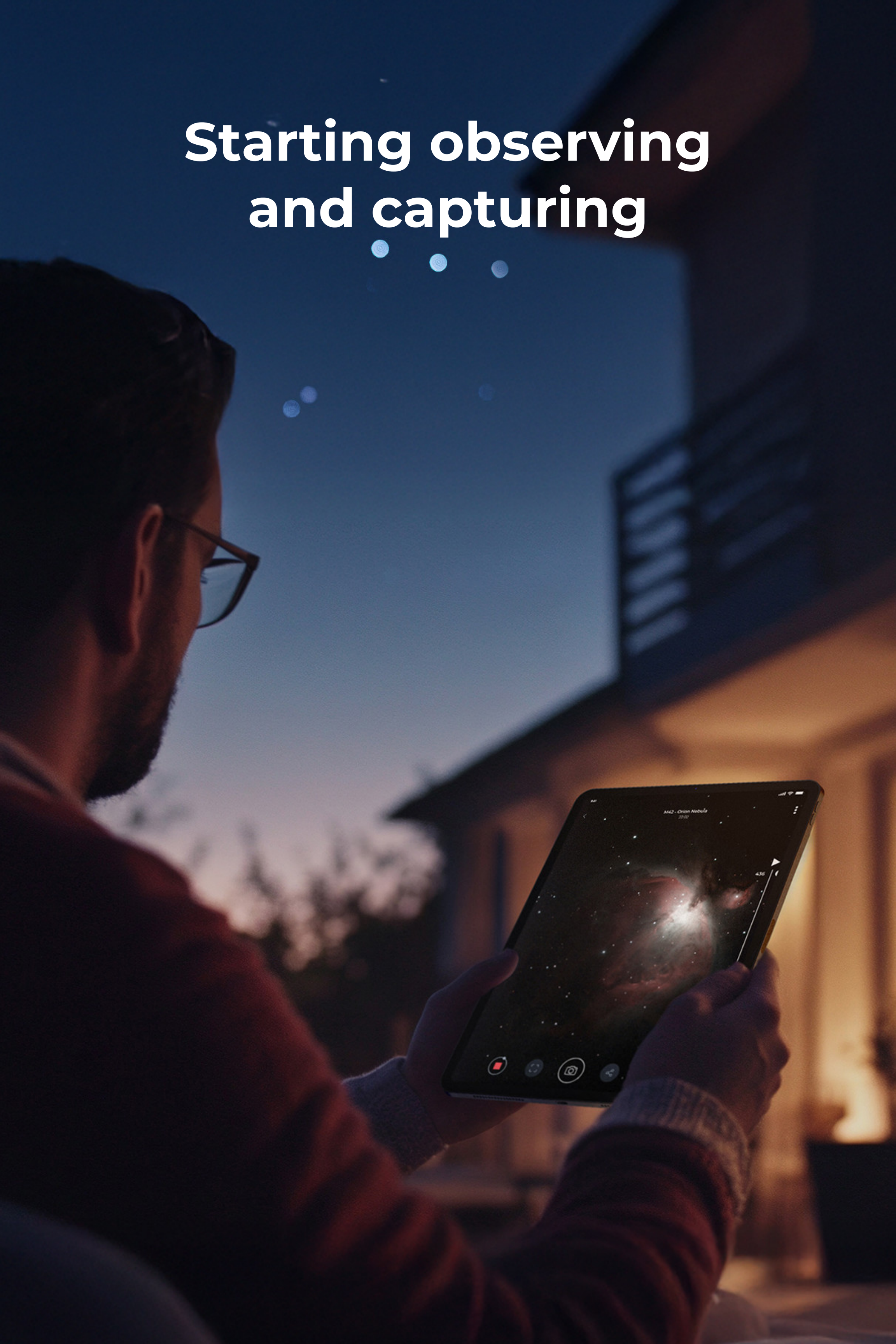
Enter the celestial coordinates of the target. If you created your manual target from an object in the extended catalog, these fields will be pre-filled.

For more details on astronomical coordinates, refer to the section Understanding the Night Sky.

FINALIZING YOUR MANUAL TARGET

Once all settings are configured, tap **Save** to confirm your manual target.

Starting observing and capturing



Before starting an observation, your telescope must be properly initialized. Refer to the corresponding section for more details.

Once you have selected your target from the Singularity catalog or created a manual target, you can start observing and capturing images directly from the target's detailed information screen. Several observation modes are available via the "Standard" and "Advanced" buttons, depending on your desired results or the type of object you want to observe.

Tips:

If you're new to Vespera, simply press the "Standard" button to start observing immediately in the easiest mode, requiring no additional adjustments. The image will appear within two to three minutes, allowing time for the telescope to aim at the target and activate tracking.

Another way to begin observations is by using **Plan My Night**, which lets you schedule an automated observation sequence. Refer to the dedicated chapter for more details.

Assisted observation vs. astrophotography

Vespera offers two main activities: assisted observation, for real-time exploration of celestial objects, and astrophotography, for capturing high-quality images for advanced post-processing.

ASSISTED OBSERVATION

When observing the universe with an automatic telescope equipped with a camera, this is known as assisted observation—as opposed to traditional telescopes, where you observe directly through an eyepiece without any electronic aid.

A real-time stacking process enhances the quality of the image, which is displayed on your smartphone or tablet screen. The observation time for each object is relatively short—just enough to produce a clear image.

This approach prioritizes discovery and exploration, allowing you to observe multiple celestial objects in a single session, without extensive post-processing or a focus on high photographic quality.

ASTROPHOTOGRAPHY

Astrophotography goes beyond assisted observation by aiming to capture high-quality images of celestial objects, requiring advanced processing to reveal their finest details.

For this, maximizing capture time on a single target is essential. Observations last significantly longer—sometimes extending over multiple nights—focusing on just one or two objects per session.

Within the Singularity app, the displayed image serves primarily as a preview, while the raw data recorded by the telescope is used for post-processing.

Astrophotography also involves more customization, such as precise framing, manual adjustments of capture settings, to achieve the best possible final image.

Observation modes

Vespera offers multiple observation modes to suit your needs, ranging from the **Standard Mode**, the simplest one to use, to **Mosaic Mode**, which provides the most advanced options.

OBSERVATION MODES COMPARISON TABLE

	STANDARD OBSERVATION	ADVANCED STANDARD	MOSAIC MODE	LIVE OBSERVATION
STACKING	DSO only	DSO only	yes	no
ADJUST CENTERING	yes	yes	yes	no
ADJUST ORIENTATION	no	no	yes	no
PRECISE FRAMING	no	no	yes	no

EXPAND FIELD OF VIEW	no	no	yes	no
FIELD ROTATION COMPENSATION	no	no	yes	no
DITHERING	yes	yes	yes	no

STANDARD OBSERVATION

This observation mode is ideal for assisted observation, offering the simplest and fastest way to start viewing a celestial object. The telescope automatically points to the target, and no specific adjustments are required.

STARTING A STANDARD OBSERVATION

- From the detailed information screen of an object (or a manual target), tap the **Standard** button.
- The image of the object will appear in Singularity's observation screen after a short moment. (See the Observation Startup Sequence section for more details.)

REFRAMING THE IMAGE

While the observation is in progress, you can adjust the framing to obtain a slightly different view of the object. However.

If you reframe the image, the observation will start over from the beginning.

- From the **Observation** screen, open the menu in the bottom left corner and select **Change Framing**.
- Drag the image to adjust the framing as desired, then confirm your selection.

ADDITIONAL ACTIONS DURING OBSERVATION

While observing, you have the option to save or share the resulting image. If needed, you can also manually refocus the telescope if the image appears slightly out of focus.

To learn more, refer to the Managing Observations section.

ADVANCED OBSERVATIONS

By selecting the **Advanced Observation** mode, you unlock additional options such as adjusting the framing of the observed region and enabling mosaic capture.

STARTING AN ADVANCED OBSERVATION

From the detailed information screen of a catalog object or a manual target, tap the **Advanced** button to open the corresponding interface. This screen features a simplified sky map, allowing you to interact and fine-tune your observation settings.

You then have two options: **Standard Advanced Observation** or **Mosaic Mode**. Use the selector at the top of the screen to choose your preferred mode.

STANDARD ADVANCED OBSERVATION

In this mode, the field of view is represented by a circle since the observation is subject to field rotation (see the dedicated chapter for more details). The final image will be slightly cropped to minimize the effects of field rotation, and image quality may be lower in the corners. The area within the circle will have optimal quality.

▸ **Adjusting the centering**

Unlike the simpler Standard Observation mode, the **Standard Advanced** mode allows you to adjust the centering before starting the observation.

- Drag the simplified sky map to position the desired region at the center of the circle.

▸ Enabling Multi-Night Observations

If you want to extend this observation across multiple nights, enable the **Multi-Night** option at the bottom of the screen. To learn more about Multi-Night projects, refer to the dedicated section of this guide.

▸ Starting the Observation

Once you are satisfied with your settings, tap **Observe** to begin.

MOSAIC MODE

Selecting this mode unlocks even more options for precise framing and allows you to expand the field of view beyond the telescope's optical limitations, capturing a wider image.

Unlike Standard Advanced Observation, Mosaic Mode compensates for field rotation.

Since this mode offers extensive possibilities, a dedicated section of this guide covers its setup and execution in detail. Refer to that section to continue configuring and start your Mosaic Capture.

LIVE OBSERVATIONS

This observation mode is automatically activated for observations that do not involve stacking.

- The Moon
- The Sun
- The planets
- The bright stars in the Singularity catalog
- Manual targets with **object type** set to **star**.

The camera's captured images appear directly in Singularity's observation screen, refreshing every 2 to 3 seconds.

In this mode, observation time does not affect image quality, as no stacking is applied—the image remains consistent throughout the session.

However, it is still possible to save all images captured during the observation. This allows for manual stacking afterward (for specific post-processing needs) or creating a time-lapse. Refer to the section Saving and Managing Images of Your Observations for more details.

STARTING A LIVE OBSERVATION

This observation mode activates automatically when you begin observing an object that does not involve stacking (see above).

LIMITATIONS OF LIVE OBSERVATIONS

- Mosaic capture and Multi-Night observations are not supported.
- The field of view cannot be adjusted.
- Only JPEG images can be saved—RAW format is not available.

Observation startup sequence

As soon as you tap the **Observe** button, Vespera's motors activate to orient the telescope's optical tube toward the estimated position of the target.

Vespera then performs astrometry, analyzing the star field to ensure accurate pointing.

- For most deep-sky objects, the telescope directly targets the selected object.
- In cases where the target is very close to the Moon (or the Moon itself), or when a manual target has been set to indirect pointing, Vespera first locks onto a nearby reference area for astrometry before shifting precisely to the chosen target.
- For solar observations, a specific startup sequence is required. Refer to the dedicated chapter for details.

If necessary, Vespera may perform an additional focusing step. Once the telescope is correctly aligned and focused, tracking is activated, and image capture begins.

There is a brief delay before the first image appears in Singularity. This corresponds to the camera's exposure time but may extend further if the initial images do not meet quality standards—Vespera waits until it captures an optimal image.

This entire process takes a few minutes, during which Singularity displays various details about the object you are about to observe.

Troubleshooting observation startup issues

There may be an unusually long delay between the activation of tracking and the appearance of the first image in Singularity, or in some cases, Singularity may report an observation failure and abort the process. Here are some common causes of this issue:

- **Tracking Issues**: Vespera is unable to capture high-quality images (e.g., distorted stars). This can occur if the observatory is not properly set up, if the leveling is incorrect, or if there are strong winds affecting stability.
- **Sky Quality Issues**: This may happen if clouds pass over during the start of the capture or if the target is located near a strong source of light pollution.

For further assistance with observation startup failures, refer to the online help.

Managing observations

Observation duration vs. image acquisition time

The **Observation** screen in Singularity features a time counter that increases progressively during sessions involving image stacking.

This counter reflects the total duration of successful image acquisition, calculated as the number of stacked images multiplied by the exposure time of each frame (10 seconds by default). However, it does not represent the total elapsed observation time.

The actual observation time will always exceed the displayed acquisition time due to several factors:

- **Frame Rejection:** Some images may be discarded due to insufficient quality. Since they are not included in the stacking process, they do not contribute to the acquisition time.
- **Dithering:** When dithering is enabled, the telescope slightly shifts its position at regular intervals. No images are captured during these movements, so the time counter remains paused. Learn more about dithering further in this guide.
- **Mosaic Capture:** In mosaic mode, the telescope regularly adjusts its pointing to cover the full field. These adjustments temporarily halt image acquisition, preventing the counter from advancing.

Because of these interruptions, the actual observation time can be up to 50% longer than the recorded acquisition time. For instance, capturing one hour of usable data may require approximately 1 hour and 30 minutes of total observation.

ABOUT THE RECOMMENDED OBSERVATION TIME

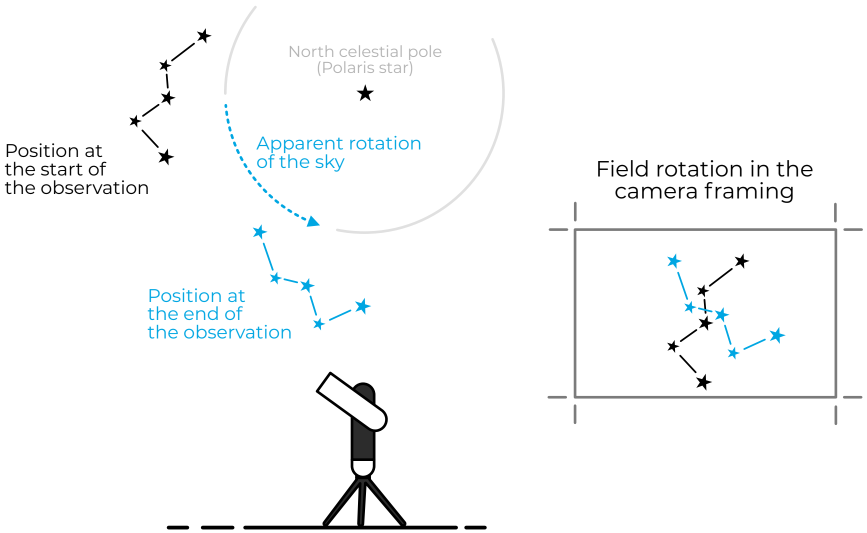
The recommended observation times listed in the Singularity catalog and this guide refer to acquisition time, not the actual duration of the observation.

To learn more about the ideal acquisition time based on your target and objectives, refer to the dedicated chapter.

Field rotation

Field rotation is a phenomenon that occurs with telescopes mounted on an alt-azimuth system, such as Vespera. Unlike equatorial mounts, which follow the sky's rotation by tilting along a single axis, alt-azimuth mounts track celestial objects by moving along horizontal (azimuth) and vertical (altitude) axes.

However, as the telescope follows an object across the sky, the apparent rotation of the celestial sphere causes a gradual shift in the object's orientation relative to the sensor. Since Vespera's camera remains fixed in orientation, this results in a slow rotation of the captured field over time. The longer the observation, the more pronounced this rotation becomes.



WHAT ARE THE EFFECTS OF FIELD ROTATION?

Field rotation primarily affects the outer edges of the image. As the telescope tracks an object, the portion of the sky captured gradually shifts, causing a misalignment over time. As a result, image stacking becomes less effective in these areas, leading to reduced signal accumulation in the corners.

HOW DOES VESPERA HANDLE FIELD ROTATION?

- **In Standard and Advanced Standard Observation Modes**
  Vespera applies a slight crop to the image to remove areas that have received insufficient signal due to field rotation. Thanks to the telescope's high sensor resolution, this cropping is barely noticeable. However, the corners of the image may still appear slightly underexposed, which can result in a bit more noise compared to the rest of the image.

- **In Mosaic Mode**
  Vespera captures a slightly larger area than the selected field of view and then crops the image to match the specified framing. This approach fully compensates for field rotation.

Dithering

Dithering is a technique used to reduce noise in astronomical images, particularly noise caused by sensor imperfections such as hot pixels.

When dithering is enabled, the telescope slightly and regularly shifts its pointing direction. This small, controlled movement makes the position of hot pixels vary randomly relative to the captured star field, making it easier to minimize their impact during image processing.

Dithering is available on Vespera II / II X_edition and Vespera Pro. On Vespera II / II X_edition, users have the option to disable it. To do so, go to the **Instrument** screen and select **Settings**.

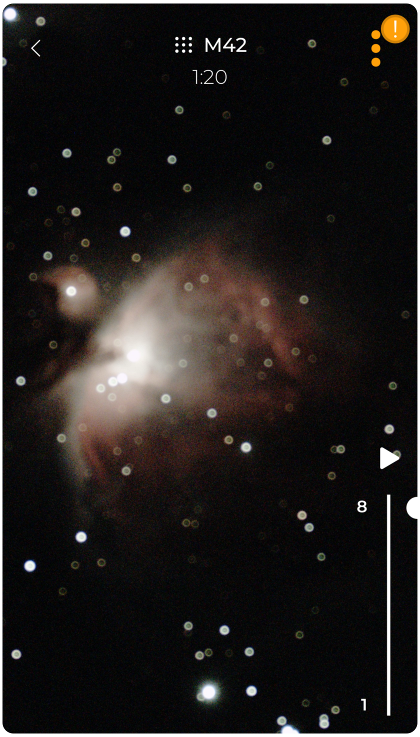
Checking image quality

The quality of captured images can be affected by various imperfections or unwanted effects. In most cases, these issues stem from an improper setup of the telescope and can be resolved by carefully following the installation guidelines and restarting the observation.

At the start of an observation, carefully verifying a few key factors is crucial, especially for astrophotography.

FOCUSING

To ensure proper focus, examine dim stars—they should appear as sharp points of light. The image below illustrates an example of an out-of-focus issue.



POSSIBLE CAUSES OF FOCUS ISSUES

- An object in the telescope's field of view, such as a tree branch or power line.
- A thin layer of clouds obstructing the sky.

HOW TO FIX A FOCUS ISSUE

- Make sure the telescope's field of view is completely unobstructed (Look for tree branches or power lines.) and that no clouds are covering the observed area.

- Open the observation menu and manually restart autofocus by selecting the **Restart Autofocus** option.
- If the issue persists, try initializing the telescope again.
- Try pointing the telescope at another area to see if the issue resolves.
- If your images remain consistently blurry despite troubleshooting, reach out to customer support for assistance.

STAR ROUNDNESS

Stars may appear elongated or take on the shape of small streaks. The image below illustrates an example of badly shaped stars.

POSSIBLE CAUSES OF ELONGATED OR DISTORTED STARS

- Most often, this is due to a tracking issue.
- If you're using a custom exposure time longer than 10 seconds, it can cause star distortion.
- Wind gusts and vibrations can also cause distorted star shapes.

HOW TO PREVENT ELONGATED OR DISTORTED STARS

- Ensure the telescope is perfectly level.
- Verify that the observatory is properly set up.
- Reduce the custom exposure time if it exceeds 10 seconds.
- Shelter the telescope from the wind.
- Minimize any vibrations in the telescope's surroundings.
- Use a sturdy tripod
- Ensure the telescope is installed on firm, level ground.

BACKGROUND GRADIENTS

Sky background gradients are a common challenge in astrophotography. They appear as uneven brightness across the background of an image (see example below).

This issue is difficult to eliminate because it results from external factors rather than the telescope itself. Additionally, gradients may not be noticeable at the start of an observation but can become apparent over time as more data is collected.

WHAT CAUSES SKY BACKGROUND GRADIENTS?

- In most cases, gradients are caused by general light pollution from the night sky or stray artificial light sources near the telescope.
- Thin cloud cover can also contribute to the effect, creating subtle variations in brightness.

HOW TO REDUCE BACKGROUND GRADIENTS

- The best way to minimize gradients is to observe from a location with minimal light pollution and shield the telescope from stray light as much as possible.
- Even with careful precautions and good sky conditions, some gradients may still persist. Vespera's internal image processing software significantly reduces their impact, and dedicated astrophotography software offers powerful tools to suppress them in post-processing.

SATELLITE AND PLANE TRAILS

The night sky is constantly crossed by satellites and airplanes, many of which are visible to the naked eye. During long exposures, these objects leave unwanted trails—thin lines for satellites and dotted streaks for airplanes (image below).

Fortunately, Vespera's real-time processing software eliminates most of these artifacts during live stacking. While some trails may briefly appear during the capture, they gradually fade as the observation progresses.

In rare cases, a few traces may still be visible in the final image. If this happens, they can be removed using image processing software.

Managing the Telescope during observation

Once the observation of an object has started, the telescope operates autonomously to track the target and capture images. It is crucial that no external actions interfere with the telescope's operation.

- During the observation, the telescope's arm moves to track the target's motion across the sky. Ensure that no obstacles, such as an external battery cable, obstruct the telescope's movement.
- The quality of the observation is highly sensitive to the telescope's stability. Do not touch the telescope during operation, avoid any vibrations nearby, and shelter it from wind as much as possible.
- Even if no observation is in progress, once the telescope has been initialized, do not move the instrument, change its orientation manually, or adjust the tripod — otherwise, you'll need to restart the initialization process.
- Avoid directing light sources into the tube. If using a red lamp to move around outdoors, always position yourself behind the telescope.

Monitoring observations

TELESCOPE CONNECTION

Once an observation is underway, it is not necessary for your smartphone/tablet and Singularity to remain connected to the telescope, as the telescope operates autonomously. You can simply reconnect later to monitor the progress of the observation. You can even reconnect using a different device from the one with which you started the observation.

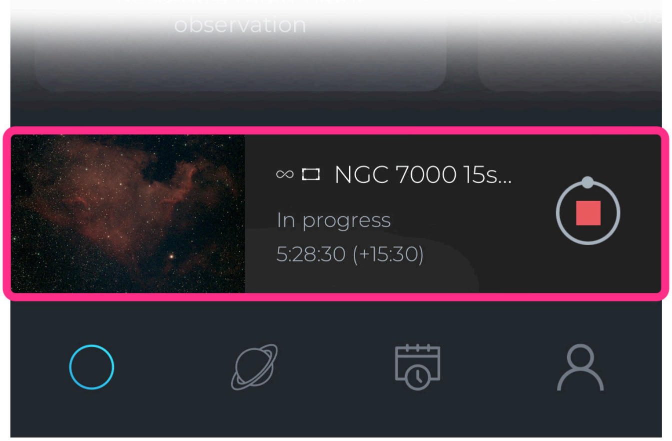
USING SINGULARITY DURING OBSERVATION

If you remain connected to your instrument during the observation, you can navigate to other screens in Singularity, such as the catalog to search for your next target or check the status of Vespera's internal storage.

OBSERVATION WIDGET

While navigating in the Singularity app during observation, a widget remains displayed at the bottom of the screen (see image below), showing the progress of the observation along with a thumbnail of the image. Tap on the thumbnail to return to the **Observation** screen.

From this widget, you can also end the observation if desired.



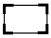
OBSERVATION PROGRESS

The **Observation** screen, along with the **Observation widget**, displays the image being captured in real-time. It is accompanied by a timer showing the total acquisition time since the start of the observation.

During mosaic capture, in the **Observation** screen, an additional indicator shows the progress of the mosaic field sweep, as well as the number of cycles completed. Refer to the section on mosaic capture for more details.

OBSERVATION SETTINGS ICONS

Some icons may appear on the observation screen or in other screens where you can view the results of an observation. Here is what they mean.

	Indicates that the observation is a mosaic capture.
	Indicates a Multi-Night observation.
	Indicates an observation conducted via "Plan my Night."
	Indicates the use of automatic image calibration during the observation (Vespera Pro only).
	Indicates the use of a filter during the observation.

MONITORING BATTERY CHARGE LEVEL

The remaining battery level can be monitored from the Instrument widget in the **Space Center** or the **Instrument** screen.

When the battery charge drops to 5%, an alert message will appear in Singularity.

When the battery level becomes too low, the telescope automatically stops the observation, closes its arm, and powers off.

MANAGING FILTER USAGE

Vaonis filters feature a detection system that confirms proper installation and allows the app to to identify which filter is in place. This information is displayed in the **Instrument** screen.

If you've installed a filter but it isn't detected by the app, ensure it is properly attached.

In some cases, the presence of a filter is essential for the telescope's operation. For example, if you started a Multi-Night observation with a filter, you will only be able to resume it if the same filter is installed.

For solar observation, the use of the certified Vaonis solar filter is mandatory. The observation will not start unless the filter is properly installed.

MONITORING TEMPERATURE AND HUMIDITY

Vespera Pro and Vespera II X_edition come with a built-in **hygrometer**, while Vespera II offers it as an optional accessory for managing the anti-dew system.

This sensor provides real-time ambient temperature and humidity data, which can be accessed from the **instrument** screen.

AUTOMATIC FOCUS CORRECTION

Vespera features a **Live Focus** system that continuously monitors and adjusts focus in real time, even during an observation.

Changes in ambient temperature can cause the telescope's materials to expand or contract, leading to slight focus shifts. To maintain optimal image sharpness, Live Focus automatically detects and corrects these shifts as needed.

When Live Focus is active, Singularity displays a notification. The observation is briefly paused during the adjustment but resumes seamlessly once the correction is complete.

ACTIVATING / DEACTIVATING LIVE FOCUS

To activate or deactivate Live Focus, go to the **Instrument** screen and select the **Settings** section. It is recommended to keep Live Focus activated for optimal performance.

MANUALLY RESTARTING THE FOCUS

If you estimate the focus is not correct, you can request a refocus:

- Go to the **Observation** screen.
- Open the menu in the bottom-left corner (**+** icon).
- Select **Restart Focus**.

Singularity will give you the option to either start over the observation from the beginning after the refocus or continue the ongoing observation.

CONVERTING A REGULAR OBSERVATION INTO A MULTI-NIGHT PROJECT

When an observation is in progress, you can convert it into a Multi-Night session, allowing you to pause and resume it later. This can be especially useful if you need to stop your observation due to worsening weather conditions.

- Go to the **Observation** screen.
- Open the menu in the bottom-left corner (**+** icon).
- Select **Enable Multi-Night**.

A new Multi-Night observation project will be created, preserving all current observation settings.

ACTIVATING THE ANTI-DEW SYSTEM

The hygrometer, included as standard on Vespera Pro and available as an option for Vespera II / II X_edition, triggers and regulates the anti-dew system.

This system activates automatically based on temperature and humidity levels to prevent dew formation on the lens. As a result, there is no manual control to enable or disable it.

While the anti-dew system protects the telescope's lens, it does not extend to any filters that may be installed. In conditions of extreme humidity, it is recommended to observe without a filter to minimize the risk of condensation.

ENDING AN OBSERVATION

You can end an observation at any time:

- from the observation screen, open the menu (**+** button) then choose **stop observation**.
- From the observation widget tap the **stop** button, represented by a red square.

Once the observation is stopped, it cannot be resumed unless it is a Multi-Night observation.

Make sure to save your observation results before starting a new one. As long as the **Observation** screen is accessible, you can still save, export, or share your observation.

When you stop an observation, the telescope remains busy for a few moments to complete certain tasks, such as saving the RAW file or Multi-Night file, if applicable. You must wait until these brief operations are completed before starting a new observation.

Note: If an observation is in progress when dawn breaks, it will automatically be interrupted and the telescope arm will close (the observation will be saved, provided that image auto-save is enabled.).

In case of prolonged or repeated cloud cover, Vespera may no longer be able to correctly point at the target, leading to a complete stop of the observation session.

Using filters

Vaonis offers three types of filters for use with Vespera: one dedicated to solar observation and two designed for nighttime observations. For more details on the solar filter, refer to the chapter on sun observation.

The nighttime observation filters help reduce the effects of light pollution or isolate the emission bands of certain nebulae to enhance their visibility. They improve the quality of deep-sky observations and astrophotography under specific conditions.

Each filter can be easily identified by the letter printed on the label inside the filter: **S** for the solar filter, **C** for the CLS filter, and **D** for the dual-band filter.

FILTER INSTALLATION

Vespera features a unique system that allows for quick and effortless filter installation. It also includes a detection mechanism that enables the telescope to recognize which filter is in place.

Filters are installed at the front of the lens, replacing the protective ring. To install a filter, the telescope arm must be open.

- Press the tab on the protective ring to release it.
- Position the filter in place, first inserting the side opposite the tab into the designated notch.
- Press down on the filter’s tab to securely clip it onto the lens.

Once the filter is properly installed, it will be detected and displayed in the **Instrument** screen of the Singularity app.

WHEN SHOULD YOU INSTALL THE FILTER?

The filter can be installed at any time—before or after telescope initialization or between observations.

Since it is placed in front of the telescope's aperture, it does not affect focus. Therefore, there is no need to refocus after installing or removing a filter.

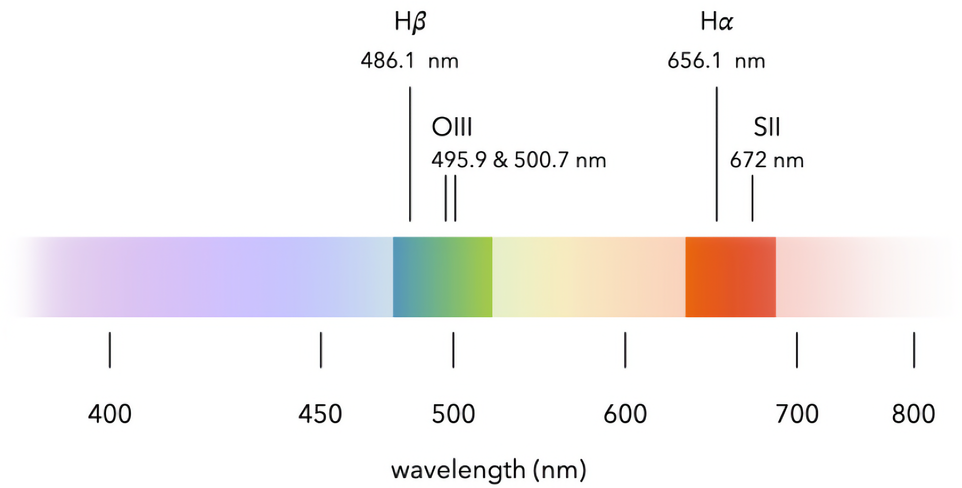
Although it is technically possible to install or remove a filter during an ongoing observation, this is not recommended. Doing so may interfere with the stacking algorithm and lead to unexpected results.

FILTER CHARACTERISTICS

CLS FILTER

The CLS (city light suppression) filter reduces light pollution while preserving the visibility of most celestial objects. It is designed for use in areas with high light pollution (Bortle scale 6 to 9).

This broadband filter transmits portions of the spectrum near the hydrogen-beta and oxygen-III lines, with a 40-nanometer bandwidth, as well as the hydrogen-alpha and sulfur-II lines, with a 35-nanometer bandwidth.



It is particularly well-suited for observing nebulae.

It is not recommended for use:

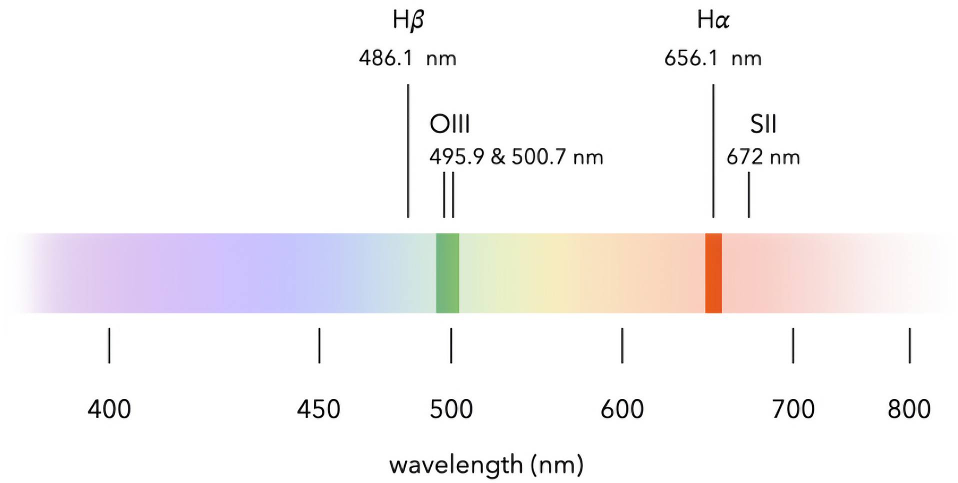
- In areas with low light pollution
- For observing galaxies, unless the light pollution is extremely high

DUAL BAND FILTER

The dual-band filter is specifically designed for observing emission nebulae. When used on these objects, it enhances contrast between the nebula and the sky background while reducing the prominence of stars.

In urban environments, it also acts as an extremely effective light pollution filter for these specific targets, allowing astrophotography even from within city limits.

This narrowband filter isolates the hydrogen-alpha and oxygen-III emission lines with a tight 12-nanometer bandwidth.



It is not recommended for:

- Observing reflection nebulae or dark nebulae
- Observing galaxies, regardless of light pollution levels
- Observing star clusters

For more details on which filter to use and when, refer to the Observation and Photography Guide section.

Saving and exporting images

You can save, export, or share the results of your observation at any time during the session. You can also configure Vespera to automatically save images to its internal storage.

An entire section of this guide is dedicated to this topic—be sure to check it out for more details.

Customizing camera settings

For deep-sky observation (nebulae, galaxies, and star clusters), which relies on image stacking, Vespera captures individual frames with a **default exposure time of 10 seconds**.

By default, the gain (which controls the sensor's sensitivity) is set to an optimized value, **typically 20 dB**, though this may evolve with future Vespera updates to enhance sensor performance.

These default settings are optimized to achieve the best observations for most celestial objects and under a wide range of conditions.

For advanced astrophotography, experienced users can capture images with customized exposure times and gain settings to achieve specific results.

CAPTURING AN OBJECT WITH CUSTOM SETTINGS

To capture an object with personalized settings, you must create a manual target for that object—even if it already exists in the catalog—and save your desired exposure time and gain. Refer to the chapter Creating a Manual Target for step-by-step instructions.

CUSTOM EXPOSURE TIME

Reducing the exposure time below 10 seconds decreases the amount of light collected from the target. This is rarely useful except for extremely bright objects.

Increasing the exposure time beyond 10 seconds can potentially enhance the signal captured from the target. However, consider the following:

- A longer exposure also captures more noise, including light pollution, in addition to the target's signal. This means increasing exposure time benefits only high-quality skies with minimal light pollution. In other conditions, the difference may be negligible.
- The longer the exposure, the more critical tracking becomes with an altazimuth mount. Stars may appear elongated rather than pinpoint sharp, leading to a loss of overall image clarity. If your sky conditions allow, you can try exposures of 15 or even 20 seconds, but going beyond that is not recommended unless you prioritize signal over sharpness.

CUSTOM GAIN

Lowering the gain reduces the sensor's sensitivity. Like with exposure time, very bright objects (such as the Orion Nebula) can cause sensor saturation. In these cases, using a lower gain can be beneficial.

A lower gain setting also improves dynamic range, meaning the sensor can better handle extreme variations in brightness. This can enhance results for objects with strong contrast differences.

On the other hand, **increasing the gain** makes the sensor more sensitive. If you choose this option, consider the following:

- Generally, higher gain leads to more image noise. However, thanks to High Conversion Gain (HCG) technology in Vespera's sensors, noise remains well-controlled, allowing for higher gain without excessive degradation.
- Increased gain reduces dynamic range, which can be problematic for objects with significant brightness variations.
- Higher gain can improve results for very faint targets, but—as with longer exposure times—the benefits are most noticeable under ideal observing conditions, such as dark skies free of light pollution.

Image enhancement with BalENS (Vespera Pro)

Exclusive to Vespera Pro, BalENS is a suite of techniques designed to enhance real-time observation rendering. It improves image dynamics, color balance, and background uniformity for a more refined viewing experience.

Please note that BalENS is currently in beta and continues to evolve with each update.

BalENS does not affect raw image files (TIFF and FITS); it only modifies the on-screen display and the saved JPEG images. For more details, refer to the Saving and Managing Images section.

ENABLING/DISABLING BALENS

You can enable or disable BalENS at any time based on your preferred image rendering style. This can be done even during an observation, allowing you to compare both rendering modes.

However, if you toggle BalENS during an ongoing observation, the change will not be immediate and may take several seconds to apply.

To activate or deactivate BalENS:

- Go to the **Instrument** screen.
- Select **Settings**.
- Enable or disable the BalENS option.
- Choose the rendering option that best suits your preferences (see below).

BALENS RENDERING OPTIONS

BalENS offers four different options that influence how the image is rendered. These settings allow you to choose the right balance between revealing faint details—at the cost of more noise—or producing higher-contrast images with reduced noise and artifacts, but potentially losing the most subtle nuances.

You can switch between the four options at any time during the observation. The rendering will adjust accordingly—just allow a few moments for the changes to be applied to the image.

soft *recommended* *hard*

SOFT

Low contrast. Nebula extensions are more visible, and stars blend smoothly into the background. Background noise is more noticeable but remains soft in the midtones.

RECOMMENDED

Medium contrast. A good balance between background noise and the visibility of faint features.

HARD

High contrast with a deep black background. The faintest nebula extensions are lost, but background noise is minimal, though it becomes more pronounced in the mid-tones.

Manually capturing calibration frames

Vespera automatically performs real-time image stacking during observations (see the How a Smart Telescope Works section for more details). This process ensures that by the end of an observation session, you have a raw image file ready for post-processing.

However, if you prefer, you can manually stack individual sub-frames captured by the telescope.

WHY PERFORMING MANUAL STACKING?

When done correctly, manual stacking allows for greater control over image selection, potentially leading to slightly better results by filtering out lower-quality frames. However, this process requires additional time and significant computing resources and particular skills.

If you decide to perform manual stacking, Vespera provides the option to capture calibration frames, known as **darks**, which are essential for properly calibrating individual images before stacking.

PREPARING FOR MANUAL STACKING

- **Enable FITS raw image saving**: Activate the option to save FITS files (see Saving and Managing Images of Your Observations for more details. Significantly increase the memory usage).
- **Capture dark frames in similar conditions**: Darks should be taken at an ambient temperature close to that of your target. A good practice is to capture them at the beginning or end of your observation session.
- **Match exposure and gain settings**: Dark frames must be captured using the same exposure time and gain settings as the target.
- **Capture sufficient darks**: A minimum of 50 dark frames is recommended. If you are stacking images from a particularly long observation session, aim for 100 or more.

HOW TO CAPTURE DARK FRAMES

Important: You need to enable **Expert Mode** to access this feature.

To activate Expert mode:

- Navigate to the **profile** tab then from the top right menu, choose **Parameters**.
- Enable **Activate expert mode**.

To capture calibration images:

- Ensure Complete Darkness: The optical tube must be fully covered to prevent any light from reaching the sensor.
- In the Singularity app from the **Space Center,** navigate to the **Instrument** screen.
- Scroll down to find the **Expert Mode** section.
- Configure the capture settings:
    - Specify the folder where the calibration images will be saved in Vespera's internal storage.
    - Set the **number of images**, **exposure time** per frame, and **gain** (ensure these match the settings used for imaging the celestial object).
- Start the Capture Process:
    - Press **Start Acquisition** to begin capturing dark frames.
    - Singularity will notify you when the process is complete. The total capture time is equal to the number of frames multiplied by the exposure time per frame.

Observing Together with the Same Telescope

You can connect **up to eight** different smartphones or tablets simultaneously to Vespera, allowing you to share observations with friends and family.

PREREQUISITE

The Singularity app must be installed on each mobile device you wish to connect to the telescope.

HOW DOES SHARED OBSERVATION WORK?

Multiple users can connect to the telescope through the app as they normally would (see Connecting to Your Smart Telescope with Singularity).

Only one device at a time can control Vespera.

Other connected users can:

- View the ongoing observation
- Save or export the image
- Navigate through the different screens of the Singularity app

They cannot:

- stop or start over an observation.
- Power off the telescope via the app.
- Take control of the telescope unless it has been released by the current user.

WHO HAS CONTROL OF THE TELESCOPE?

By default, the first user to connect to the telescope receives control.

To check who currently has control:

- Go to the **Instrument widget** in the Space Center
- Or check the **Instrument screen**, to the right of the telescope image

VIEWING CONNECTED USERS

To see the list of users currently connected to the telescope:

- Navigate to the **Instrument screen.**
- Open the **Control** tab.
- The list of connected users will appear. The user who has control is highlighted.

TRANSFERRING CONTROL TO ANOTHER USER

To allow another user to take control of the telescope, **you must first release control**.

If you're currently in control and your smartphone goes to sleep or the Singularity app is no longer active in the foreground, **control is automatically released**.

If you reopen Singularity while still connected to the telescope's Wi-Fi, and no one else has taken control, it will be reassigned to you automatically.

To manually release control:

- Go to the **Instrument** screen
- Open the **Control** tab
- Tap **Release Control**.

The telescope will then be available for any connected user (including you) to take control.

TAKING CONTROL OF THE TELESCOPE

To take control, the current user must first release it (see above).

Once control becomes available, a **Take Control** button will appear in:

- The Instrument widget
- The Control screen

Tap **Take Control** to assume control of the telescope.

LumENS companion: getting context on what you are observing

WHAT IS LUMENS?

LumENS is your intelligent astro companion working hand in hand with your smart telescope. Whether you’re capturing a galaxy for the first time or revisiting your favorite nebula, LumENS transforms each session into a guided, interactive journey. With just a few taps, it listens, speaks, and responds — contextualizing the cosmos in real time.

PREREQUISITES FOR USING LUMENS

At the time this guide was written, LumENS is only available on iOS devices. Support for Android devices is planned for a future release.

An internet connection is required to use LumENS features while your instrument is connected. On iOS, the app handles this dual-connection seamlessly: Wi-Fi to the telescope + mobile data for LumENS access. If no internet is available, LumENS features are disabled — except for any previously downloaded audio teasers.

LumENS supports English and French, both for voice and text input, as well as for audio explanations.

LumENS is only accessible while an observation is in progress, whether it's a standard observation or part of a scheduled "Plan My Night" session. It is currently not available during manual target observations.

HOW TO USE LUMENS

TOGGLING BALENS ACTIVATION

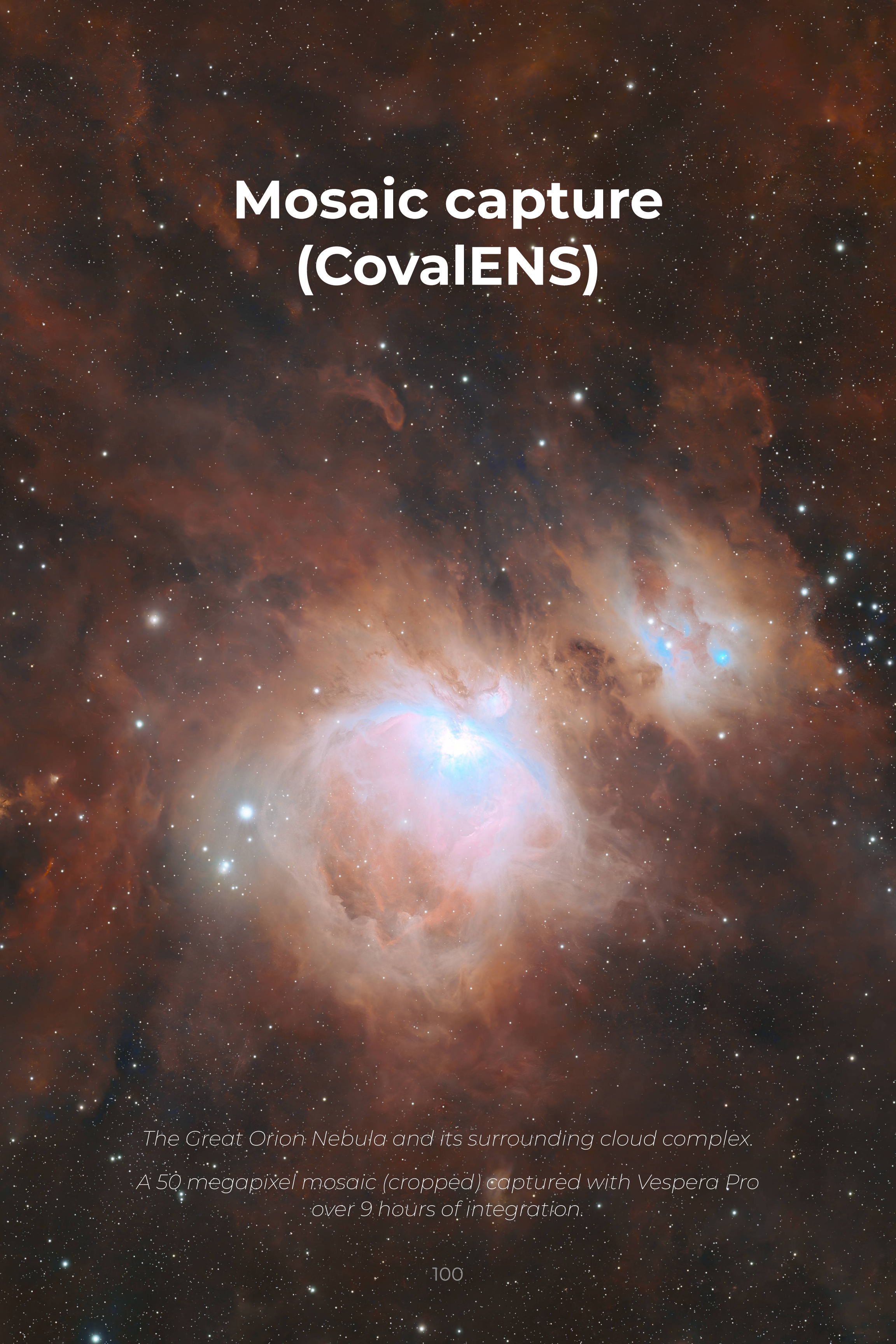
LumENS is enabled by default. Here’s how to disable / enable it:

- Go to the Profile screen
- From the top-right menu, select Settings
- Scroll down to the Enable LumENS section

INTERACTING WITH LUMENS

- From the **Observation screen**, tap the **blue circle** in the bottom right corner (only available when observing and object from the curated catalog).
- You can either type your question or speak directly to LumENS in English or French.

Mosaic capture (CovalENS)



The Great Orion Nebula and its surrounding cloud complex.

A 50 megapixel mosaic (cropped) captured with Vespera Pro over 9 hours of integration.

Video tutorial

Visit the Vaonis YouTube channel to watch a step-by-step video tutorial on capturing mosaics.

What is mosaic capture, and why use it?

Vespera is a fixed-focal telescope, meaning that both its field of view and magnification remain constant.

While Vespera's field of view is wide enough to capture most celestial objects in their entirety, some objects exceed its native frame. In other cases, a wider field of view could enhance the observation experience.

Mosaic Mode addresses these situations by extending Vespera's field of view beyond the physical limits of its optics and sensor.

BENEFITS OF MOSAIC CAPTURE

- **Capture large deep-sky objects in full**: Perfect for wide celestial structures such as the Andromeda Galaxy, the Rosette Nebula, the Carina Nebula, the Small Magellanic Cloud, or expansive star clusters like the Pleiades.
- **Frame multiple objects within a single view**: Enables the capture of nebula pairs like the Lagoon and Trifid Nebulae, star cluster groups such as M46 and M47, or vast galaxy fields like Markarian's Chain.
- **Capture asterisms** (groups of stars with a particular aesthetic) such as the Kemble's Cascade .
- **Precisely control framing**, orientation, and image aspect ratio: Provides flexibility in composing astrophotography shots.
- **Compensate for field rotation effects**: See the About Field Rotation section for more details.

In addition to expanding the field of view, Mosaic Mode also increases image resolution accordingly. This ensures that no detail is lost, preserving the quality and sharpness of the final image.

How does it work?

The process of capturing a mosaic is completely automatic.

After launching the observation in mosaic mode, Vespera progressively scans the field of view that you have defined in the Singularity application by shifting the pointing of the telescope in small steps. Simultaneously, images are captured to compose the mosaic. As the images are captured, the large overlapping portions of the images are used to stack these areas.

This technique, called sliding stacking, allows the mosaic to build in real time, so you don't have to wait until the end of the capture process to start seeing the result.

When the mosaic is complete, you can continue capturing. The extra time will be used to perform additional scans of the field, gradually enhancing the overall quality of the final image.

The mosaic capture begins at the center of the defined field and gradually expands outward. Due to this process, the outer regions of the image receive slightly less signal than the center.

Mosaic Characteristics.

FIELD OF VIEW WIDTH

In addition to capturing a wider region of the sky, the mosaic mode also allows you to define the aspect ratio of the captured area, ensuring a perfectly framed composition for the celestial object.

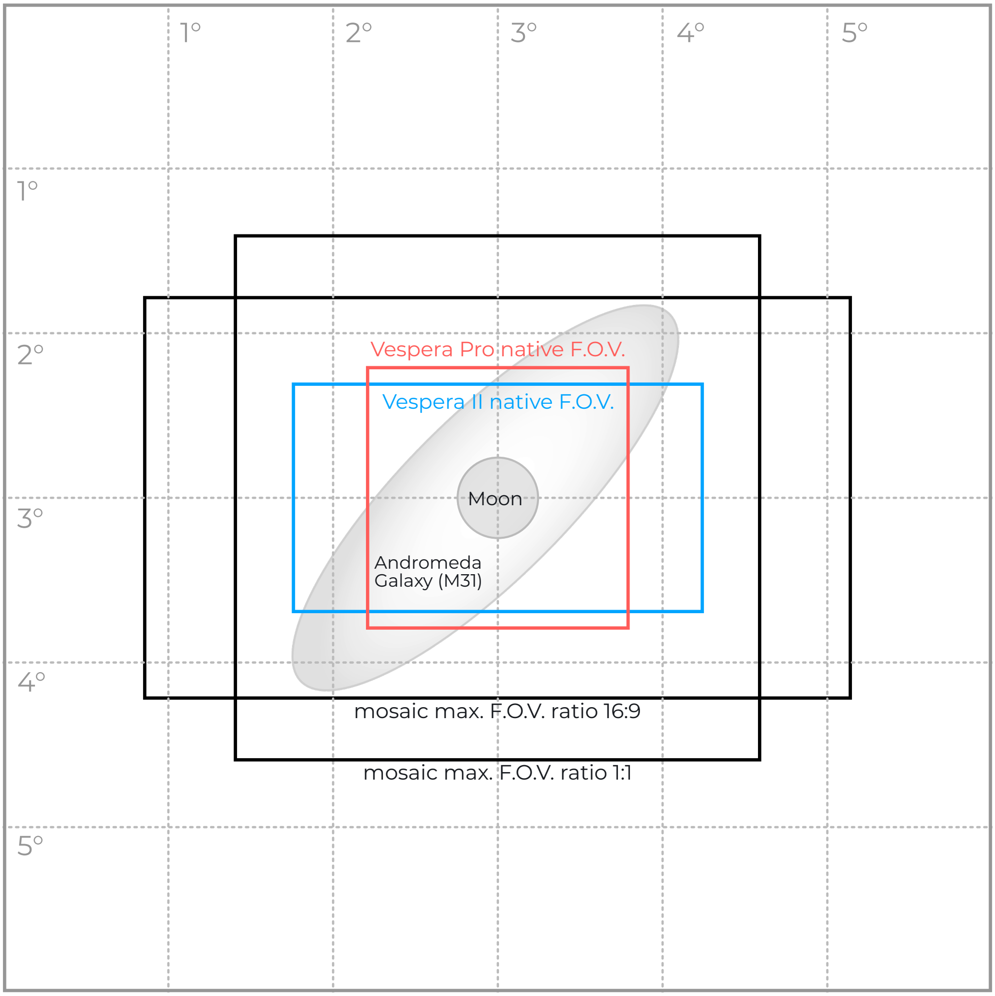
Users can set the mosaic size anywhere between the native field (minimum size) and the maximum size listed above.

The aspect ratio of the captured area is fully customizable within these limits, allowing for square, landscape, portrait, or panoramic formats.

The table below summarizes the maximum mosaic field dimensions for each telescope model and common aspect ratios.

	NATIVE FIELD OF VIEW	MOSAIC MAX. SQUARE RATIO	MOSAIC MAX. RATIO 16:9	MOSAIC MAX. RATIO 9:16
VESPERA II / II X_EDITION	2.5° x 1.4°	3.25° x 3.25°	4.33° x 2.43°	2.43° x 4.33°
VESPERA PRO	1.6° x 1.6°	3.2° x 3.2°	4.18° x 2.45°	2.45° x 4.18°

The following diagram compares the size of the native field of view and the mosaic field with several typical objects.



To learn more about the angular size of celestial objects, refer to the corresponding chapter in this guide.

OUTPUT IMAGE SIZE

The resolution of the final image is directly linked to the chosen mosaic size.

- With **Vespera II / II X_edition**, a mosaic at its maximum size can achieve a resolution of **24 megapixels**.
- With **Vespera Pro**, a maximum-sized mosaic can reach **50 megapixels**.

The table below summarizes the image resolutions (in pixels) for each telescope models and aspect ratios.

	NATIVE IMAGE SIZE	MOSIC MAX. SQUARE RATIO	MOSAIC MAX. RATIO 16:9	MOSAIC MAX. RATIO 9:16
VESPERA II / II X_EDITION	3840 x 2160	4992 x 4992	6650 x 3733	3733 x 6650
VESPERA PRO	3536 x 3536	7072 x 7072	9475 x 5554	5554 x 9475

Mosaic mode compatibility and limitations

- **Mosaic mode is compatible with Plan My Night**, allowing you to include one or multiple mosaic captures in a plan.
- **Mosaic mode is compatible with Multi-Night observations**, enabling you to capture a mosaic over several nights. The parameters and progress of the mosaic are saved in Vespera's internal memory, allowing you to resume the capture with a single press of a button. Refer to the section on multi-night observations for more details.
- **Mosaic mode cannot be used in Live Observation mode** (Sun, Moon, or planets).
- **Mosaic mode is compatible with manual targets**, except when the object type of the manual target is set to **star**.
- **You can use the CLS or Dual-band filter** for mosaic captures, just as you would for a regular observation.

Planning a Mosaic Capture

Capturing a mosaic can take longer than a standard observation, as a larger portion of the sky needs to be covered.

Regardless of the brightness of the target, a minimum amount of time is required to scan the entire mosaic field. This duration depends, among other factors, on the size of the mosaic.

For a mosaic set to its maximum allowable size, completing the first full capture cycle takes approximately **2 hours**.

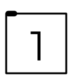
Additional time is required if you choose to run extra scanning cycles to further enhance the quality of the final image.

Thanks to **Multi-Night observations**, capturing large mosaics with a sufficient number of cycles for high-quality results is easily achievable.

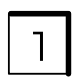
Monitoring the progress of a mosaic capture

As with any observation, Singularity displays the image acquisition time. However, keep in mind that the actual observation time is longer. For more details, refer to the dedicated chapter.

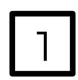
During mosaic capture, an additional indicator (a number inside a rectangle) shows the number of completed mosaic cycles and the progress of the current cycle.



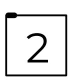
Starting mosaic capture



Mosaic 50% complete



Mosaic complete (one pass)



Starting second capture cycle (image enhancement)

Second capture cycle in progress

Second cycle completed, third cycle in progress...

THE MOSAIC SETTING SCREEN

target name

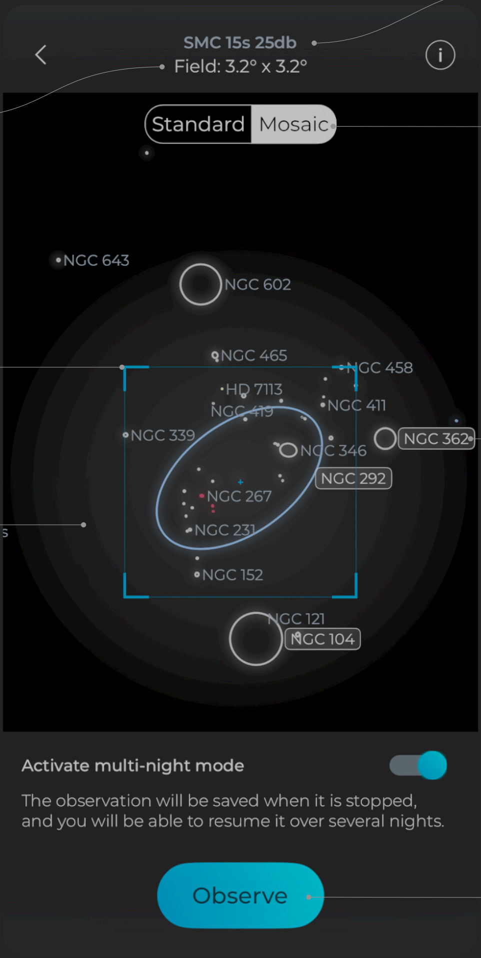
mosaic field of view angular size

activate mosaic mode

drag the handles to set the mosaic size

tap a highlighted object to get information

drag and rotate the map to adjust framing and orientation



start the mosaic capture

Setting up and running a mosaic capture

As with any observation using Vespera, your smart telescope must be properly initialized before starting a mosaic capture.

Refer to the section Setting up and initializing your smart telescope and ensure that all the steps have been completed.

A mosaic capture begins much like any other observation—by selecting a target from the Singularity catalog.

Additionally, a mosaic can be included in a **Plan My Night** program. Refer to the Plan My Night section in this guide to learn more.

CHOOSING A TARGET.

- Navigate to the **Singularity catalog** and search for a target just as you would for any other observation.
- Mosaic capture is available only for deep-sky objects (nebulae, galaxies, and star clusters) or for manual targets where the object type is set to one of these three categories.

CHOOSING THE OBSERVATION MODE.

- Once you've selected your target, tap **Advanced** to activate advanced observation mode.
- A simplified sky map centered on your chosen target will appear. At the top of the screen, select **Mosaic**.
- If you wish to capture your mosaic over multiple nights, enable **Multi-Night** at the bottom of the screen. If you're capturing your mosaic with a filter, you must place the filter on the telescope before activating the Multi-Night mode.

SETTING THE SIZE OF THE MOSAIC.

- Drag one of the handles on the mosaic frame to adjust its dimensions as needed.
- The field size of the mosaic is displayed at the top of the screen.

ADJUSTING FRAMING AND ORIENTATION.

- Drag the sky map with your finger to refine the mosaic’s positioning.
- Use two fingers to rotate the map and adjust the framing orientation.
- On the simplified map, objects with framed names provide additional information. Tap on an object's name to view its details.

STARTING THE MOSAIC CAPTURE.

Once you are satisfied with your settings, tap **"Observe"** to begin capturing the mosaic. The process start just like a standard observation.

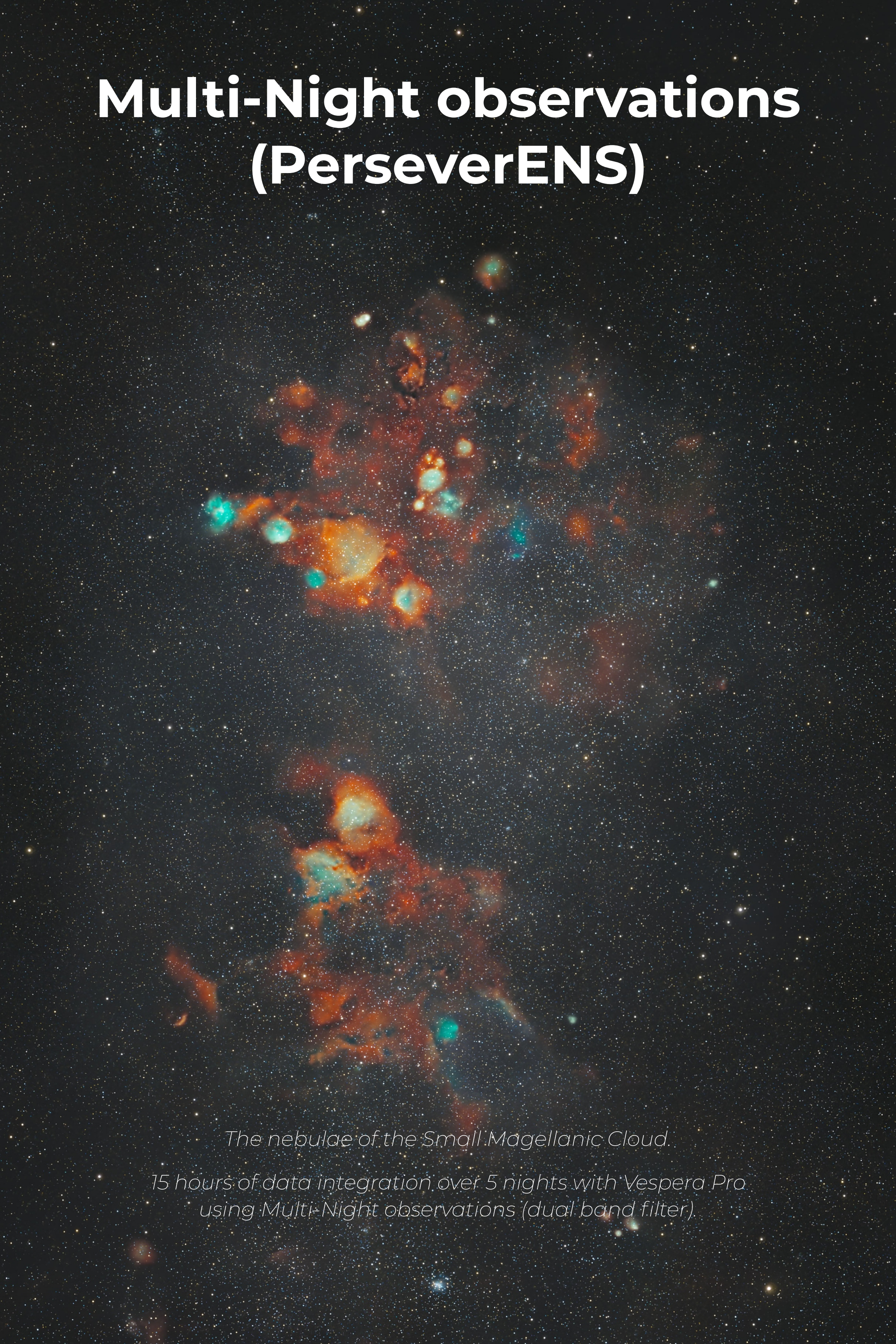
STOPPING A MOSAIC CAPTURE.

- You can stop the mosaic capture at any time, just as you would with a regular observation. However, completing at least one full cycle before stopping is recommended to ensure a complete mosaic.
- If capturing in **Multi-Night mode**, you can stop even if the mosaic is incomplete and resume later from the point where you left off.
- It is best to stop the mosaic capture at the end of a cycle to ensure the most consistent image quality across the entire mosaic.

Saving and sharing the resulting image of a mosaic

You can save, export, or share your observation results at any time, just as you would with a regular observation. Check the dedicated section of this guide to leanr more.

Multi-Night observations (PerseverENS)



The nebulae of the Small Magellanic Cloud.

15 hours of data integration over 5 nights with Vespera Pro using Multi-Night observations (dual band filter).

Video tutorial

Visit the Vaonis YouTube channel to watch a step-by-step video tutorial on performing Multi-Night observations.

What are Multi-Night observations, and why use them?

Deep-space objects are incredibly faint, requiring telescope sensors to be pushed to their limits to capture enough light. This often introduces noise into images, making it challenging to achieve a clear view of your target.

Image stacking is a powerful technique to reduce noise and enhance image quality (see the dedicated chapter to learn more). A typical observation session of 1 to 4 hours can yield sharp, high-quality images, which can be further improved through post-processing. However, for large nebulae or expansive deep-sky scenes, a single night of imaging may not be enough to achieve the best results.

This is where **Multi-Night Observations** come in. This feature allows you to capture the same object over multiple nights or across several sessions in a single night, all without additional effort.

Your session data—including target settings and image parameters, as well as Live Mosaic framing (if used)—is saved automatically. The stacking process resumes seamlessly from where it left off, integrating all captured data into a single, high-quality final image. This final result is ready for easy sharing or further refinement using your preferred image editing software.

BENEFITS OF MULTI-NIGHT OBSERVATIONS

- **Limitless acquisition**: There's no cap on the total integration time you can accumulate on a target.
- **Smart Storage**: You don't have to worry about filling up your device with raw files. The system stores the observation as a single file, and you can safely delete individual exposures without losing the overall result (just remember to save the raw file you'll need for post-processing).

- **Target and Settings Preservation**: Your telescope remembers all your capture settings, including framing and filter configurations, across sessions. Just press a button to continue the project. You can create manual targets with personalized camera settings (exposure and gain) and resume the entire observation. Singularity will remind you to install a filter, if applicable, to maintain the consistency of your configuration across sessions.
- **Manage Multiple Projects at Once**: Your smart telescope can manage up to five Multi-Night projects simultaneously. Depending on the visibility of different targets, you can juggle multiple observation projects within the same night.
- **Seamless Integration with mosaic capture**: Multi-Night Observations unlock the full potential of Live Mosaic capture. It preserves your exact framing and progress. Should you stop a session before a mosaic cycle is complete, the next session will resume exactly where the previous one left off. Read the section dedicated to mosaic capture to learn more.
- **Automation with Plan My Night**:You can automate your Multi-Night observations, allowing you to accumulate a large amount of data on your target without the need to constantly monitor your telescope.

LIMITATIONS OF MULTI-NIGHT OBSERVATIONS

- To create a new Multi-Night Observation, **you need to be connected** to your telescope.
- Since a Multi-Night capture is linked to the capabilities and configuration of your smart telescope, you can't start a Multi-Night observation on one telescope and resume it on another.
- If you're using filters for your captures, the same filter must be installed for every observation session of the Multi-Night observation. This consistency ensures the best quality for your final image.
- You can manage up to **five** Multi-Night projects at a time. If you already have five and need to start a new one, you'll need to delete an existing project first.

The Multi-Night screen

The Singularity app features a dedicated screen for managing Multi-Night projects. This screen allows you to:

- View a list of ongoing Multi-Night projects along with their status, including the total accumulated observation time.
- Preview the captured Multi-Night image.
- Resume a Multi-Night observation.
- Export an image from the Multi-Night observation.
- Delete a Multi-Night project.

To access this screen, you must be connected to your telescope via the Singularity app, as the data is stored in Vespera's internal memory rather than the app itself.

There are two ways to access the Multi-Night projects screen:

1. From the **Space Center**, via the **Multi-Night observation** tab located under the instrument widget.
2. From the **Instrument Screen**, by scrolling through the available sections until you reach the **Multi-Night observations** section.

For more details on managing Multi-Night observations from this screen, refer to the chapter Managing Multi-Night Projects later in this guide.

THE MULTI-NIGHT SCREEN

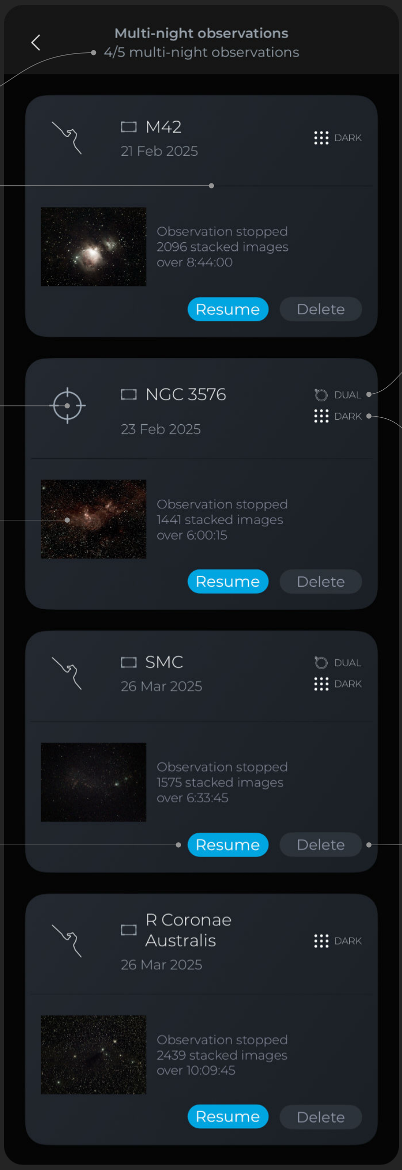
Multi-Night project counter

Multi-Night project

target type (manual target)

tap to view the image and access export options

resume observation



use of a filter (if applicable)

use of image calibration (if applicable)

delete the Multi-Night project.

Starting a new Multi-Night project

Your smart telescope must be properly initialized before starting a mosaic capture. Additionally, the Singularity app must be connected to your telescope.

When Multi-Night mode is enabled, an infinity symbol (**∞**) icon appears on the observation screen.

There are three ways to start a new Multi-Night observation project:

1 - ENABLING MULTI-NIGHT WHEN SETTING A NEW OBSERVATION

This is the primary method.

- Once you have selected your target—whether from the catalog or as a manual target—tap **Advanced** to enable advanced observation mode.
- Choose the **Advanced Standard** or **Mosaic** mode and adjust the mosaic framing if applicable.
- If you plan to use a filter, make sure to install it before activating the Multi-Night option.
- Enable **Multi-Night** at the bottom of the screen.
- Tap **Observe** to start the session. The observation will proceed just like a standard one.

2 - CONVERTING AN ONGOING REGULAR OBSERVATION INTO A MULTI-NIGHT PROJECT

If you started an observation without initially planning to make it a Multi-Night project but change your mind while it is in progress, you can convert it—provided you haven't reached the limit of five simultaneous Multi-Night projects.

- From the **Observation** screen, open the **(+)** menu in the bottom left corner.
- Select **Enable Multi-Night** to convert the ongoing observation into a Multi-Night project.

3 - CREATING A NEW MULTI-NIGHT OBSERVATION FROM PLAN MY NIGHT

When setting up a new plan, you can add an observation target and enable the Multi-Night mode for that target. Once the plan starts automatically, a new Multi-Night project will be created.

For more details on creating or resuming a Multi-Night observation with Plan My Night, refer to the dedicated section in this guide.

Multi-Night observations with Plan my Night.

Plan My Night allows you to schedule the start of a brand-new Multi-Night project or resume an existing one. It's important to distinguish between these two options.

In the list of available targets within Plan My Night, you will see both:

- The Multi-Night project you have already started.
- The original target used for that project, displayed under the same name.

To help differentiate them, the Multi-Night project (used to resume an ongoing observation) is marked with the ∞ (infinity) symbol.

Refer to the Plan my Night section to learn more.

Interrupting a Multi-Night observation

When you are ready to interrupt your observation session, follow the same steps as for a regular observation:

- From the **Observation** screen, open the **(+)** menu in the bottom left corner.
- Select **Stop Observation**.

You still can resume the observation later.

Singularity will save the result of your Multi-Night observation. This may require some time since the file to be saved contains 32 bits RAW data and is very large, particularly if your observation is a mosaic.

While your smart telescope is saving the file, a message will appear on the observation screen. During this process, starting a new observation is not possible.

Resuming a Multi-Night observation.

To resume a Multi-Night observation, the target must be visible, regardless of your observation location.

Multi-Night observation sessions can take place from different locations. However, each time you change your observation site, you must select the correct observatory during the telescope's initialization.

Steps to Resume a Multi-Night Observation:

- Ensure your telescope is properly initialized, as with any observation.
- Navigate to the Multi-Night screen to view the list of ongoing Multi-Night projects.
- Verify that your telescope has the correct filter configuration (this information is displayed for each project in the list).
- Click the "Resume" button for the corresponding project. (If the button is inactive, the telescope's filter configuration does not match the project's requirements.)
- The observation will resume exactly from where it was last stopped.

Monitoring a Multi-Night observation

- When a Multi-Night observation is in progress, an infinity symbol (∞) is displayed on both the observation screen and the observation widget.
- The observation screen shows the total cumulative acquisition time from all sessions of the Multi-Night project. If capturing a mosaic, the mosaic indicator displays the total number of completed mosaic cycles since the project began.
- The observation widget also displays the cumulative acquisition time but additionally shows the acquisition time for the current session.

This allows you to easily track how much time has been added to the project.

Managing Multi-Night projects

CHECKING THE STATUS OF MULTI-NIGHT PROJECTS

You can view your list of Multi-Night projects, check their status, and preview or export the results at any time—even outside an observation—as long as you are connected to your telescope via the Singularity app.

The Multi-Night screen only displays projects for which at least one observation session has been initiated. If you have scheduled a new Multi-Night project through a **Plan My Night** program but the observation has not yet started, the corresponding Multi-Night project will not appear in the Multi-Night screen.

MULTI-NIGHT PROJECT LIMIT

The number of simultaneous Multi-Night projects is limited to **five**.
If you attempt to start a new Multi-Night observation while this limit has already been reached, Singularity will display a message indicating that the operation cannot proceed.

To create a new project, you must first delete at least one existing Multi-Night project (see the section below).

Since Multi-Night projects scheduled in Plan My Night do not appear in the Multi-Night screen until the first observation has taken place, you may receive a limit reached notification even if the Multi-Night screen displays fewer than five active projects.

DELETING A MULTI-NIGHT PROJECT

Deleting a Multi-Night project is permanent and cannot be undone. Make sure you have saved or exported your observation results before proceeding with deletion.

To delete a project:

- Open the **Multi-Night Observations** screen.
- Tap the **Delete** button for the project you wish to remove.

Once a project is deleted, a new slot becomes available, allowing you to start a fresh Multi-Night observation.

Viewing and saving the result of a Multi-Night Observation

DURING AN ACTIVE MULTI-NIGHT OBSERVATION

While the observation is in progress, you can save, share, and export the current results just as you would for a regular observation.
Simply use the options available in the **Observation screen**.

For more details, refer to the section Saving and Managing Images of Your Observations.

ACCESSING RESULTS OUTSIDE AN OBSERVATION

You can still view and export your results even when the Multi-Night observation is not active, as long as your smart telescope is connected through the Singularity app.

To retrieve and share your Multi-Night observation results:

- Open the Multi-Night screen.
- Tap on the thumbnail of the Multi-Night project you want to export or share.
- The observation result will open in a new screen.
- Use the (**+**) menu at the bottom left to access the save and share options.

Multi-Night observation best practices

The quality of your Multi-Night captures will depend on several factors, including atmospheric conditions and light pollution. Since your smart telescope averages the quality of each stacked image, it's best to perform each session of the Multi-Night project under consistent conditions. For instance, try not to resume a session captured under a new moon during a full moon, as this could diminish the final quality.

Multi-Night file management

A Multi-Night master file is saved in the telescope's **system folder** for each of your Multi-Night projects. This is the only file essential for Multi-Night observations to function properly. The contents of the system folder must not be modified by the user under any circumstances.

All other images that may be saved in the **user folder** (depending on your settings)—except for the FITS sub-images used for stacking—are derived from these master files. As a result:

- Actions taken in your **user folder** (e.g., deleting files) do not affect the Multi-Night master files or how the Multi-Night observation feature works.
- Images in the **user/observation folders** always combine the results of all observation sessions, not just the most recent one (except for the FITS sub-images used for stacking). This means that you can, for example, process an image using the TIFF file from the most recent observation session of your Multi-Night project. This file contains all the data captured so far.

Since Multi-Night master files are stored in your telescope's internal memory, they are independent of the Singularity app and the device used to control the telescope. You can update or reinstall the app, or switch to another device, and your Multi-Night projects will remain available.

For a deeper understanding of Vespera's file management, refer to the section Saving and Managing Images of Your Observations.

Solar observations

Observing the Sun is an activity fundamentally different from deep-sky observations. Unlike distant celestial objects, which require gathering as much light as possible, the Sun emits far too much light to be observed safely with any optical instrument.

While using a smart telescope ensures safety for the observer (as their eyes are not directly exposed to sunlight), a highly attenuating filter is still essential to protect the telescope's sensor.

Additionally, since solar observations take place during the day, the telescope cannot rely on star patterns for initialization and astrometric calibration.

For these reasons, observing the Sun with Vespera follows a distinct process, with a dedicated mode specifically designed for safe and effective solar tracking.

Solar observations do not involve stacking. Instead, the image is streamed live to your smartphone or tablet and refreshed every 2 to 3 seconds, without any additional processing.

Note: the Vaonis solar filter transmits only 1/100,000 of the solar radiation

Observing safely

While observing with a smart telescope poses no risk to your eyes, solar observation with Vespera requires the certified solar filter to be installed in order to protect the instrument’s sensor. **The telescope will not initiate solar pointing unless the filter is properly attached**.

Never manually point the telescope’s optical arm toward the Sun without the solar filter in place, as this could cause permanent and irreparable damage to your smart telescope.

⚠

Never look directly at the Sun through any optical instrument without proper solar protection, as this can lead to irreversible eye damage.

The only time it is safe to observe the Sun without protection is during the brief moments of a total solar eclipse, when the Moon completely blocks direct sunlight.

Conditions Required for Solar Observation

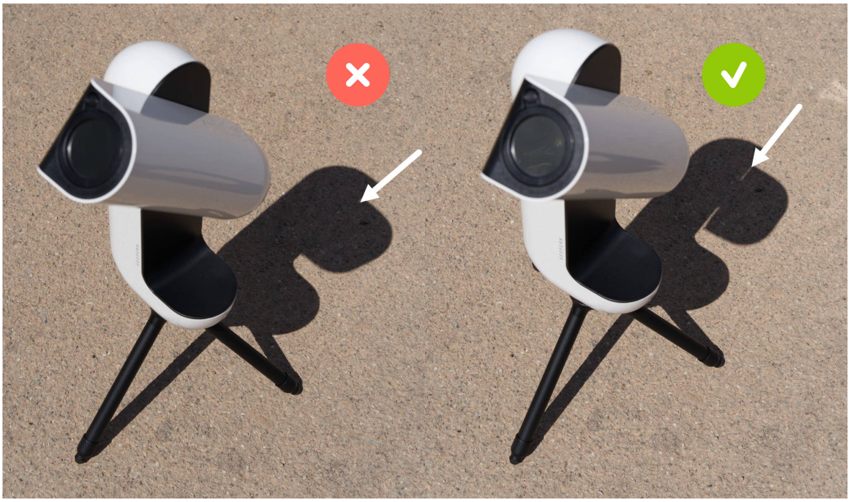
Important: Before making your first solar observation, you must have previously completed at least one nighttime observation (regardless of the location). After this initial step, it won't be required again, even if you wish to observe the Sun from a different location than your usual observation site.

- Solar observations can only be performed in broad daylight and under clear skies.
- While it is technically possible to observe the Sun through a thin layer of clouds, this may interfere with the telescope's focusing or alignment process. In any case, image quality will be diminished if clouds obstruct the view.
- The Vaonis solar filter must be securely attached to the telescope at all times.
- If you begin a solar observation with the filter in place and then remove it during the session, the observation will be immediately interrupted, and the telescope's optical arm will automatically retract for safety.

Starting a Solar Observation

Note: During solar observation, when the solar filter is detected, the brightness of Vespera's button light ring is automatically set to maximum intensity to ensure visibility in daylight.

- As with any observation, begin by setting up your telescope outdoors on a flat, stable surface, and **carefully level the tripod**.
- Power on your smart telescope and connect to it using the Singularity app.
- In the app, make sure the selected observatory matches your actual observation site.
- **Manually** point the telescope toward the Sun for an initial rough alignment. To do this:
    - manually rotate the telescope clockwise on its base until a beam of light passes through the gap between the arm and the body of the telescope and projects onto the ground (illustration below).



- Take the Vaonis solar filter.
- From Singularity's home screen (Space Center), tap the **Solar Mode** tab located below the instrument widget.

- On the next screen, tap Start. Vespera's arm will raise into a safe position to allow you to install the solar filter.
- Following the on-screen instructions, carefully place the solar filter on the telescope.
- Once the filter is detected by Vespera, tap **Confirm Filter Installation**.
- If you haven't already aligned the instrument toward the Sun, you can do so at this stage by following the on-screen guidance.
  Then tap **Confirm Arm Orientation**.
- The telescope arm will close for calibration, then reopen and begin scanning the sky to locate the Sun.
  This pointing process takes a few moments.
- Once the Sun is detected and focus is achieved, the live image will appear in the Observation screen of Singularity.

Ending a Solar Observation

When you're ready to end your solar session:

- From the **Observation** screen, tap the **(+)** menu in the bottom left corner, then select **Stop Observation**.
- The arm will close to an intermediate safe position, allowing you to remove the solar filter.
- Once the filter is removed, tap **Close the arm**.

Special Case: Observing Solar Eclipses

PARTIAL ECLIPSE

Using the solar filter is absolutely essential when observing a partial solar eclipse. The observation process is exactly the same as for regular solar observations.

TOTAL ECLIPSE

In the case of a total eclipse, a specific observation procedure must be followed. During the partial phases, the solar filter must remain in place. However, to observe the total phase, the filter must be removed at the precise moment of totality.

By default, Vespera's safety system automatically stops solar observations when the filter is removed.

Ahead of a total solar eclipse, Vaonis provides a dedicated eclipse observation mode. This special mode allows you to safely disable the filter detection system during the brief window of totality, while keeping safe and uninterrupted observation.

This mode is only available during the period of a total solar eclipse.
It will be released ahead of the total solar eclipse on August 12, 2026.

Saving Images from a Solar Observation

Only live observation images in JPEG format can be saved during solar sessions. To enable automatic saving:

- Go to the **Instrument** screen
- Open the **Image Formats** section
- Enable the **Live Images** option

For more details, refer to the Saving and Managing Images of Your Observations section in this guide.

Note: While solar observation doesn't involve stacking, you can automatically save the JPEG live images from the session and manually stack them later to perform advanced processing and improve image quality.


Saving and managing
images of your
observations.

Singularity offers multiple ways to save, share, and export your observation results. Images can be automatically stored in Vespera's internal memory for retrieval after your session, and you can also manually save them during your observation for instant sharing.

Managing Vespera internal memory

Vespera is equipped with an internal memory to store images captured by your smart telescope. The available storage capacity depends on your telescope's model:

- Vespera II / II X_edition : 25 GB
- Vespera Pro : 225 GB

CHECKING AVAILABLE STORAGE CAPACITY BEFORE STARTING AN OBSERVATION

Before starting your observation session, it is best to check that you have enough free space to save your upcoming images. The required storage space depends on the type of images you plan to record.

- **High storage usage**: If you choose to automatically save individual raw FITS images, you'll need a significant amount of space.
- **Low storage usage**: If you only save stacked raw images (TIFF), the required space will be minimal.

For more details on file sizes, refer to the Image File Formats section.

Managing storage beforehand.

Transferring data from Vespera’s memory to a computer can take a significant amount of time, especially if you're copying a large number of individual images used for stacking. To avoid storage issues, check the instrument's available space before your observation. If necessary, back up your images and clear internal storage to make room for new captures.

HOW VESPERA'S INTERNAL STORAGE IS ORGANIZED

Vespera's storage is divided into two sections:

- **System Folder**: Used for firmware and storing essential files such as Multi-Night observation data. *This folder should never be modified by the user.*
- **User Folder**: Stores automatically saved images from your observations.

The **User Folder** is further organized into subfolders, each corresponding to:

- An observation of a specific target
- A Plan My Night program
- A telescope initialization sequence
- A calibration image capture

The organization of observation folders is detailed later in this guide.

CHECKING INTERNAL STORAGE STATUS

- Connect to your telescope via the **Singularity** app.
- Navigate to the **Instrument Screen** (accessed via the Instrument Widget in the Space Center).
- Under the **Storage** section, check the available memory. Tap on it to open the storage management screen.
- A diagram will display the memory usage and remaining available space.
- Select the **User Folder** to view a list of observation folders and their storage usage.
- You can further select an individual observation folder to see its subfolders.

DELETING OBSERVATION FOLDERS TO FREE UP SPACE

Deleting an observation folder is permanent and cannot be undone. Ensure you have transferred any important images before proceeding (see the chapter on transferring images from vespera to a computer).

DELETING ALL OBSERVATION DATA

To erase the entire contents of the **User Folder**:

- Open the Internal Storage screen.
- Select the **User Folder**.
- Tap **Delete All** at the bottom of the screen.
- Confirm the deletion request.

The deletion process takes some time, during which the telescope cannot be used for observations.

DELETING SPECIFIC OBSERVATION FOLDERS

If you only need to free up part of the storage, you can delete selected observation folders, such as older ones. (Folders are named with the observation date followed by the target name.)

- Open the Internal Storage screen.
- Select the **User Folder**.
- Tap **Select** in the top right corner.
- Choose the folders you want to delete by checking the blue circles next to them.
- Tap **Delete** at the bottom of the screen.

The deletion time depends on the amount of data being removed.

Images file format

Vespera can save captured and processed images in different formats, each designed for specific purposes. Understanding the properties of each format will help you decide which images you need to save and export.

JPEG FORMAT

JPEG is a widely used standard image format, and Vespera utilizes it in the following cases:

- The automatic saving of observation results as stacking progresses. If automatic saving is enabled, a JPEG is saved at each stacking step (when a new frame is added to the stack).
- The automatic saving of images during a live observation (Sun, Moon, planets and manual targets with the type set to **stars**)
- Storage in the Singularity Cloud Library.
- When saving images to your smartphone or tablet's photo gallery for quick sharing.

CHARACTERISTICS OF JPEG IMAGES:

- Small file size – Require minimal storage.
- Compressed with limited dynamic range – Not suitable for advanced image processing but can be slightly enhanced using basic photo editing apps.

TIFF FORMAT

TIFF is an uncompressed raw format used to save the final Vespera auto-stacked image of an observation.

By using the resulting TIFF image of an observation **you don't need to perform manual stacking**. You can directly post-process the image with your favorite astrophotography software.

- It is automatically saved in Vespera’s internal memory at the end of an observation (if this option is enabled).
- Can be generated on demand during an observation and exported to a smartphone, computer, or other storage locations.
- Only available for stacked observations – Not used for observations of the Moon, the Sun, or manual targets classified as "star."

CHARACTERISTICS OF TIFF IMAGES:

- High-quality 16-bit raw images – Ideal for advanced post-processing with specialized software.
- The file size is significant, especially for mosaic captures. However, by default, only a single image is saved at the end of the observation, so storage usage remains minimal.
- May appear completely black when viewed unprocessed – This is normal due to the high dynamic range.

FITS FORMAT

FITS is a raw astronomical format used to store individual exposure frames before stacking.

- Automatically saved in Vespera’s internal memory (if this option is enabled).
- Saves all captured images – including those used for stacking and those rejected due to quality issues.

CHARACTERISTICS OF FITS IMAGES:

- Dedicated for manual stacking for advanced astrophotography workflows.
- Large file sizes – Each file can be several tens of megabytes, and hundreds of images may be saved per observation, consuming significant storage space.
- Only available for stacked observations – Not used for the Moon, Sun, or manual targets classified as "star".

CHOOSING THE RIGHT FORMAT

- **JPEG** – Best for quick sharing and minimal storage usage. Unsuitable for image processing except for solar and lunar observation (they can be stacked)
- **TIFF** – Best for high-quality single-file results and direct processing.
- **FITS** – Best for astrophotographers performing manual stacking.

To optimize your storage, enable FITS saving only if you plan to perform manual stacking, as these files take up substantial space.

	JPEG	TIFF	FITS
MEMORY OCCUPATION	low	low	huge
COMPRESSED	yes	no	no
IMAGE DYNAMIC	8 bits	16 bits	16 bits
SUITABLE FOR POST PROCESSING	no	yes	yes
AUTOMATIC SAVING	yes	yes	yes
MANUAL SAVING	yes	yes	no
AFFECTED BY BALENS (VESPERA PRO)	yes	no	no

Methods for Saving and Sharing Images

There are five ways to get the images from your observation:

① AUTOMATIC IMAGE SAVING IN THE INTERNAL MEMORY

You can configure your telescope to automatically save observation images to its internal memory. You can also choose which types of images to save.

This option allows you to focus on observing without having to remember to export your images after each session.

To enable this feature:

- Go to the **Instrument** screen in the app.
- Scroll down to the **Image Format** section and open it.
- Select the type of image you want to be automatically saved.

② MANUAL IMAGE SAVING IN SINGULARITY CLOUD GALLERY

At any time during an observation, you can save the current image to your Singularity Gallery.
This library offers 200 MB of cloud storage linked to your Singularity user account. Images saved here are stored in the cloud and automatically synchronized across your devices if applicable. You need to be connected to the internet for synchronization to work.

Images saved to the Singularity Gallery are in JPEG format, which makes them suitable for quick viewing and sharing, but not ideal for advanced image processing.

- From the **Observation** screen, open the (**+**) menu at the bottom left.
- Select **Save in Singularity**.

To learn more about how to view the images in your Singularity gallery, refer to the following chapters.

③ MANUAL IMAGE SAVING IN YOUR SMARTPHONE PHOTO ROLL

At any time during an observation, you can save the current image directly to your smartphone or tablet.
These images are not accessible from within the Singularity app — you'll need to open your device's photo gallery to view them.

Images saved this way are in JPEG format.

- From the **Observation** screen, open the **(+)** menu at the bottom left.
- Select **Save in Photos**.

④ EXPORTING A RAW IMAGE FOR POST-PROCESSING

At any time during an observation, you can export a RAW file in TIFF format for advanced manual processing.
This file is typically exported at the end of the observation, as it then contains the full signal accumulated during stacking — but you can also export it earlier if needed.

To access this export option, you must first enable it in the app settings:

ENABLING MANUAL TIFF EXPORT

- Go to the **Profile** screen in Singularity
- Tap the menu icon in the top right corner
- Select **Parameters**
- Enable the **TIFF export** option

MANUALLY EXPORTING A TIFF FILE

- From the **Observation** screen, open the **(+)** menu in the bottom left
- Select Export a TIFF
- Wait a few moments while Singularity prepares the file
- Choose where to save the file — either on your smartphone/tablet, or export it to a computer or any other sharing option available on your device

⑤ OTHER IMAGE SHARING METHODS

You can share the current image of your observation on social media, via email or messaging apps, to cloud storage services, or through any other sharing method supported by your smartphone.

- From the **Observation** screen, open the **(+)** menu in the bottom left corner.
- Select **Share.**
- Choose the most appropriate sharing destination.

Which image saving method is best for your needs?

Here are the most common observation scenarios, along with the most suitable image-saving method for each.

ASSISTED OBSERVATION

SCENARIO:

You use Vespera simply to explore the universe and enjoy observing deep-sky objects. You don't plan to edit the images, but you'd like to keep a record of your observations.

SUGGESTED METHOD:

There's no need to enable automatic image saving (regardless of the format). You can simply save an image manually to the Singularity Gallery or to your smartphone's photo album (see methods 2 and 3).

ASTROPHOTOGRAPHY: PROCESSING FROM VESPERA'S AUTOMATIC STACKING

SCENARIO:

You want to perform advanced post-processing using dedicated software, starting with the image produced by Vespera's automatic stacking.

SUGGESTED METHOD:

Enable automatic saving of the **TIFF** file (see method 5).
There's no need to activate FITS saving, as these files take up significant storage and won't be necessary for this workflow.

At the end of your session, manually save the final image to the Singularity Gallery or your smartphone's photo album as a reference.
Use method 4 to export intermediate TIFF files manually if needed.

ASTROPHOTOGRAPHY: MANUAL STACKING OF INDIVIDUAL EXPOSURES

SCENARIO:

You want to manually stack all the individual frames captured by the telescope to try getting an even better result.

SUGGESTED METHOD:

Enable automatic saving of **FITS** files (raw individual frames), and also enable **TIFF** saving for comparison or backup. This lets you compare your manual stacking result to the one produced by Vespera.

PROCESSING IMAGES OF THE MOON AND THE SUN

SCENARIO:

You want to stack frames of the Moon or the Sun to improve image quality and apply post-processing.

Note: Moon and Sun observations are only available in JPEG format.

RECOMMENDED SETUP:

Enable automatic saving of live images (method 1). Also, save a reference image manually to the Singularity Gallery or your smartphone’s photo album (method 2 and 3).

Managing your Singularity image gallery

The images in your Singularity Gallery are stored in the cloud, not on your smart telescope. This means you can view them at any time, even when you're not connected to your telescope.

VIEWING YOUR IMAGE GALLERY

- In the Singularity app, go to the **Profile** tab at the bottom of the screen from the **Space Center**.
  Your gallery will appear along with an indicator showing the amount of storage used versus the total available.
- You can choose to view your photos individually or grouped by celestial object. To switch between views, tap the icon next to the number of objects/images.
- Tap on any image's thumbnail to open the full-size version, where you can zoom in.
- From the image detail screen, you can:
    - View observation details related to the image
    - Save it to your smartphone or tablet’s photo gallery
    - Share it
    - Delete it
- If you see a cloud icon with a cross on an image, it means the image has not yet been synced to the cloud. Make sure your smartphone is connected to the internet while the Singularity app is running.

Transferring images from Vespera to a computer

CONNECTING TO VESPERA WITH A COMPUTER

To access files stored in Vespera's internal memory from your computer, you must connect to your smart telescope via Wi-Fi. Note that you cannot access the internal storage by connecting your computer to Vespera through the USB port.

- Your smart telescope must be powered on.
- You do not need to connect to Singularity.
- The telescope does not need to be initialized.

Simply select the Wi-Fi network starting with "Vespera..." from the list of available networks on your computer.

WI-FI FREQUENCY AND TRANSFER SPEED

Vespera supports two Wi-Fi frequencies:

- **2.4 GHz:** Offers a longer range but slower transfer speeds.
- **5 GHz:** Provides faster file transfer speeds but with a shorter range.

If you plan to transfer a large volume of data, it's advisable to set Vespera's Wi-Fi to 5 GHz.

CHANGING THE WI-FI FREQUENCY:

- In the Singularity app, ensure you are connected to your smart telescope.
- Navigate to the **Instrument** screen.
- Select the **Settings** section.
- Tap **"Switch to 5GHz / 3GHz Wi-Fi"** to change the Wi-Fi frequency.

- Vespera’s Wi-Fi connection will reset during the transition. Once completed, return to your smartphone or computer’s Wi-Fi settings and reconnect to the Vespera network.

TRANSFERRING FILES

Image transfer between Vespera and your computer **is performed via FTP** (File Transfer Protocol). Whether you’re using Windows or MacOS, this file transfer method is natively supported by your operating system. Alternatively, you can use an FTP app.

USING THE FEATURES OF YOUR OPERATING SYSTEM.

Make sure your computer is connected to Vespera’s Wi-Fi to proceed.

WINDOWS

- Make sure to disable any firewall or antivirus software on your computer.
- Open the File Explorer and go to the navigation bar.
- Type “ftp://10.0.0.1” in the navigation bar and press Enter.

MAC OS

- From the Finder, open the "Go" menu and select "Connect to Server".
- Enter “ftp://10.0.0.1” in the server address field and press Enter.
- In the connection window that appears, select "connect as guest" then click "Connect".

- Once connected, a window will display the file hierarchy of your Vespera memory, which consists of two folders: **system** and **user**.
- Open the **user** folder to access the observation folders containing your images.
- You can either copy them to your computer or delete them from Vespera.

USING AN FTP CLIENT

There are many FTP clients available for both Windows and macOS, free or paid. All of them offer the necessary features to access the files stored in Vespera's internal memory.

Here's an example using two popular and free FTP clients available for both Windows and macOS.

FileZilla

- Ensure your computer is connected to Vespera's Wi-Fi.
- In the Quickconnect bar at the top, enter: ftp://10.0.0.1
- Click Quickconnect to establish the connection.

Cyberduck

- Click Open Connection.
- In the dialog box that appears, set the following:
    - Protocol: FTP
    - Server: 10.0.0.1
    - Port: 21
- Click Connect to access Vespera's internal storage.

Understanding Vespera folders and files hierarchy.

When you connect to your smart telescope from your computer (see method above), you'll see two folders: **system** and **user**.
The **user** folder contains the images from your observations. It is the only folder from which you can delete files to free up storage space on your telescope.

The **system** folder contains essential files required for your telescope to operate properly. This folder and its contents must not be altered under any circumstances.

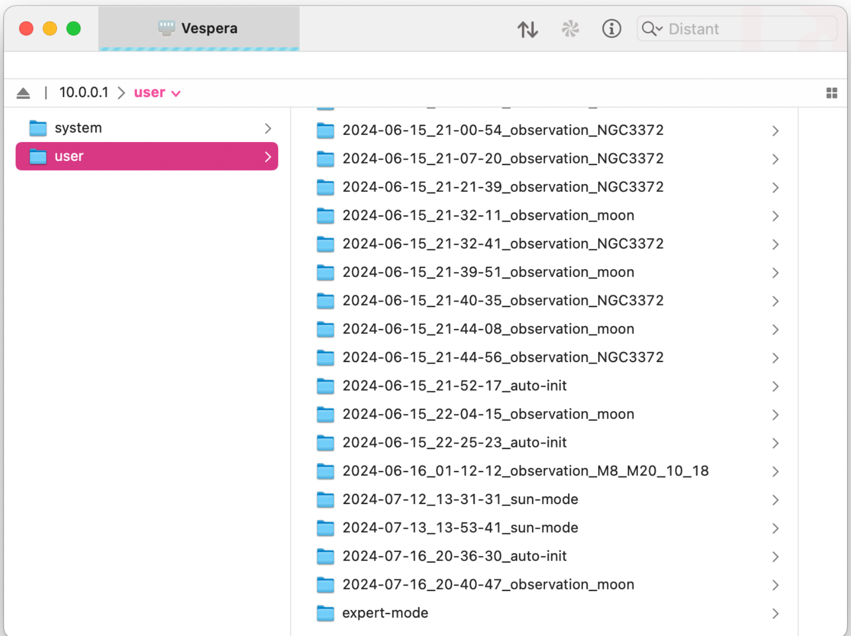
USER FOLDER STRUCTURE AND ORGANIZATION.

Summary

The images from your observations are stored in the **"user"** folder, organized by observation.

Each **observation** folder contains a subfolder named **"images-initial"**, which holds all the images saved during that session.

If you performed a reframing during the observation, the corresponding images will be found in the **"images-adjust-framing"** folder.



Example of folders contained within the "user" directory.

"OBSERVATION" FOLDERS

The images saved during your observations are organized into folders, each corresponding to a specific observation. This makes it easy to locate and retrieve the images you want.

- Each observation folder is named using the date of the observation, the time the folder was created (in Universal Time), and the name of the observed object — for example: 2025-02-28_09-20-21_observation_M42.
- If the observation involves a manual target, the folder name will include the name you assigned to that manual target.

To learn more about observation folders and how to locate your images, refer to the chapter Observation folder structure.

"PLAN" FOLDERS

When you run an observation program using Plan My Night, the images are saved in a folder named **Plan**, prefixed with the date and time, followed by the name you gave the plan — for example: 2025-03-04_08-56-26_plan_ursa_major_galaxies.

Inside the Plan folder, images are organized into subfolders corresponding to each target in your plan.

"AUTO-INIT" FOLDER

These folders contain data generated by Vespera during the initialization process, including the images used for astronomical calibration.

You typically won't need to access or use the contents of these folders.

"CALIBRATION IMAGE" FOLDERS

If you use **expert mode** to manually capture calibration frames, those images will also be saved in the user folder, inside a subfolder named after the label you specified during the calibration setup.

Refer to the chapter Manually capturing calibration frames for more details.

MULTI-NIGHT OBSERVATIONS

Each time you resume a Multi-Night observation, a new observation folder is created, just like with standard sessions.

You can retrieve your images from these folders if needed. Deleting these folders won't affect the progress or functionality of your Multi-Night observation project since the master file is saved in the System folder.

You can always access the latest results of a Multi-Night project through the dedicated **Multi-Night** screen in the Singularity app.

Refer to the section on multi-night observations to learn more.

OBSERVATION FOLDER STRUCTURE

Each observation folder is organized into several subfolders, each serving a specific purpose:

"POINTING-INITIAL" FOLDER

This folder contains data generated during the initial pointing of the target. You generally won't need to access or use these files.

"IMAGES-INITIAL" FOLDER

This is the main folder containing your saved images in JPEG, TIFF, or FITS format, depending on the automatic saving options you've selected in Singularity.

(For more information, see the chapter automatic image saving in internal memory.)

"IMAGES-ADJUST-FRAMING" FOLDER

If you applied a framing adjustment during a standard observation, the resulting images will be saved in this folder instead of images-initial.

"AUTOFOCUS-LIVE" FOLDER

This folder contains data generated by Vespera when an automatic focus adjustment is performed during the observation.You generally won't need to access or use these files.

Observation log files

In addition to images, the various observation folders may contain files with a **.json** extension.
These are log files that store information about the processes running during your observation, or metadata related to the captured images.

In most cases, you won't need to access these files. However, if a potential issue with your smart telescope arises, the customer support team may request some of these files to help diagnose the problem.

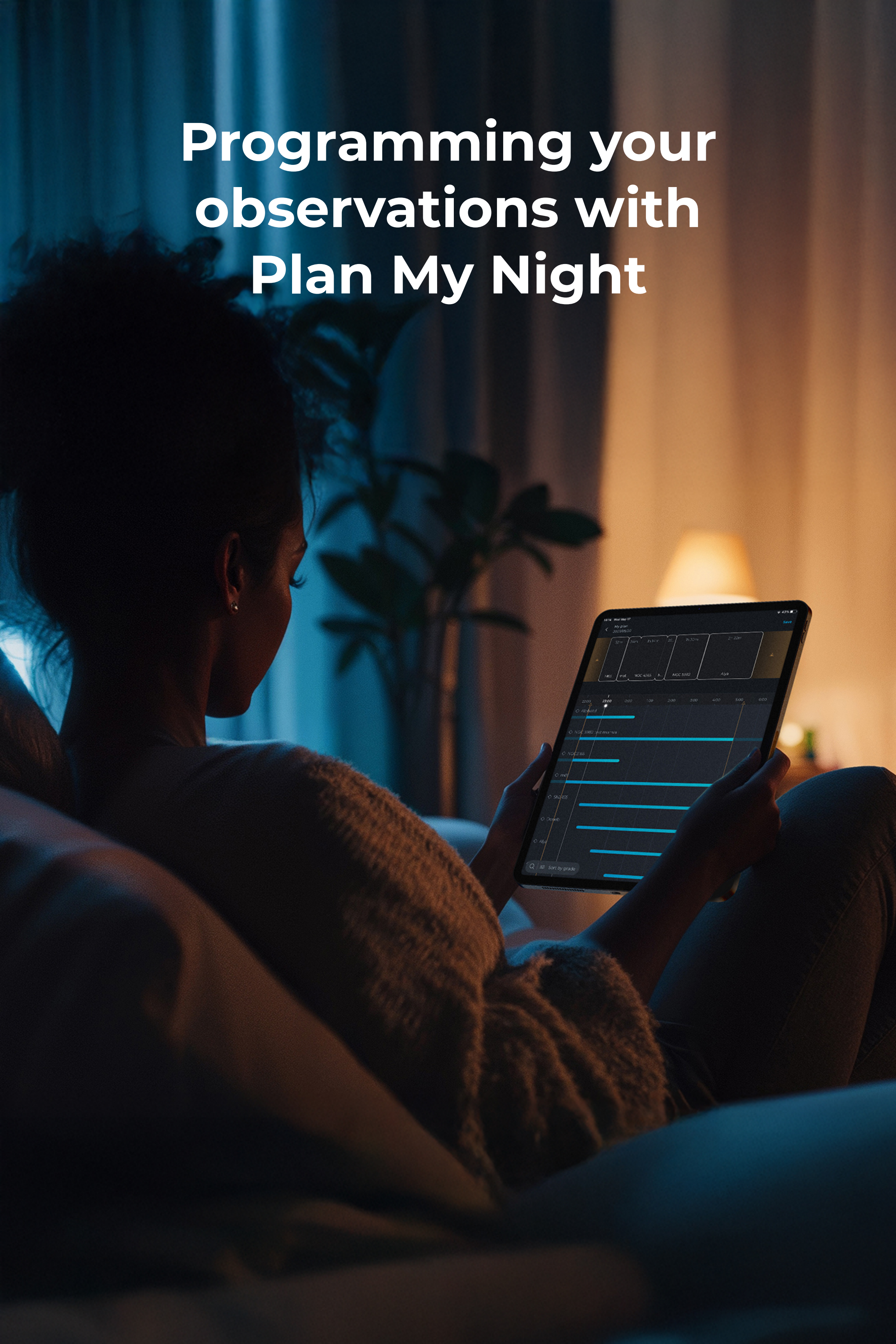
AUTOMATIC LOG FILE SAVING

Just like image saving, you can enable or disable the automatic saving of log files.

To do this:

- Open the Singularity app and go to the **Instrument** screen.
- Tap on **Image Formats.**
- Enable or disable the **Debug Files** option as needed.

Programming your observations with Plan My Night



Video tutorial

Visit the Vaonis YouTube channel to watch a step-by-step video tutorial on how to use Plan my Night.

What is Plan My Night, and why use it?

Plan My Night lets you schedule your smart telescope to automatically carry out a sequence of observations without requiring any supervision. Vespera becomes a fully robotic telescope.

Simply select the list of celestial objects you wish to capture, set the date of the session, and define the timeframe for each target. Vespera will automatically begin observing at the right moment, switch from one target to the next according to your schedule, save the results, and automatically close the optical arm once the observation sequence is complete.

This is especially useful for long-duration captures without staying up all night, or for imaging targets that only become visible later in the night—without having to wake up in the middle of it.

BENEFITS OF PLAN MY NIGHT

- Fully automated execution of a pre-scheduled observation program.
- No limit to the number of targets you can include in a plan.
- Vespera automatically initializes at the start of the session and close itself when the plan is complete.
- Defines a specific time slot for each target—Vespera switches between them automatically based on your schedule.
- Observation results are automatically saved for later viewing and export.
- If a target fails to be captured for any reason, Vespera will still attempt to observe the remaining targets in the plan.

- Plan My Night supports both mosaic captures and Multi-Night observations. You can even combine regular targets, mosaics, and Multi-Night sessions within the same plan.
- You can schedule multiple plans for different dates.

The Plan My Night screen

The Singularity app includes a dedicated screen for managing your observation plans. From this screen, you can:

- View a list of your existing plans.
- Create a new plan or edit an existing one.
- Delete plans.
- Check the status of a running plan.
- Access the resulting image from the most recently completed plan.

To open this screen, from the Space Center tap the **Plan My Night** tab in the bottom toolbar.

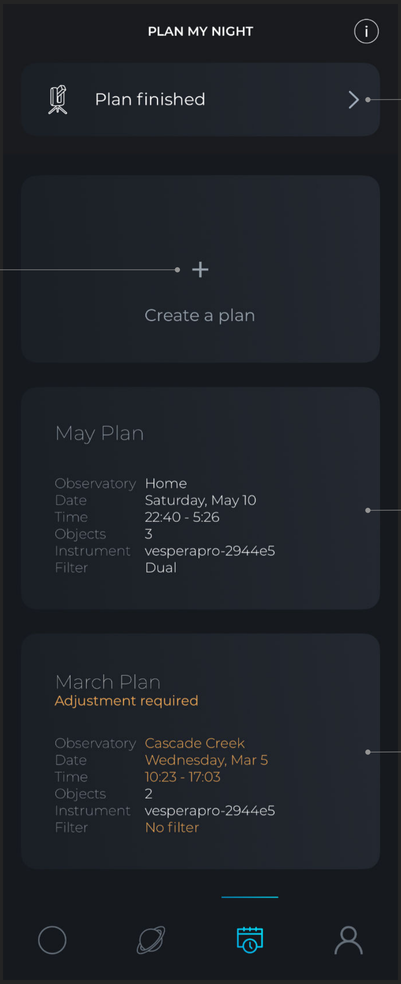
Setting up a new plan

REQUIREMENTS FOR CREATING A NEW PLAN

You can create a new observation plan at any time—there's no need for your smart telescope to be initialized.

However, if your plan is supposed to include a Multi-Night observation or a mosaic capture, you must be connected to your smart telescope during the plan creation process. If your plan only includes standard targets, you can create it without connecting to the telescope.

PLAN MY NIGHT SCREEN



Navigate to the results of the last completed plan or to the plan currently in progress

create a new plan

pending plan, tap to edit or delete

Outdated plan Requires updates before re-execution

CREATING A NEW PLAN

1. From the Plan My Night screen, tap **Create a plan**.
2. Select the observatory corresponding to the location where the plan will be executed. If the location hasn't been saved yet in Singularity, you can create a new observatory during this step.
3. Choose the date of the night when the plan should run. This refers to the start date of the night.
   For example, select April 30 for a plan running on the night of April 30 to May 1.

Important: If your observation is scheduled for the second half of the night, still enter the date that corresponds to the start of the night.
For instance, for a session that starts on May 1 at 2 a.m., you must choose April 30 as the date.

4. Enter a name for your plan.
5. If your plan includes mosaics or Multi-Night observations, enable **Advanced Observation.**
   Note: You must be connected to your telescope for this option to be available.
6. Validate your settings to proceed to the **schedule screen**.
7. The **schedule screen** is divided into two main sections:
   - **Target Browser (bottom section)**
     Use this section to search for and select celestial objects to add to your observation plan.
   - **Plan Timeline (top section)**
     This section displays the list of targets you've added to your plan. You can adjust each target's observation timeframe and configure additional options.
8. From the target browser, tap on a celestial object to add it to the plan timeline.
   To learn more about how to use the target browser effectively, refer to the dedicated chapter later in this guide.
9. Drag the observation **start** and **end handles** to define the specific timeframe you want for that target's observation.

For more information on how to use the plan timeline, see the relevant chapter later in the guide.

10. If you wish to capture a mosaic or create a new Multi-Night observation from this target, tap the **pencil icon** located in the lower left corner of the plan timeline to access advanced observation settings.
    For more details on configuring mosaics and Multi-Night observations within Plan My Night, refer to the dedicated chapters further on.

11. Once you're satisfied with the settings for this target, confirm your choices by tapping the **checkmark icon** in the lower right corner of the plan timeline.

12. Add any additional targets to your plan by repeating the process from step 8.

13. When you’ve finished building your observation plan, tap **Save** in the upper-right corner of the screen.
    Singularity will confirm that your plan has been successfully created. You can edit or delete it using the options at the top of the screen.

14. Once your plan is ready, you’ll need to send it to Vespera to be executed.
    Refer to the chapter Executing a plan to learn more.

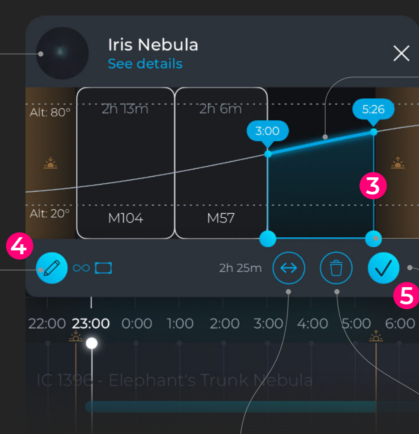
PLAN MY NIGHT SCHEDULING SCREEN

- sunset
- timeline
- target name (tap to add to the plan)
- target visibility window (filtered criteria applied)
- search for a specific target
- filter target list
- save the plan and return to the main Plan my Night screen
- sunrise
- target observation slot, tap to edit (see below)

QUICK HOW TO

1. Search for a target or filter target list.
2. Tap a target to add it to the plan.
3. Set observation timeframe.
4. Set observation parameters.
5. Validate to add the target to the plan.
6. Save the plan after adding all the targets.

EDITING TARGET TIMEFRAME AND OBSERVATION PARAMETERS



- target
- set observation parameters (mosaic mode, Multi-Night...)
- target altitude curve
- drag handles to set the observation timeframe
- validate to complete editing.
- Set the time range to the maximum duration
- delete target slot

The target browser (schedule screen)

This section of the **schedule screen** is where you choose the targets to include in your observation plan.

Since there are thousands of celestial objects to choose from, the **target browser** provides a range of tools to help you **search**, **filter**, and **sort** objects based on various criteria.

VISIBILITY PERIOD AND ALTITUDE ABOVE HORIZON

For each object listed, a blue bar indicates the period during the night when the object is visible. This visibility window can be refined using object elevation constraints—that is, how high the object is above the horizon.

To refine visibility based on object elevation:

- Tap the **filter icon** in the bottom-left corner of the Target Browser.
- Scroll to the sections labeled **Minimum Elevation** and **Maximum Elevation**.
- Enter the desired elevation values to limit the observation timeframe accordingly.
- To further filter objects based on their **minimum visible duration**, fill in the **Minimum Visibility** field.
- When you're done, tap the **back arrow** in the top-left corner to return to the Schedule screen and apply your changes.

Example:
You are building a plan for capturing high-quality astrophotography images. To optimize your results, you want to observe only when targets are above 20° (for better seeing conditions) but below 75° (to avoid tracking issues). Since you're aiming for long acquisition times, you also want to filter the list to only show targets with a visibility period of at least 4 hours, considering your altitude constraints.

HOW IS THE TARGET LIST ORGANIZED?

By default, the Target Browser displays all the observable objects of the Singularity catalog, as well as any manual targets you've created and any Multi-Night projects you've already started.

When the sort order is set to **Sort by Grade**, manual targets and Multi-Night projects will always appear at the top of the list.

MANUAL TARGETS

Manual targets are marked with a **crosshair icon** to help you easily identify them in the list.
You can choose to hide these targets or display only manual targets if preferred (see filtering options below).

MULTI-NIGHT PROJECTS

Multi-Night observations are marked with an **infinity icon**.
If the Multi-Night project was created from a manual target, **both icons** will appear in front of the name.

SEARCHING FOR A TARGET

To search for a specific target by name:

- Tap the **magnifying glass icon** in the bottom-left toolbar of the Target Browser.
- Start typing part of the object's name.
- Matching results will be displayed at the top of the list.

FILTERING THE TARGET LIST

You can filter objects by source **type** (catalog targets, manual targets, favorites) or by object **category** (e.g., nebulae, galaxies, etc.).

- Tap the **filter icon** in the bottom-left toolbar.
- Select the types and categories you wish to display.
- Tap the **back arrow** in the top-left to apply your selections.

SORTING BY VISIBILITY DURATION

To bring targets with the longest visibility durations to the top of the list:

- Tap **Sort by Grade** in the bottom-left toolbar of the Target Browser to switch to duration-based sorting.
- Alternatively, you can open the **filter menu**, scroll to the bottom, and select the appropriate sorting criteria.

The plan timeline (schedule screen)

This section of the **schedule screen** is where you set the observation start and end time of each target of your plan.

AVAILABLE TIMEFRAME

The maximum timeframe in which observations can be scheduled extends from sunset to sunrise. These values are automatically calculated by Singularity based on the selected date and observatory.
It's not possible to schedule any target outside of this time range.

Note: While you can technically schedule the first target as early as sunset, Vespera cannot initialize until the sky is dark enough.
It's recommended to schedule the first target 30 to 60 minutes after sunset. For more details on when it's truly dark enough to start using Vespera, see the chapter Sky Darkness.

TARGET ELEVATION CURVE

When you add a target to your plan in the timeline, a curve appears over the selected observation timeframe, showing how the object's elevation changes throughout the night. This helps assess target's visibility and observation conditions.

EDITING A PLAN TIMELINE

To modify the observation start and end time of a target:
Tap the target's block in the timeline, adjust the start and end time handles, then confirm your changes.

To remove a target from the plan:
Tap target's block in the plan timeline, then tap the delete button (trash can icon).

Setting up a mosaic capture in Plan my Night

Once you've added a target to your plan, you can enable advanced observation options to configure a mosaic capture.

Important: You must be connected to your smart telescope when creating the plan in order to access this feature.

- Add the desired target to your plan and set its start and end observation time.
- Tap the pencil icon located in the lower-left corner of the plan timeline.
- Just like with a standard observation, select Mosaic at the top of the screen, then define your framing. (Refer to the Mosaic Capture section for detailed instructions.)
- Once your mosaic settings are configured, confirm them.
- Tap the checkmark icon in the bottom-right corner of the timeline to validate and save the target in your plan.

Adding a Multi-Night observation to a plan

There are two ways to add a Multi-Night observation to a Plan My Night schedule. It's important to distinguish between them, as they lead to different results.

Important: You must be connected to your smart telescope when creating the plan in order to access this feature.

1 – ADD AN ONGOING MULTI-NIGHT PROJECT

This option allows you to schedule **additional sessions for an ongoing Multi-Night observation**—one that has already been started and includes at least one prior observation session.

Since the project already exists, it appears in the **target browser**, marked with the infinity icon (∞).

Make sure your telescope's filter settings allow for the project to be displayed (see the relevant section for filter configuration).

To add an existing Multi-Night project to your plan:

- Tap the Multi-Night project name in the target browser.
- In the plan timeline, set the desired start and end times for the observation.
- Since the capture settings were already configured when the Multi-Night observation was created, no further setup is required. Simply confirm the addition of the observation to the plan.

Tip:

You can schedule multiple observation slots for the same Multi-Night project within a single plan. This is especially useful if the target encounters poor visibility conditions during the night—for example, if it drops below 20° or rise above 80° in elevation. Splitting the observation into separate time windows can help maintain optimal data quality.

2 – SCHEDULE THE START OF A NEW MULTI-NIGHT PROJECT

This involves scheduling the first observation that will define and initiate a new Multi-Night project (as opposed to continuing an existing one).

Note: You can have a **maximum of five** active Multi-Night projects. If this limit has been reached, you'll need to delete an existing project before creating a new one from a Plan my Night.

To start a new Multi-Night project from Plan my Night:

- If you plan to use a specific filter for this Multi-Night project, install it on your telescope now.

- From the **target browser**, select the celestial object you want to use as the starting point for the Multi-Night observation.
- In the **plan timeline**, set the start and end times for the observation.
- Tap the **pencil icon** to open advanced options.
- If desired, configure mosaic settings.
- At the bottom of the screen, activate **Multi-Night Mode**.
- Tap **Confirm**.
- Finalize the addition by tapping the **checkmark icon** at the bottom right of the timeline.

Note:

The Multi-Night project will be created and visible in the Multi-Night screen only after the first observation has been completed. However, the moment you add a new Multi-Night project to a plan, a slot is reserved for it.

Because of this, you may receive a notification that the maximum number of Multi-Night projects has been reached—even if fewer than five appear in the Multi-Night screen. This is normal, as some slots may already be reserved by scheduled (but not yet executed) plans.

Filter Configuration When Creating a Plan

When you create a new Multi-Night project—whether through the standard method or from within Plan My Night—the telescope filter configuration is saved as part of that Multi-Night project's parameters. The same filter configuration is required when resuming the Multi-Night observation.

The Plan My Night target browser only displays Multi-Night projects that are compatible with the current filter configuration of your telescope .

If you don't see one of your Multi-Night projects in the target browser, you need to either add or remove a filter to match the one used when the Multi-Night project was originally created.

Executing a Plan

To begin executing a plan, ensure that your telescope is powered on and the tripod is leveled. However, there's no need to perform the telescope initialization, as this will be done automatically when the plan starts.

TO EXECUTE A PLAN:

- Before the scheduled start time of the first observation, connect to your smart telescope.
- Go to the Plan My Night screen and select the plan you wish to execute.
- Tap Start Plan.
- If you've previously executed a plan, its results will be overwritten. Make sure to save the images from your last Plan My Night session.
- Leave your telescope powered on. At the scheduled time, the observations will begin automatically.

Monitoring Plan Progress

Once a plan is running, you don't need to remain connected to your smart telescope or keep the Singularity app open.

While supervision is not required, you can still monitor the plan's progress and view the observations in real-time. Here's how:

- Connect to your smart telescope using the Singularity app.
- Navigate to the Multi-Night screen.
- At the top of the screen, a widget will show the plan currently in progress.
- Tap the widget to view details of the ongoing operations. Select a thumbnail of a completed observation or the current one to see the results.
- You can also tap the **Observation widget** at the bottom of the Singularity welcome screen to view the image being captured at that moment.

End of a Plan My Night Session

Once all targets have been observed, the session ends and **the telescope arm automatically closes**. However, the telescope remains powered on.

If, for any reason, the observation of a target fails, the telescope will continue attempting to capture it throughout the allocated time window before moving on to the next target—or ending the session if it was the final object in the plan.

Saving and collecting the results of Plan My Night sessions.

Whether or not you've enabled automatic image saving from the Instrument screen, the results of the last executed Plan My Night session are always saved temporarily. Once a plan has been completed, you can perform the following actions for each observation:

- Export the resulting image in TIFF format.
- Save the resulting image to the Singularity Cloud Library (JPEG format).
- Save the resulting image to your smartphone's photo roll (JPEG format).
- Share the resulting image using your smartphone’s native sharing options.

If you wish to access the individual FITS frames for manual stacking, you must enable automatic saving for this file type in advance. Plan My Night does not save FITS frames by default.

Important:
When you execute a new Plan My Night session, the results from the previous plan are deleted **unless you’ve activated auto image saving** in the instrument screen. Be sure to back up your observations before launching a new plan.

TO EXPORT OR SAVE THE RESULTS OF YOUR PLAN MY NIGHT OBSERVATIONS:

- Go to the **Plan My Night** screen.
- At the top, tap **Plan finished** to access the results of the last session.
- Tap the thumbnail of the observation you wish to export or save—the image will open.
- Tap the **(+)** menu at the bottom left of the screen.
- Choose the desired action from the available options.

Editing / deleting a saved plan

You can modify the settings of a plan at any time, as long as it is not currently running.

Even a previously executed plan can be edited—for example, to change its date if you wish to run it again at a later time.

EDITING A PLAN

- From the **Plan My Night** screen, select the plan you want to edit.
- Tap the **pencil icon** at the top of the screen.
- Confirm or update the observatory, then proceed.
- Confirm or update the plan name, then proceed.
- Edit the plan's timeline as needed (see instructions above).
- Tap **Save** to confirm and apply your changes.

DELETING A PLAN

Warning: Deleting a plan is permanent and cannot be undone.

- From the **Plan My Night** screen, select the plan you want to delete.
- Tap the **trash can icon** at the top of the screen, then confirm the deletion.

Understanding the night sky

© Insung Yoon | Unsplash

Navigating the Night Sky

Even with the help of a smart telescope that automates many tasks, understanding the sky empowers you to choose the right targets at the right time, anticipate upcoming events, and make the most of your observing sessions.

The sky is not a static backdrop—it changes with the time of night, the seasons, and your location on Earth. Some celestial objects are only visible during specific months or from certain parts of the world. Others, like the Moon and planets, move across the sky from night to night.

Learning how to orient yourself using cardinal directions, recognize major constellations, and understand celestial coordinates gives you a solid foundation for exploring the universe. It turns stargazing from a passive activity into an intentional, informed experience.

CONSTELLATIONS AND STAR MAP

The night sky is divide into constellations: groups of stars that appear to form a recognizable pattern in the night sky. These patterns often represent mythological figures, animals, objects, or other cultural symbols. Their name date back to ancient civilizations, especially Greek, Roman, and Arab cultures.

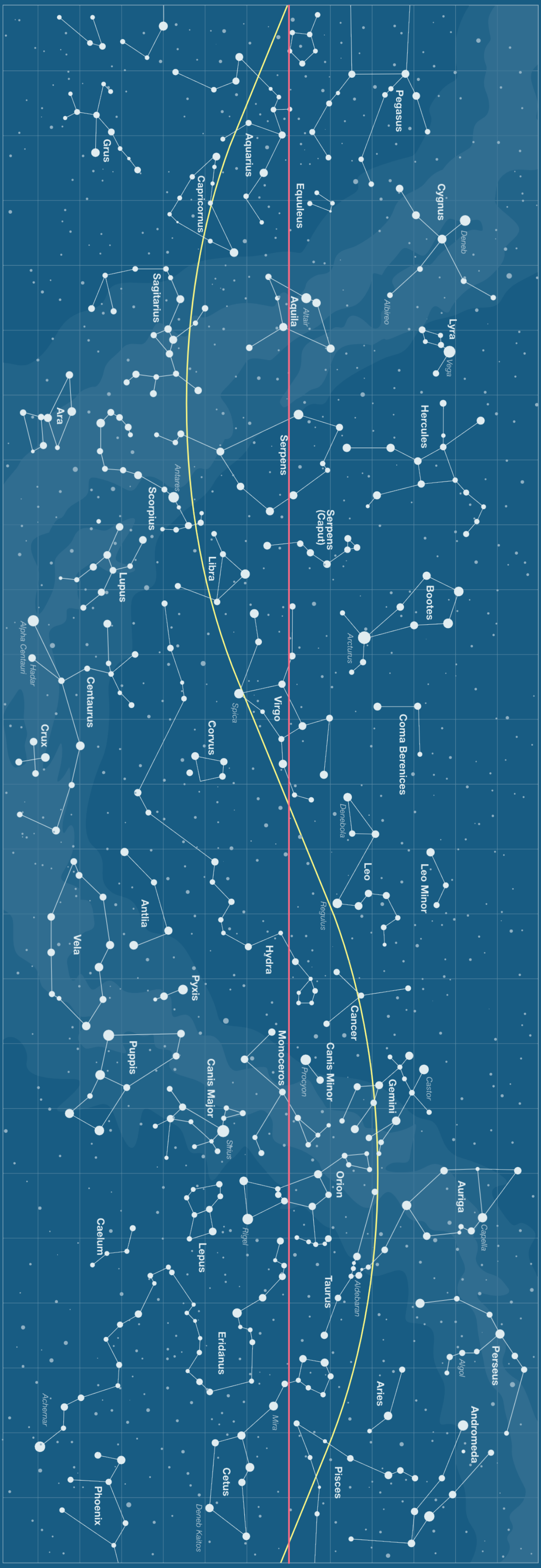
Constellations are an easy way to broadly locate an object in the night sky and determine if it is observable.

Constellations are named using Latin names and have specific designations, often with abbreviated forms.

There are officially 88 constellations, each of which has a specific boundary as defined by the International Astronomical Union (IAU). These constellations cover the entire celestial sphere.

Among the most popular constellations, we find: Ursa Major, Orion, Sagittarius, Cygnus, Cassiopeia, Centaurus...

For a complete list of constellations and their maps, refer to the IAU website.



EQUATORIAL STAR MAP

Celestial equator

Ecliptic

The equatorial map shows the constellations that the celestial equator crosses or passes near. These constellations are at least partially visible from both hemispheres—except for locations very far to the north or south—depending on the time of year, making them familiar to stargazers around the world.

Polar star maps (next page) show the regions of the sky near the celestial poles—either the North Celestial Pole (near Polaris, in the Northern Hemisphere) or the South Celestial Pole (which lacks a bright pole star). Unless you live near the Earth's equator, where the entire night sky is visible over the course of a year, these constellations are only visible from either the Northern or Southern Hemisphere.

The Milky Way—the galaxy that contains our Solar System—is visible as a glowing, cloud-like band in the night sky when viewed from a location with sufficiently dark skies. On the map, it is represented by the lighter blue areas.

N

Northern
hemisphere

POLAR STAR MAP

S

Southern
hemisphere

In the Singularity app catalog, you can explore the list of observable objects by constellation. Refer to the section Choosing a target from the Singularity app catalog for more details.

Constellations should not be confused with asterisms. Asterisms are informal, smaller patterns of stars that are easier to recognize, whereas constellations are official groupings of stars with defined boundaries.

Despite being part of the same region of the sky, the stars of a constellation have no physical connection and can be located at very different distances from Earth.

OTHER LANDMARKS IN THE NIGHT SKY

To better navigate the night sky and enhance your overall stargazing experience, it also helps to be familiar with the following reference points.

CARDINAL POINTS

Cardinal points are the four main directions: **North, South, East, and West**. Just like we use them on maps and compasses, they also apply to the sky.

When looking at the night sky, these directions help you understand where stars, planets, and the Moon will appear or disappear. For example, most celestial objects rise in the east and set in the west, just like the Sun.

ZENITH

The zenith is the point in the sky directly above your head—the highest point in the sky from where you're standing.

Objects near the zenith offer the best viewing conditions, as you're looking through less of Earth’s atmosphere. On the other hand, tracking an object near the zenith is challenging with an alt-az mount like the one used on Vespera.

We recommend limiting your observations to objects below 75° in elevation, which still provide excellent viewing conditions.

CELESTIAL POLES (NORTH & SOUTH)

The celestial poles are two imaginary points in the sky where Earth's axis, if extended into space, would intersect the sky (refer to the polar star map).

- The **North Celestial Pole** is almost exactly where Polaris, the North Star, is located. It's above the horizon if you're in the Northern Hemisphere.
- The **South Celestial Pole** has no bright star marking it. It lies in the constellation Octans in the Southern Hemisphere.

Stars appear to rotate in circles around these poles due to Earth’s rotation. That’s why, in long-exposure photos, stars appear to form circular trails centered on the celestial pole.

CELESTIAL EQUATOR

The celestial equator is an imaginary line in the sky that is directly above Earth’s equator (refer to the equatorial star map).

- Think of it as a projection of Earth’s equator into space.
- It divides the sky into a northern half and a southern half.

If you're standing on Earth’s equator, the celestial equator goes straight overhead. The farther north or south you go, the lower it appears in the sky.

Among the major constellations that the celestial equator crosses, we find Aries, Taurus, Orion (with the celestial equator passing very close to Orion’s Belt and the Horsehead Nebula), Leo, Virgo, Aquarius, and others.

ECLIPTIC

The ecliptic is the path the Sun appears to trace across the sky over the course of a year (refer to the equatorial star map). This path is defined by the plane of Earth's orbit around the Sun.

- This path is also followed closely by the Moon and the planets, which is why we often see them along the same line in the sky.
- The ecliptic is tilted relative to the celestial equator because Earth’s axis is tilted.

Understanding the ecliptic is important for finding planets and predicting eclipses—they always happen close to this path!

The ecliptic also defines the zodiac, and the constellations it crosses are called the zodiac constellations. There are 13 zodiac constellations in total: the 12 traditionally known ones (Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius, Capricornus, Aquarius, Pisces), plus Ophiuchus.

The changing aspect of the sky

The night sky isn’t a static picture, it changes constantly. You may notice that the stars, planets, and even constellations appear to move across the sky during the night, and that the sky looks different from one season to another or from one place on Earth to another. These changes are completely natural and are due to the way Earth moves through space.

THE APPEARANCE OF THE SKY IS DETERMINED BY EARTH'S MOTION

There are two main movements of Earth that affect what part of the sky we can observe:

DAILY ROTATION (EARTH SPINS ON ITS AXIS)

Earth rotates counterclockwise once every 24 hours (when viewed from above the North Pole). This rotation causes the stars to appear to move across the sky in the opposite direction, from east to west, just like the Sun. In reality, it’s not the sky that’s moving; it’s Earth that’s spinning.

This is why a telescope must track celestial objects during observation to keep the target perfectly centered in the field of view.

The celestial pole (north or south, depending on your hemisphere) is the center of the sky’s apparent rotation. Constellations located close enough to this pole, depending on your observing latitude, appear to circle around it without ever dipping below the horizon. As a result, they remain visible all night long. This is the case, for example, with the Big Dipper (Ursa Major) for observers at mid-northern latitudes.

Such constellations are known as circumpolar.

YEARLY ORBIT AROUND THE SUN

As Earth orbits the Sun, the night side of our planet faces different directions in space over the course of the year. This gradually changes which constellations and deep sky objects are visible at night.

Some objects are only visible during certain seasons. For example, the famous Orion constellation is best seen in winter in the Northern Hemisphere, while the Milky Way's center is best viewed in summer.

APPEARANCE DEPENDING ON YOUR LOCATION ON EARTH

Where you are on Earth also has an impact on which part of the sky you can see. It mainly depends on your latitude (How far north or south you are).

- Observers in the Northern Hemisphere see a different portion of the sky than those in the Southern Hemisphere.
- Observers near the equator have the unique opportunity to view all constellations from both the Northern and Southern Hemispheres throughout the year.
- In mid-latitudes (like Europe, the US, or Australia), you can see a good mix of northern and southern sky, but some constellations never rise above the horizon.
- At the pole you'd only ever see half of the celestial sphere — the same half all year round.
- Constellations close to the celestial equator make excellent targets for observers at any location, as they can be seen from both the northern and southern halves of the Earth. Orion is one of the most famous examples: visible from nearly everywhere and centered right on the celestial equator.

Naming astronomical objects

The observable universe contains hundreds of thousands of celestial objects that have been cataloged throughout history. Early astronomical catalogs were limited by the observational tools of their time and included only a small number of objects. However, some of these historical catalogs are still in use today. More recent catalogs have incorporated objects from older ones, assigning them new designations. As a result, the same celestial object may appear in multiple catalogs under different designations.

In the Singularity app, the object information screen displays both the official designation and, when applicable, the commonly used name.

Here are some of the most widely used astronomical catalogs for deep sky objects.

OFFICIAL CATALOGS

MESSIER CATALOG (M)

This is the most popular catalog among amateur astronomers, as it lists relatively bright nebulae, galaxies, and star clusters that are easier to observe. It was compiled by astronomer Charles Messier in 1774 and includes 110 objects visible from the Northern Hemisphere. Each object is designated with the letter "M" followed by a number from 1 to 110 (e.g., M31 for the Andromeda Galaxy).

CALDWELL CATALOG (C)

This catalog, also aimed at amateur astronomers, lists bright nebulae, galaxies, and star clusters that are not included in the Messier catalog, particularly those visible from the Southern Hemisphere. It was first compiled in 1995 by Patrick Moore Caldwell and now contains 109 objects. Each object is designated with the letter "C" followed by a number from 1 to 109.

NEW GENERAL CATALOG (NGC)

After the Messier catalog, this is the most well-known among amateur astronomers. It contains 7,840 deep-sky objects cataloged by John Dreyer up until 1888. As a result, most deep-sky objects accessible to amateur astronomers are included in this catalog. However, some of these objects can be very challenging to observe or even unobservable with Vespera, so checking their magnitude is essential. Objects in this catalog are designated with the letters "NGC" followed by a number.

INDEX CATALOG (IC)

This is another deep-sky object catalog compiled by John Dreyer, listing objects not included in the NGC catalog. Objects in this catalog are designated with the letters "IC" followed by a number.

LYNDS' CATALOG OF DARK NEBULAE (LDN)

Originally compiled in 1962, this catalog lists about 1,800 dark nebulae. Objects in this catalog are designated with the letters "LDN" followed by a number.

BARNARD CATALOG

This is another catalog that lists dark nebulae. It contains 349 objects, one of the most famous being the Horsehead Nebula: Barnard 33 (with the emission nebula in the background being another referenced object: IC 434).

SHARPLESS CATALOG (SH2)

Originally compiled in 1953, this catalog lists 313 HII regions, which are emission nebulae. Objects in this catalog are designated with "Sh2" followed by a number.

VAN DEN BERGH CATALOG (VDB)

Originally compiled in 1966, this catalog lists 158 reflection nebulae. Objects in this catalog are designated with "vdB" followed by a number.

DEEP SKY OBJECTS (DSO) USAGE NAME

In addition to their official catalog names, many deep-sky objects are commonly known by other usage names, often derived from their appearance, the constellation they reside in, or historical observations. These names can be informal or even derived from mythological or cultural references. While not official, they are sometimes more widely used than the official catalog designations, notably because they can be easier to remember.

Some objects may even have multiple common names, such as the cluster M44, which is known as the Beehive Cluster, the Manger Cluster, or even Praesepe.

NAMING CONVENTIONS FOR STARS

The brightest stars can have common names often based on mythology, historical context, or their position in the sky. However, like deep sky objects, any star has an official designation. Among the many possible ways to designate a star, the Bayer designation is the most commonly used among amateur astronomers (in addition to the usage name if any)

BAYER DESIGNATION

This is one of the oldest systems for naming stars. The system uses a Greek letter (α, β, γ, etc.) followed by the Latin name of the constellation in which the star is located. The Greek letter represents the star's brightness within that constellation, with α being the brightest star, β the second brightest, and so on.

Example: α Centauri (Alpha Centauri) — The brightest star in the Centaurus constellation (and also one of the closest stars to the Sun).

THE IAU (INTERNATIONAL ASTRONOMICAL UNION) NAMING SYSTEM

The IAU is the official organization responsible for naming celestial objects, including stars. While stars that are part of well-known constellations often retain their historical names, the IAU is the body that assigns official names to stars in new discoveries or in cases where stars do not have traditional names. The IAU's goal is to standardize naming conventions to avoid confusion.

For instance, α Centauri (Alpha Centauri) is actually a triple star system comprised of Alpha Centauri A and Alpha Centauri B, the two brightest stars, and Alpha Centauri C a.k.a. Proxima Centauri, the closest star to our solar system.

Astronomical coordinates

The **equatorial astronomical coordinate system** is a way to precisely locate objects in the sky, just as we use latitude and longitude to find places on Earth.

Imagine the sky as a giant sphere surrounding the Earth. To navigate this celestial sphere, astronomers use two main coordinates:

- **Right Ascension (RA)** – This is like longitude on Earth. It measures how far an object is located eastward along the celestial equator. Instead of degrees, RA is measured in hours, minutes, and seconds, because the sky appears to rotate over time due to Earth's rotation. One full circle around the sky is **24 hours** of RA. The origin point from which right ascension is measured is called the vernal point. It represents the position of the sun at the March equinox. It also coincides with the crossing of the celestial equator by the ecliptic.
- **Declination (Dec)** – This is like latitude on Earth. It measures how far an object is located north or south of the celestial equator, in degrees. A declination of **0°** is at the celestial equator, **+90°** is at the north celestial pole (near Polaris), and **-90°** is at the south celestial pole.

WHY IS THIS SYSTEM USEFUL?

Unlike coordinates based on a viewer's location, which change as the Earth rotates, the equatorial coordinate system is **fixed relative to the stars**. This means that if you know an object's RA and Dec, you can always find it in the sky, no matter where you are on Earth or what time it is—just like knowing a city's latitude and longitude lets you find it on a globe.

ASTRONOMICAL COORDINATES IN THE SINGULARITY APP

- In the Singularity app, you can find the astronomical coordinates of an object at the bottom of its information page, under the **Observation Data** section.
- When creating a **manual target**, you can manually enter astronomical coordinates, allowing you to observe any region of the sky—even if it doesn’t contain an object from the Singularity catalog.
- If you need to determine the coordinates of a specific point in the night sky, you can use a **star chart application** to assist you.

Measuring time in astronomy

Astronomical observations rely on highly precise timing to measure phenomena such as the positions of stars, planets, and moons, as well as to predict events like eclipses.

Time in astronomy is primarily measured using **Universal Time (UT).**

Universal Time is a time standard that does not change regardless of geographic location. It is based on the Earth's rotation relative to the stars, and it is often referred to as **Greenwich Mean Time (GMT)** in a historical context.

The use of Universal Time ensures that all measurements are standardized and comparable, regardless of location or local adjustments to time.

When an astronomical event is given in UT (Universal Time), this is explicitly stated, and the time is typically followed or preceded by the UT designation.

WHY NOT USE LOCAL TIME?

While local time can be convenient for everyday activities, it is impractical for global astronomical coordination for several reasons:

- **Time Zone Differences**: Earth is divided into many time zones, and each region adjusts its local time based on its longitude. This means that the same event may be happening at different local times in different parts of the world, making it difficult to coordinate observations. Universal Time eliminates this confusion by providing a uniform reference.
- **Daylight Saving Time (DST)**: Local time can be influenced by seasonal changes like daylight saving time, where clocks are moved forward or backward. This can create inconsistencies when tracking astronomical events, especially those that span multiple days or times of year. Universal Time, on the other hand, remains unaffected by DST.

TIME IN SINGULARITY

For convenience, the times displayed in Singularity for sunrise, sunset, moonrise, and moonset are shown in **local time** based on the observatory location you've set.

When scheduling observations with **Plan My Night**, you should also use your local time as reference.

TIME CONVERSION

To convert Universal Time (UT) to local time or local time to UT, you need to account for the time zone of the location in question. Here's how to do it:

CONVERTING UT TO LOCAL TIME

To convert UT to local time, you need to know the local time zone offset from UT. The offset is typically represented as UTC ± X hours, where X is the number of hours ahead or behind the time zone is from Universal Time (UT).

Steps:

- Determine the time zone offset for the specific location.
    - For example, UTC +2 hours means the local time is 2 hours ahead of UT, and UTC -3 hours means the local time is 3 hours behind UT.
- Add or subtract the offset from the UT to find the local time.

Example:

If it is **15:00 UT** and you want to convert it to **Paris time** (which is UTC +2 hours during daylight saving time):

- Add the offset: 15:00 UT + 2 hours = **17:00 local time in Paris**.

CONVERTING LOCAL TIME TO UT

To convert local time to UT, you need to subtract (positive offset) or add (negative offset) the local time zone offset value from the local time.

Steps:

- Determine the time zone offset for the location.
    - For example, UTC +3 hours means you subtract 3 hours from the local time to get UT, and UTC -1 hour means you add 1 hour to the local time to get UT.
- Subtract / add the offset from the local time to get the time in Universal Time.

Example:

If it is **12:00 local time in New York** (which is UTC minus 4 hours during daylight saving time), and you want to convert it to **UT**:

- Add the offset (since it is negative): 12:00 local time + 4 hours = **16:00 UT**.

Important Notes:

- Be aware of **Daylight Saving Time (DST)**, which affects local time in many countries. In some regions, the local time changes by 1 hour during the summer months. For example, **Paris** might be **UTC +1** during the winter months but **UTC +2** during daylight saving time. Always check if DST is in effect when making conversions.
- To account for **time zones** properly, you can use **online converters** or apps that automatically adjust for DST and the specific time zone of any location.

Observation and photography guide

The Veil Nebula in the constellation Cygnus.

Captured with Vespera II during 4.5 hours of integration time.
(dual band filter)

Recommended acquisition time.

The light from celestial objects is incredibly faint. Capturing it with a smart telescope requires performing multiple long exposures and combining them through a process called stacking. The quality of the resulting image depends on the number of stacked frames, which is tied to the total acquisition time.

When selecting a target in the Singularity app, a suggested acquisition time provides a baseline for achieving decent results. However, extending the acquisition time beyond this recommendation is often essential for producing high-quality astrophotography. In some cases, accumulating data over several nights is necessary.

UNDERSTANDING NOISE REDUCTION AND SIGNAL TO NOISE RATIO.

Your smart telescope's sensor captures light from celestial objects, known as the signal. However, it also generates noise, an undesirable byproduct caused by several factors such as light pollution and the functioning of the sensor electronic itself.

Since the signal from deep-space objects is so faint, it can easily be overwhelmed by noise, leading to poor image quality.

Fortunately, the noise is randomly distributed across each individual frame, while the signal remains consistent. This is where stacking comes into play: it progressively cancels out the noise while preserving the signal.

The quality of the final image can be expressed as a signal-to-noise ratio (SNR), which measures the clarity of the captured data. This is the primary concern in astrophotography.

- High SNR: The signal dominates the noise, resulting in sharp, clear, and detailed images.
- Low SNR: The noise competes with the signal, blurring details and reducing image quality.

The more images you stack, the less noise will affect your final image.

Less noisy images are easier to post-process, reveal more details and offer a cleaner result.

The rule of noise reduction.

The reduction in noise achieved through stacking increases with the square root of the number of subframes:

- Stacking 2 frames reduces noise by approximately 1.4 (the square root of 2).
- Stacking 4 frames reduces noise by a factor of 2.
- Stacking 9 frames reduces noise by 3, 16 frames by 4, 25 frames by 5, and so on.

THE ACQUISITION TIME RULE OF THUMB.

Achieving a significant improvement in SNR requires a substantial increase in acquisition time.

Smaller increments, such as increasing acquisition time by a factor of 1.5 (e.g., from 2 hours to 3 hours), yield limited benefits. For example, this would improve the SNR by only 1.22 times (the square root of 1.5), or 22%, which may not be visually noticeable in the final image.

As a general rule of thumb, doubling the acquisition time is necessary to achieve a meaningful step in quality improvement.

The acquisition time rule of thumb.

Want noticeably better than what you have?
Double the acquisition time!

STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6	STEP 7
15mn	30mn	1h	2h	4h	8h	16h

This leads to diminishing returns as acquisition time increases. While there's no hard limit, the effort required to improve image quality grows significantly. The total acquisition time required can escalate quickly, making it essential to weigh the potential gains against the effort involved.

The ideal acquisition time also depends on the type of object you're observing, your filter configuration (e.g., whether you're using a dual-band filter), and your capture mode (regular or mosaic). You’ll find baseline recommendations depending on the object type in the following sections.

Finally, remember that to fully leverage the benefits of extensive acquisition times, post-processing is essential.

By working with the raw TIFF files provided by the telescope, you can reveal the true potential of your data. In assisted observation mode, however, the difference may be barely noticeable.

Observing Galaxies

Galaxies are the largest structures in the universe and serve as its fundamental building blocks. They can span from just a few thousand light-years across in the case of dwarf galaxies up to a million light-years for the largest giants.

We ourselves are located inside a galaxy—its presence can be seen as a luminous band in the night sky, known as the Milky Way.

Curious to learn more about the galaxies you are observing? Ask your astro-companion **LumENS** to discover their size, age, and formation history, how they’re structured, what lies at their center, and how many stars they contain.

OBSERVATIONAL CHARACTERISTICS OF GALAXIES

Although galaxies are the largest structures in the universe, they are also incredibly distant. As a result, they often appear pretty small and faint through a telescope.

However, a handful of galaxies break this rule and stand out more clearly:

Andromeda Galaxy (M31)	A close neighbor of our own galaxy, it has a large apparent size in the sky. Visible to the naked eye and very easy to observe with Vespera. Requires Mosaic mode to capture it in full.
Triangulum Galaxy (m33)	It is also part of our local group of galaxies, which gives it a relatively large apparent diameter. Its spiral structure is clearly visible.
Small and Large Magellanic Clouds (SMC, LMC)	These are two dwarf satellite galaxies of our own, located very close to the Milky Way. They contain star clusters and nebulae that are easily observable. They are the only galaxies beyond the Milky Way where individual stars can be clearly seen.

M51 galaxy (Canis Venatici constellation) captured with Vespera Pro (post-processed image. integration time : 7h)

There are several types of galaxies: spiral, elliptical, and irregular. Spiral galaxies are particularly fascinating to observe, as their structure is clearly visible. Depending on their orientation, they may appear face-on or edge-on, and in some cases, you can even make out the dust lanes running through their arms.

WHERE TO OBSERVE GALAXIES?

Observers in the Northern Hemisphere have access to a wider variety of galaxies compared to those in the Southern Hemisphere. However, M31—arguably the most beloved galaxy among amateur astronomers—remains visible under good conditions as far south as approximately 25° latitude.

That said, the southern sky also offers remarkable targets, particularly the Magellanic Clouds.

Because galaxies are grouped into clusters and superclusters, they tend to be concentrated in specific regions of the sky. Notable galaxy-rich constellations include Ursa Major, Canes Venatici and Leo, as well as the Virgo and Coma Berenices clusters..

Very few galaxies are visible along the plane of the Milky Way. This is simply because they are obscured by the dense disk of gas and dust in our own galaxy.

WHEN TO OBSERVE GALAXIES?

Galaxies can be observed throughout the year. However, for observers in the Northern Hemisphere, spring is the prime season. This is when constellations like Leo, and galaxy-rich regions such as the Virgo and Coma Berenices clusters are best placed in the sky.

In the Southern Hemisphere, the Magellanic Clouds are most favorably observed from late in the year through the early months, while the Andromeda Galaxy (M31) becomes visible towards the end of the year, down to latitudes around -25°.

HOW TO OBSERVE GALAXIES

The light we see from distant galaxies comes primarily from the combined glow of the countless stars they contain, and to a lesser extent, from the light emitted or reflected by the gas clouds within them. As a result, a galaxy emits across the entire spectrum of visible light.

For this reason, **it's generally best not to use any filters when observing galaxies**, as doing so can significantly reduce the amount of light captured. Even **the CLS filter should only be used in cases of severe light pollution**. Under moderate light pollution, it’s preferable to observe galaxies without any filter at all.

That said, there may be some benefit to using a dual-band filter when imaging galaxies—specifically to highlight the nebulae found within their spiral arms. In such cases, it’s common to combine an image taken with the dual-band filter with one captured without any filter. This requires conducting two separate observation sessions of the same object and blending the results.

The Triangulum Galaxy (M33) is particularly well suited to this kind of experiment, as it contains numerous nebulae that are relatively easy to distinguish.

Because galaxies are typically among the faintest deep-sky objects, **capturing a high-quality astrophotography requires longer acquisition times**.

If you're observing under a high-quality sky (Bortle class 1 to 4), you may consider increasing the exposure time per frame to 15 seconds. To do this, you'll need to create a manual target.

Below are some basic guidelines for exposure duration, which can be shortened for the brightest galaxies (magnitude below 10).

Observation Goal	Acquisition Time
Object preview	30 min
Assisted observation	1 h
Basic photo	1 to 2 h
Astrophotography	4 h
High-quality astrophotography	8 h

SHORT LIST OF MUST-SEE GALAXIES WITH VESPERA

(N) / (S) = northern hemisphere / southern hemisphere.

Galaxies	constellation	best time
M81, M82, M101	Ursa Major	Spring (N)
M51	Canes Venatici	Spring (N)
Andromeda Galaxy (M31)	Andromeda	Late Summer to Fall (N), winter (S)
Triangulum Galaxy (m33)	Triangulum	October to January (N), Nov. (S)
Leo triplet	Leo	February to April (N & S)
Markarian's Chain	Virgo	March to May (N & S)
Needle Galaxy (NGC 4565)	Coma Berenices	March to May (N), May (S)
Large Magellanic Cloud	Dorado - Mensa	November to March (S)
Small Magellanic CLoud	Tucana - Hydrus	September to January (S)
Sculptor Galaxy	Sculptor	September to December (S)
Southern Pinwheel Galaxy (M83)	Hydra	April to July (S)
Centaurus A	Centaurus	April to July (S)

There are many more galaxies to observe with Vespera. Browse the Galaxies section of the Singularity objet catalog to discover them.

Observing Nebulae

Nebulae are vast, diffuse clouds of gas and dust that play a crucial role in the life cycle of stars. Spread throughout galaxies—particularly within the spiral arms—these cosmic structures serve both as stellar nurseries and as remnants of stellar death.

Nebulae can be categorized into several types based on their origin and how they interact with light:

- **Emission nebulae** emit their own light. They are primarily composed of ionized hydrogen (H II regions) and glow due to high-energy radiation from nearby young, hot stars.

- **Reflection nebulae** do not emit light themselves but instead reflect the light of surrounding stars, often appearing blue due to the scattering of shorter wavelengths.
- **Dark nebulae** are dense regions of cold molecular clouds and dust that obscure background stars and light, visible mainly by the contrast they create.
- **Planetary nebulae** are shells of ionized gas expelled by aging stars similar in mass to the Sun, marking the transition from red giant to white dwarf.
- **Supernova remnants** are the expanding debris fields left behind after the explosive death of a massive star.

Additionally, some cloud complexes can be a mix of several nebula types.

When observing nebulae, learn all about their type, formation, gas composition, and their place within the galaxy with the help of the **LumENS** astro companion. Just ask!

OBSERVATIONAL CHARACTERISTICS OF NEBULAE

Nebulae are arguably the most fascinating objects to observe with Vespera, thanks to their incredible variety of shapes, sizes, and colors. Their observational characteristics mainly depend on their type.

EMISSION NEBULAE

- **Color**: Typically red or pink due to strong H-alpha emissions from hydrogen; can show green or blue hues depending on the presence of oxygen or other elements.
- **Brightness**: Large range of brightness.
- **Size**: Ranges from compact regions (a few arcminutes) to sprawling complexes spanning several degrees (like the North America Nebula).
- **Shape**: Irregular and diffuse, often with complex, cloudy structures and bright cores.
- **Notable Examples**: North Amercia Nebula.

REFLECTION NEBULAE

- **Color**: Blue, due to scattering of shorter wavelengths.
- **Brightness**: Usually fainter than emission nebulae.
- **Size**: Often small to medium-sized (a few arcminutes to half a degree). A few specimens of bigger ones.
- **Shape**: Soft-edged and diffuse, with a wispy, ghost-like appearance.
- **Notable Examples**: The Pleiades Nebulae.

DARK NEBULAE

- **Color**: Appear as black or dark patches against a brighter background.
- **Brightness**: Not bright themselves; their visibility depends on background contrast.
- **Size**: Can range from small dark blotches (a few arcminutes) to large complexes (several degrees).
- **Shape**: Irregular, sometimes serpentine or filamentary; often appear to "cut" through star fields or bright nebulae.
- **Notable Examples**: Horsehead Nebula, Coalsack Nebula.

PLANETARY NEBULAE

- **Color**: Often greenish-blue due to strong emission lines from ionized oxygen (O III); some may show red from H-alpha..
- **Brightness**: Many are bright and compact, easy to observe.
- **Size**: Very small to medium (usually under 1 arcminute to a few arcminutes).
- **Shape**: Often round or elliptical with sharp edges; some show complex structures with rings or lobes.
- **Notable Examples**: Dumbbell Nebula (M27), Helix Nebula (NGC 7293).

SUPERNOVA REMNANTS

- **Color**: Multicolored—often with red (H-alpha), green-blue ([O III]), and other emission lines.

- **Brightness**: Typically faint; long acquisition time is necessary.
- **Size**: Often large (can span over a degree); some very faint despite their size.
- **Shape**: Filamentary, chaotic structures; sometimes spherical or looped shapes.
- **Notable Examples**: Veil Nebula.

The Carina nebula captured with Vespera II
(post-processed image. integration time 2h30)

WHERE TO OBSERVE NEBULAE?

Since most nebulae are located within the spiral arms of our galaxy, they generally appear along or near the band of the Milky Way in the sky.

The galactic core—found in the constellations Sagittarius and Scorpius—as well as the constellations Cygnus and Cassiopeia in the Northern Hemisphere, and Centaurus and Carina in the Southern Hemisphere, are particularly rich in spectacular nebulae.

The constellation Orion, visible from both hemispheres, is also home to some of the most iconic and widely observed nebulae.

Planetary nebulae, on the other hand, are more widely scattered across the sky.

WHEN TO OBSERVE NEBULAE?

In the Northern Hemisphere, spring is the least favorable season for observing nebulae, as most are not visible during this time. Outside of spring, however, nebulae can be observed throughout the rest of the year.

The core of the Milky Way, and the many nebulae it contains, is best viewed in summer.

The Southern Hemisphere offers a prime vantage point for observing the Milky Way. Nebulae are visible year-round, though conditions are less favorable toward the end of the year. The nebulae located in the constellations of Sagittarius and Scorpius are best observed from May to September.

HOW TO OBSERVE NEBULAE?

When observing a nebula, you should consider its type, size, and whether you're observing under light-polluted skies.

- **Emission nebulae and supernova remnants** benefit from being captured with the dual-band filter—which specifically targets their emission wavelengths—even under dark skies.

- In contrast, **reflection nebulae** should not be observed with the dual-band filter. However, when light pollution is significant (Bortle class > 5), it's recommended to use the CLS filter instead.
- **In urban areas, the dual-band filter** is highly effective at reducing light pollution for emission nebulae, and often delivers better results than the CLS filter—but only for this specific type of nebula.
- **For nebula complexes that combine multiple types**, it's generally best to observe without any filter, unless your goal is specifically to highlight the emission regions.
- Diffuse nebulae and supernova remnants often have a large apparent size. In such cases, **enabling mosaic mode** is recommended to capture the entire structure.
- Mosaic mode can also be used effectively to **frame groups of nearby nebulae**, such as the Lagoon and Trifid nebulae.
- If you're **observing under a high-quality sky** (Bortle class 1 to 4), you may consider increasing the exposure time per frame to 15 seconds. To do this, you'll need to create a manual target.
- **For nebulae with very bright, high-contrast cores**—such as the Orion Nebula (M42) or the Lagoon Nebula—it's best not to increase the exposure time per frame, as this could lead to overexposure of the core. In such cases, you may even consider reducing the sensor gain.

Below are some basic guidelines for exposure duration, which can be extended for fainter nebulae (magnitude above 10) and dark nebulae.

Observation Goal (no mosaic)	Acquisition Time
Object preview	15 min
Assisted observation	30 min
Basic photo	1 h
Astrophotography	3 h
High-quality astrophotography	6 h

When using Mosaic mode, the acquisition time required to complete a full cycle at maximum field of view is approximately 1.5 hours. For high-quality astrophotography, several mosaic cycles are required. Two or three cycles are recommended, bringing the total acquisition time to several hours.

SHORT LIST OF MUST-SEE NEBULAE WITH VESPERA

(N) / (S) = northern hemisphere / southern hemisphere.

Nebulae	type	constellation	best time
M42	emis. & reflec.	Orion	winter (N), summer (S)
HorseHead	dark & emiss.	Orion	winter (N), summer (S)
Rosette	emission	Monoceros	Jan. to Mar. (N), Dec. to Fev. (S)
Veil	remanant	Cygnus	July to Nov. (N), Aug. to Oct. (S)
Pleiades	reflection	Taurus	Nov. to Feb. (N), to January (S)
Heart & Soul	emission	Cassiopeia	Oct. to Jan. (N)
Lagoon & Trifid	emis. & reflec.	Sagittarius	summer (N), May to Sept. (S)
Eagle	emission	Sagittarius	summer (N), May to Sept. (S)
Helix	planetary	Aquarius	August to November (N & S)
Dumbbell (M27)	planetary	Vulpecula	summer (N)
Carina	emis. & reflec.	Carina	January to June (S)
Tarantula	emis. & reflec.	Dorado	November to March (S)

There are many more great nebulae to observe with Vespera. Browse the Nebulae section of the Singularity object catalog to discover them.

Observing Star clusters

Star clusters are gravitationally bound groups of stars.There are two main types of star clusters, each with distinct characteristics and observational interest:

Omega Centauri, the GOAT star cluster captured with Vespera Pro (post-processed image)

OPEN CLUSTERS

Open clusters are loose associations of a few dozen to a few thousand stars. They are relatively young in astronomical terms—often only a few million to a few hundred million years old—and are mostly found in the spiral arms of galaxies, including the Milky Way.

GLOBULAR CLUSTERS

Globular clusters are much older and more densely packed, containing hundreds of thousands to millions of stars within a spherical shape. They orbit the galaxy in a halo and are typically composed of older, redder, and more evolved stars.

OBSERVATIONAL CHARACTERISTICS OF STAR CLUSTERS

Star clusters are among the easiest objects to observe. They are less affected by light pollution, making them ideal targets from urban areas or around the full moon.

OPEN CLUSTERS

- **Size (angular)**:Typically 10' to 1° across, some are large
- **Shape**:Irregular or loosely grouped—no clearly defined boundaries.
- **Brightness**: Moderate to bright. Some are visible to the naked eye (e.g. Pleiades).
- **Color**: Often blue-white due to young, hot stars. Some may include red giants, adding color variation.
- **Visibility**: Often visible even under moderate light pollution. Good targets for beginners.

GLOBULAR CLUSTERS

- **Size (angular)**: 5' to 50'—more compact than open clusters but very dense.
- **Shape**: Round, centrally condensed—bright core with stars gradually fading outward.
- **Brightness**: Bright core easily visible; Some are visible to the naked eye (e.g. Omega Centauri).
- **Color**: Dominated by red and yellow stars (older population).
- **Visibility**: Often visible even under moderate light pollution. Good targets for beginners.

WHERE AND WHEN TO OBSERVE STAR CLUSTERS?

They are found throughout the sky, and there are always several observable in every season, from both hemispheres.

- **Open clusters** are typically found along or near the Milky Way band, in constellations such as Sagittarius, Scorpius, Cassiopeia, Perseus, Monoceros, and Carina.

- **Globular clusters**, on the other hand, orbit the galactic core and are located in the galactic halo, so they aren't confined to the Milky Way band.
- The Northern Hemisphere boasts the **most popular open cluster**—the Pleiades—while the Southern Hemisphere showcases the **largest globular clusters**: Omega Centauri and 47 Tucanae.

HOW TO OBSERVE STAR CLUSTERS?

Star clusters are best observed without any filters, unless they are associated with nebulae—in which case, refer to the nebula observation guidelines.

As they are generally bright, they do not require long acquisition times, even for high-quality astrophotography. Mosaic mode may be necessary for the largest open clusters.

Below are some basic guidelines for exposure duration.

Observation Goal	Acquisition Time
Object preview	5 min
Assisted observation	15 min
Basic photo	20 min
Astrophotography	45 min
High-quality astrophotography	2 h

SHORT LIST OF MUST-SEE STAR CLUSTERS WITH VESPERA

(N) / (S) = northern hemisphere / southern hemisphere.

Star cluster	type	constellation	best time
Pleiades (M45)	open	Taurus	Nov. to Feb. (N), to January (S)
Double Cluster	open	Perseus	October to January (N)
Wishing Well	open	Carina	February to June (S)

Ptolemy's Cluster (M7)	open	Scorpius	May to September(S)
Hercules (M13)	globular	Hercules	May to August (N)
M5	globular	Serpens	May to July (N), to August (S)
M15	globular	Pagasus	July to October (N)
Omega Centauri	globular	Centaurus	April to July (S)
47 Tucanae	globular	Tucana	September to January (S)
Jewel Box	open	Crux	March to June (S)

Observing individual stars

Although stars appear only as points of light and may seem unremarkable at first glance, there are in fact several fascinating types well worth observing.

Double and multiple stars: While many stars seem solitary to the naked eye, a closer look through a telescope can reveal two or more stars orbiting one another (although this is sometimes just an optical illusion). These double or multiple stars offer striking, colorful views and are excellent, accessible targets for beginners.

Variable stars: Unlike most stars that shine with a steady light, variable stars change in brightness over time. These variations can be regular or unpredictable, gradual or rapid. Observing them is not only intriguing—it also provides an opportunity to contribute to participatory science projects.

Stars associated with nebulae can form breathtaking celestial scenes that are worth capturing.

HOW TO OBSERVE STARS

It's recommended to observe stars without any filter in order to capture their true color, and because they are generally unaffected by light pollution.

There are two ways to observe stars:

1. LIVE OBSERVATION

When selecting a star from the Singularity catalog, Vespera initiates a live observation that doesn't involve stacking. The image is streamed in real time and updated every 2 to 3 seconds. This is ideal for assisted observation and quick exploration.

2. STACKING FOR HIGH-QUALITY IMAGING

If you want to capture a high-quality image of a star and benefit from extended observation settings, it's better to perform a traditional observation using image stacking.
To do this, create a manual target. Set a short exposure time between 1 and 5 seconds and reduce the sensor gain (experiment to find the optimal setting).
Important: when creating the target, **do not select Star** as the type—**choose Cluster instead** to enable live stacking.

Measuring Brightness Variations in Variable Stars

To estimate a variable star's brightness, compare it to nearby stars of known magnitude, these are called comparison stars, and they're essential for accurate measurements.
Make sure to observe under similar sky conditions each time to maintain consistency. Always record the UT (Universal Time) of your observation and your magnitude estimate carefully. Over time, you can plot your data points on a graph to track brightness variations.

Software is available to enable the measurements of variable stars (MaxIm DL,Vstar...)

You can also create a timelapse by assembling the images you've captured at different times with Vespera to visually highlight the star's fluctuations.

SHORT LIST OF STARS WORTH OBSERVING WITH VESPERA

Star	type	constellation	note
Albireo	multiple	Cygnus	showcase striking color contrasts, easy
Eta Cassiopeiae	multiple	Cassiopeia	Tight Yellow and red pair
Algol	variable	Perseus	Short-period eclipsing binary
Delta Cephei	Cepheid	Cepheus	Prototype of Cepheid variables; slow, smooth pulsation
Antares	star	Scorpius	Associated with nebula & nearby cluster
Betelgeuse	star	Orion	Orange-red supergiant
T Coronae Borealis	nova	Corona Borealis	Next outburst expected soon
Alpha Centauri	multiple	Centaurus	Closest star system to the sun
51 Pegasi	binary	Pegasus	First confirmed sun-like star with planets

Observing Supernovae

Apart from the Magellanic Clouds, it is impossible to distinguish individual stars in other galaxies due to their immense distance. However, there is one exception: supernovae.

Supernovae are among the most dramatic and powerful events in the universe: the explosive deaths of certain stars. In just moments, a supernova can release more energy than our Sun will emit over its entire lifetime.

When a star goes supernova, it can outshine its entire host galaxy, giving us a rare opportunity to distinctly observe a single star in another galaxy.

HOW AND WHEN TO OBSERVE SUPERNOVAE

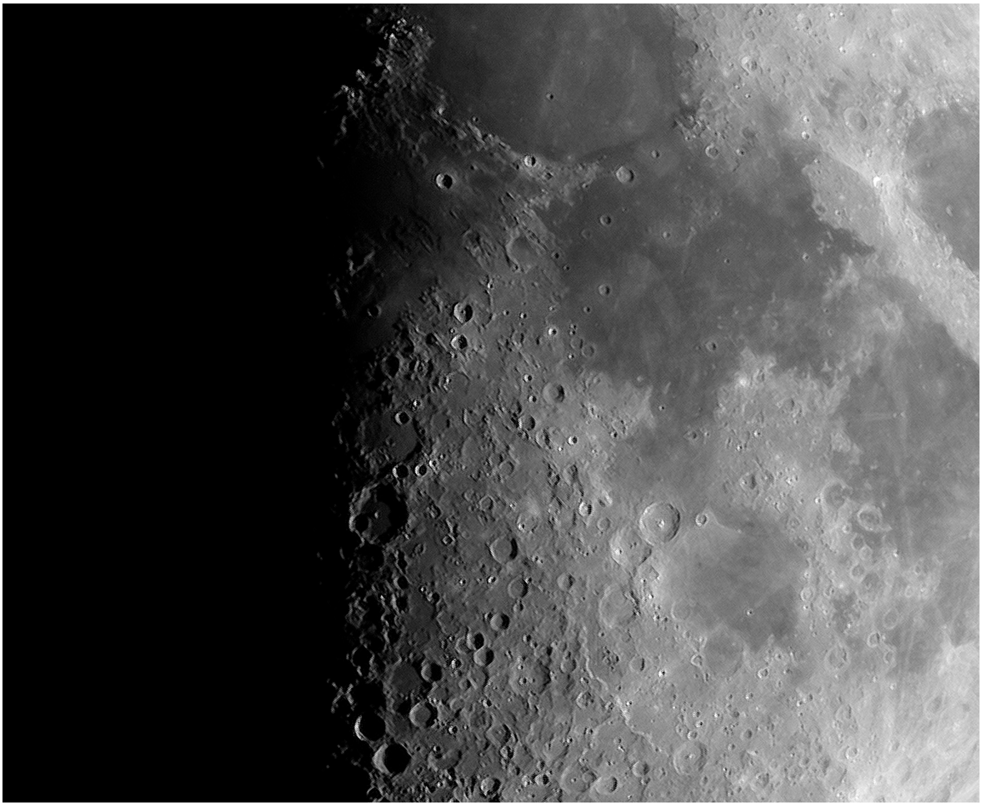
Supernovae are unpredictable and short-lived on astronomical timescales. They brighten rapidly over the course of days or weeks, then gradually fade over months. While catching one in real time is rare, you can still observe it once it has been discovered and compare before-and-after images of the host galaxy.

When a bright supernova becomes visible, the event is announced in the Singularity app's ephemerides, accessible via the Space Center. Additional details may also be shared on the Vaonis blog.

To observe a supernova, simply search for its host galaxy in the Singularity catalog and start the observation. It’s recommended to observe without any filter for best results.

Observing The Moon

The Moon, Earth's natural satellite, is an easy target to observe. With Vespera, you can explore its craters, mountain ranges, lava plains, and shadowed valleys. As it goes through a cycle of phases each month, the lighting on the lunar surface constantly changes, revealing different features depending on the date.



Close up of the moon captured with Vespera Pro.
(post-processed image)

WHEN TO OBSERVE THE MOON

The most striking views of the Moon occur during the quarter phases, when the shadows near the lunar terminator (the line between night and day) create dramatic contrast and highlight the relief.

- From the **first crescent** to the full moon, it is primarily visible during the first part of the night.
- Around the **full moon**, it can be observed throughout the entire night. However, since there are no long shadows on the surface to highlight details, the relief becomes barely perceptible. This is the least favorable period for observation.
- From the full moon to the **last crescent**, it is mostly visible during the second half of the night.
- During the **new moon** phase, it is, of course, not observable.

WHAT CAN YOU SEE ON THE MOON SURFACE?

- **Craters**: Lunar craters are the most iconic features of the Moon's surface. They come in different sizes and ages, and some even have central peaks or ray systems.
- **Seas (Maria)**: The Maria are large, dark plains of solidified basaltic lava, making them distinct from the brighter, heavily cratered regions. These areas are smooth, so they reflect less light, giving them their dark appearance.
- **Mountains**: The Moon has several mountain ranges, many of which are crater rims or the result of ancient impacts. The light from the Sun at low angles can cast long shadows, enhancing the detail of the lunar mountains.
- **Rills (Rimae)**: Rills are winding channels that may have been carved by ancient lava flows or tectonic activity. They appear as linear depressions or valleys.
- **Rays**: Some craters are surrounded by bright, linear streaks of ejecta, known as lunar rays (carters Tycho, Copernicus, Kepler). These are

created when an impact explosion sends debris in all directions, forming a network of radial white streaks visible at certain angles of illumination.

- **The Terminator**: The line between the illuminated and dark parts of the Moon. This is where crater rims, mountain peaks, and rills are most pronounced because of the sharp contrast between light and dark.

HOW TO OBSERVE THE MOON

In the Singularity catalog, simply search for the Moon to initiate an observation. Your smart telescope must be properly initialized, just as you would for a regular observation.

Note : When starting a lunar observation, Vespera first points to a nearby star to perform astrometric calibration. So it's normal for the telescope not to appear to aim directly at the Moon at first.

Moon observation is a live observation that does not involve stacking. The image is streamed live and refreshed every 2 to 3 seconds. However, for astrophotography purposes, you can save the images from your observation and stack them afterward for manual processing.

No filter is required for observing the Moon.

Chasing the thinnest crescent

A fun and challenging activity with the Moon is trying to capture the thinnest crescent. During this time, the Moon is low on the horizon and bathed in twilight glow.

Since observing the Moon requires Vespera to be initialized, this experiment can only be done during the last crescent phase, just before the new moon. You'll need to initialize Vespera while it's still dark and then aim it at the Moon as soon as it rises above the horizon.

For an additional fun activity, try capturing the Moon every day and then create a timelapse that shows the progression of its phases in motion.

MARIA

A – Mare Frigoris (Sea of Cold)
B – Mare Imbrium (Sea of Showers)
C – Mare Srenitatis (Sea of Serenity)
D – Mare Crisium (Sea of Crises)
E – Mare Vaporum (Sea of Vapors)
F – Mare Tranquillitatis (Sea of Tranquility)
G – Mare Fecunditatis (Sea of Fecundity)
H – Mare Nectaris (Sea of Nectar)
I – Oceanus Procellarum (Ocean of storms)
J – Mare Insularum (Sea of Islands)
K – Mare Cognitum (Sea of Knowledge)
L – Mare Humorum (Sea of Humors)
M – Mare Nubium (Sea of Clouds)

CRATERS

1 – Plato
2 – Aristoteles
3 – Endymion
4 – Hercules
5 – Cassini
6 – Eudoxus
7 – Atlas
8 – Archimedes
9 – Aristillus
10 – Posidonius
11 – Manilius
12 – Pallas
13 – Murchison
14 – Ptolemaeus
15 – Albategnius
16 – Cyrillus
17 – Theophilus

First quarter

THE MOON

In the Southern hemisphere, the Moon appears upside down, (north at the bottom).

CRATERS

18 – Alphonsus
19 – Azarchel
20 – Purbach
21 – Regiomontanus
22 – Deslandres
23 – Walter
24 – Magnus
25 – Eratosthenes
26 – Kepler
27 – Copernicus
28 – Reinhold
29 – Grimaldi
30 – Lansberg
31 – Bullialdus
32 – Pitatus
33 – Longomontanus
34 – Clavius

MISCELLANEOUS

A – Montes Alpes
B – Vallis Alpes
C – Montes Caucasus
D – Montes Apenninus
E – Sinus Iridium

Last quarter

vaonis

SHORT LIST OF PROMINENT MOON FEATURES TO LOOK FOR.

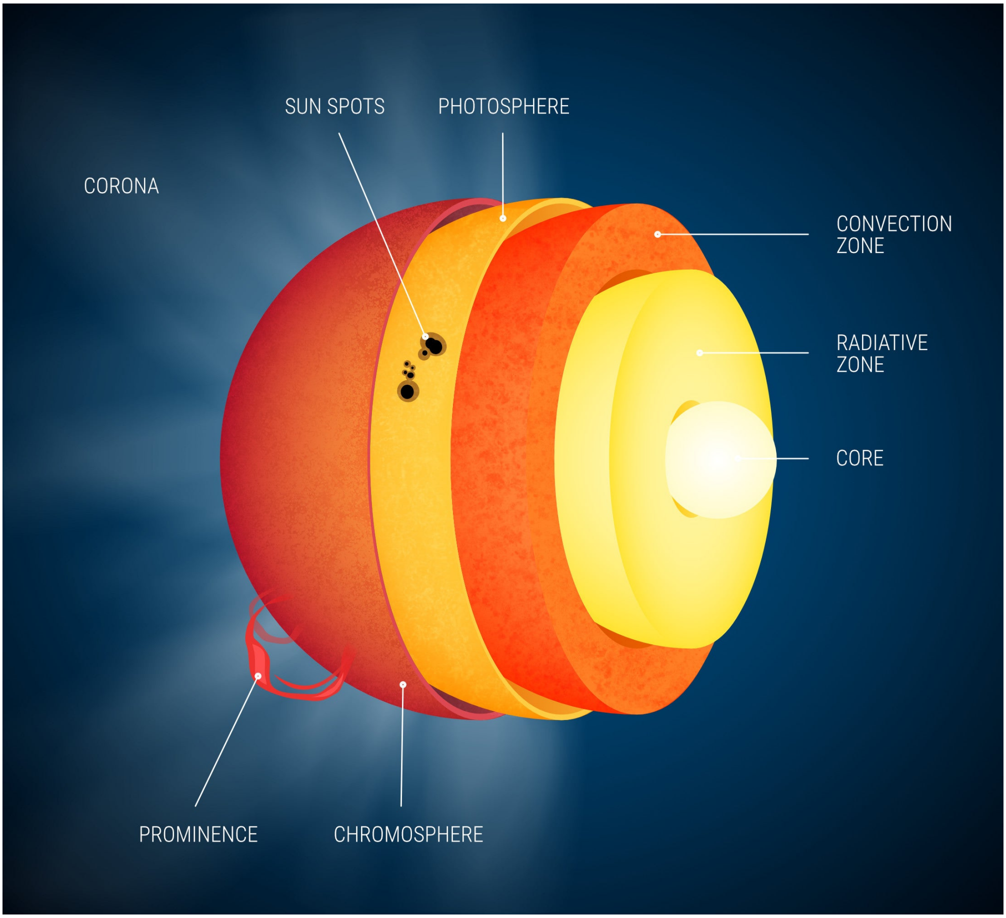
Feature	note
Clavius Crater	One of the largest craters on the Moon (225 km).
Copernicus Crater	A large crater with terraced walls and prominent ray system.
Tycho Crater	A brilliant ray system that stretches across the Moon's surface.
Plato crater	a large impact crater with a flat floor.
Ptolemaeus, Alphonsus, and Arzachel Craters	These three craters form a cluster.
The Apennine Mountains	A mountain ranges well-defined at first quarter with long shadows that highlight the peaks and valleys.
The Alps	A beautiful range of mountains north-east of Mare Imbrium.
Vallis Alpes	130km-long Vallis cutting through the Alps.
Rupes Recta (Straight Wall)	A 110km thin black line near to crater Birt.
Mare Crisium	A 620x570km lunar sea, one of the most distinctive features on the Moon. Located close to the eastern limb.

Observing The Sun

The Sun comprises several layers. Although it has no solid surface, one of the outer layers – called the photosphere – is the source of more than 99% of solar radiation. In practice, the photosphere is what is referred to as the Sun's surface, and it is this layer that you can observe with Vespera fitted with the solar filter.

The photosphere is about 400 kilometers thick and has a temperature of about 5500°C.

Surrounding the photosphere is the solar atmosphere. Its lower part is called the chromosphere and is only observable with special instruments able to filter the part of the light spectrum corresponding to H-alpha emission. We can also see fragments of it (solar prominences) with Vespera during a total solar eclipse (pink spots on the edge of the disk). Finally, the upper part of the solar atmosphere is called the corona and can be observed either with a specific instrument called a coronagraph, or with the naked eye and with Vespera during a total solar eclipse.



The structure of the Sun.

HOW TO OBSERVE THE SUN

A specific mode is available for solar observations. Please refer to the dedicated section in this guide for more details.

WHAT CAN YOU SEE ON THE SUN SURFACE?

SUNSPOTS

The photosphere has a relatively uniform appearance without permanent formations, unlike those that can be found on the planets or the Moon. However, **isolated or groups of dark spots appear regularly**. These are known as sunspots, which can be clearly seen with Vespera.

The **lifespan** of a sunspot varies from **a few days to several weeks**. They follow the rotation of the Sun but also have their own movements across the surface.

By carefully observing the biggest spots and groups of spots, you will notice that the very dark center of the spots (the umbra), is often surrounded by a halo that is not quite as dark (the penumbra).

Sunspots are cooler regions with a temperature of about 3500°C.

The smallest spots are a few thousand kilometers across while the largest ones reach 50,000 kilometers in diameter. They are so large they could hold Earth several times over.

FACULAE

On the edge of the solar disk, near sunspots, you may be able to observe **brighter areas**. These are faculae.

The contrast between them and the rest of solar disk is not as strong, so they are much more difficult to observe than sunspots. They are only visible along the periphery due to the apparent darkening of the edges of the solar disk.

The faculae are hotter magnetic regions (about 8000°C). They can be grouped into a very large range of faculae.

The sun captured with Vespera Pro
(post-processed image)

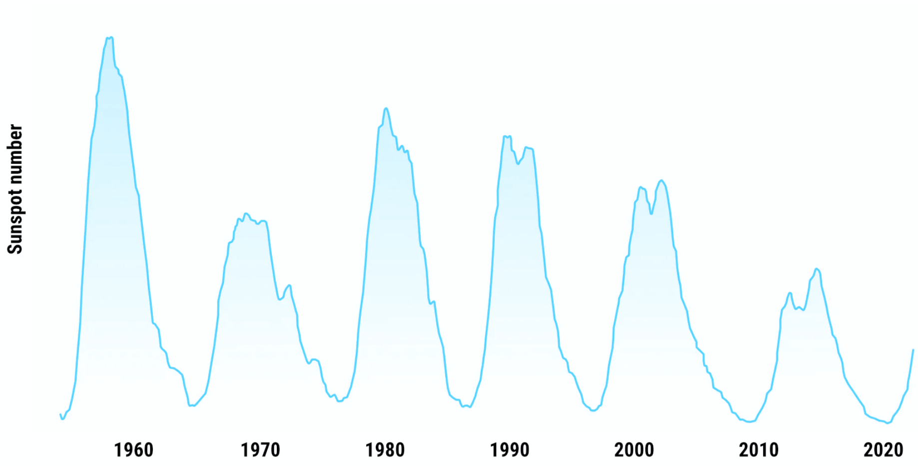
MONITORING THE SUN'S ACTIVITY

The number of sunspots at any given time is extremely variable and depends on the intensity of the solar activity.

Over more than a century of observation, astronomers have noticed that **the number of spots varies regularly according to a cycle of about 11 years**.

At the beginning of each cycle, the Sun is nearly devoid of sunspots. The number gradually increases to reach a maximum before decreasing again.

With Vespera, you can regularly count the sunspots and thus monitor changes in the Sun's activity.



Evolution of solar activity over the years

Observing Planets

Observing planets requires a completely different approach than observing deep-sky objects (DSOs). While DSOs are faint but often span large areas of the sky, planets are, in contrast, extremely bright yet have very small apparent sizes. As a result, each activity typically calls for different telescope configurations.

Vespera is optimized for deep-sky observation and is therefore less suited to planetary observation. However, it still allows you to explore all the planets of the Solar System and observe some details on a few of them.

WHAT TO EXPECT WHEN OBSERVING PLANETS

MERCURY, URANUS, AND NEPTUNE

These planets are either very small (Mercury) or extremely distant (Uranus and Neptune). As such, they appear only as bright points of light. Uranus and Neptune may reveal a faint bluish tint.

VENUS

As an inner planet, Venus orbits closer to the Sun than Earth and exhibits phases—just like the Moon. Its apparent size changes dramatically depending on whether it is on the same side of the Sun as Earth (closer and larger) or on the far side (smaller).

MARS

Although Mars is relatively close, it is a small planet, and its surface features are too fine to be resolved by Vespera. However, its distinctive reddish hue is clearly visible.

JUPITER

The largest planet in the Solar System, Jupiter has a significantly larger apparent diameter. With Vespera, you may be able to make out its equatorial cloud bands, which add texture to its surface.

SATURN

Also a gas giant, Saturn is best known for its stunning ring system. Vespera can reveal its iconic rings, which are much more prominent than those of the other giant planets.

WHERE AND WHEN TO OBSERVE THE PLANETS

Since all the planets - including Earth - are constantly orbiting the Sun, their positions in the sky are not fixed. They move at varying speeds across the celestial sphere but always remain near the ecliptic (see the chapter Other Landmarks in the Night Sky for more on this concept).

From Singularity's object catalog, you can easily check which planets are currently visible. You may also use a sky map app to view their positions on any given date.

Inner Planets (Mercury and Venus)
Being close to the Sun, these planets also appear close to it in the sky. They are never very high above the horizon and are visible either at dawn or at dusk, depending on whether they lie to the east or west of the Sun.

Outer Planets (Mars through Neptune)
These planets are best observed when they are in *opposition*, meaning

they are directly opposite the Sun from Earth's perspective. This is when they are highest in the sky, visible for the longest duration during the night and offer the largest angular size.

HOW TO OBSERVE PLANETS

From the object catalog in Singularity, activate the **Solar System** category to display a list of planets, then select the one you'd like to observe.

Planet observation is a live observation that does not involve stacking. The image is streamed live and refreshed every 2 to 3 seconds.

Do not use any filter when observing planets.

Observing Jupiter's Moons

You can observe Jupiter's four largest moons—Io, Europa, Ganymede, and Callisto—and even witness their motion around the giant planet. However, to make them stand out clearly, you'll need longer exposure times than those used in live observation mode.

To do this, create a manual target in Singularity (select "Cluster" as the target type, for example) and set the exposure time to a few seconds. This will allow you to better capture the moons and their changing positions over time.

Observing Comets

Comets are small celestial bodies composed primarily of ice, dust, and rocky material that orbits the Sun. They originate from the outer regions of the Solar System, such as the Kuiper Belt and the Oort Cloud.

When a comet approaches the Sun, solar radiation heats its surface, causing the ice to sublimate (turn directly from solid to gas) and release dust and gas into space. This creates a glowing coma (a cloud surrounding the nucleus) and often one or more tails that can stretch for millions of kilometers. These tails always point away from the Sun due to the pressure of the solar wind and sunlight.

Comet Tsuchinshan ATLAS captured with Vespera Pro in the pre-dawn sky (post-processed image)

OBSERVATIONAL CHARACTERISTICS OF COMETS

Comets are among the most unpredictable celestial objects, with the exception of the few known periodic comets (such as Halley's Comet). Most are discovered only shortly before entering the inner Solar System, and their visibility and behavior near the Sun and Earth can be difficult to predict. While some comets turn out to be spectacular surprises, they may break apart approaching the sun, transforming from promising targets to nearly unobservable objects.

Because of this uncertainty, it’s important to follow their evolution day by day, especially as they approach their closest point to the Sun and Earth—when observation conditions are most favorable.

WHEN AND WHERE TO OBSERVE COMETS

As previously mentioned, most comet appearances cannot be predicted far in advance, except in the case of periodic comets. To know when a comet becomes visible, it's essential to stay informed by following astronomy news.

When a comet is observable, **it will appear in the Singularity ephemeris** (on the app's home screen). Updates are also provided via the Vaonis blog and the Vaonis Community Facebook group.

HOW TO OBSERVE COMETS

Because comets are typically not known in advance, they are not included in Singularity's object catalog. To observe one, **you'll need to create a manual target** using the comet's astronomical coordinates. These can usually be found online or in sky charting software—provided that the database has been updated to include the newly discovered comet.

- When a comet passes close to the Sun or Earth, its apparent motion across the sky can be rapid. This means you may need to **frequently update the coordinates of your manual target** to keep the comet centered in your field of view.
- When setting up your manual target in Singularity, **choose "Nebula" or "Star Cluster" as the object type**. This will enable image stacking, which is useful for faint objects like comets.
- Due to their fast motion, it's recommended to **use short exposure times** (typically between 1 and 5 seconds) and to keep sessions relatively short to prevent blurring.
- Alternatively, you can choose to save the individual FITS frames and later stack them manually using specialized software. These tools can detect the motion of the comet against the background stars and align the images on the comet itself, producing a clean final result.

Observing lunar eclipses

The Moon orbits the Earth in a little over 27 days. Under certain specific conditions, the Sun, Earth, and Moon align perfectly, with our planet positioned between the Sun and the Moon. As a result, the Moon enters the Earth's shadow and is no longer directly illuminated by the Sun—this is a lunar eclipse.

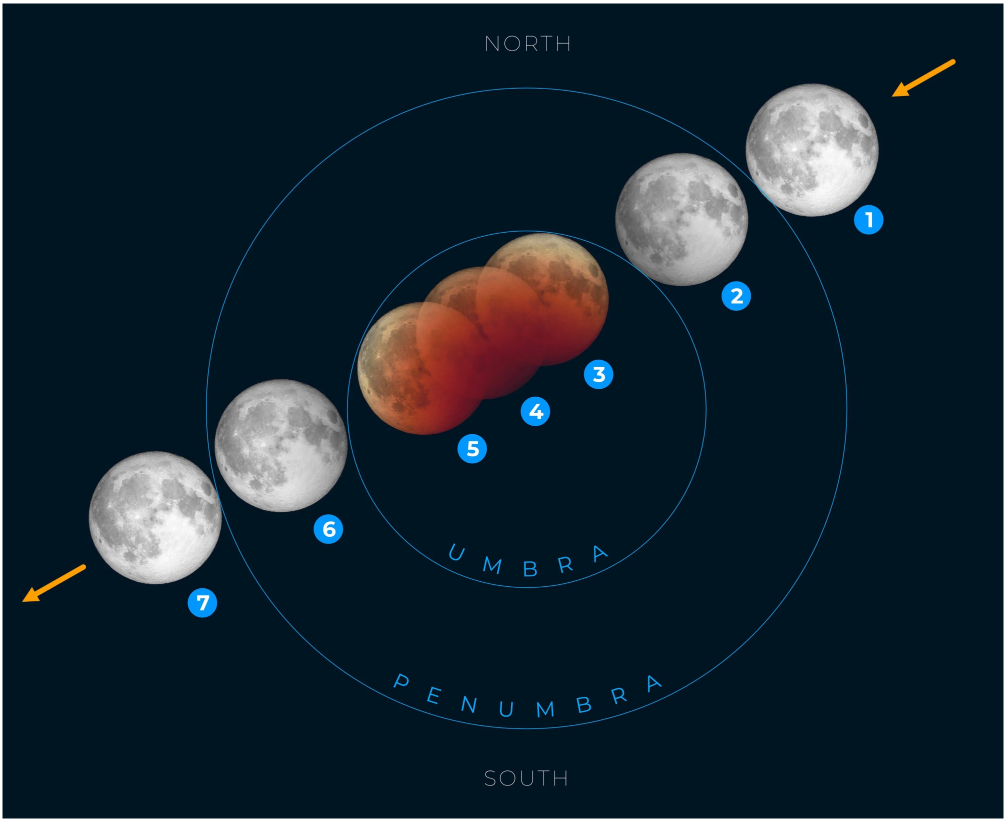
- If the alignment is perfect, the entire Moon is plunged into Earth's shadow: this is a **total eclipse**.
- If the alignment is slightly off, only part of the Moon enters the Earth's shadow: this results in a **partial eclipse**.

WHAT CAN YOU OBSERVE DURING A LUNAR ECLIPSE?

A lunar eclipse unfolds over several hours. As time progresses, the Moon gradually enters Earth's shadow. As long as it is not completely immersed, the eclipse remains partial. Therefore, all total lunar eclipses begin and end with a partial phase.

KEY STAGES OF AN ECLIPSE

1. **Penumbral entry** -The Moon starts receiving less sunlight, but the dimming is barely noticeable.
2. **Beginning of the partial eclipse** -Part of the Moon enters the Earth's shadow, appearing as a growing dark area on the lunar disk.
3. **Beginning of the total eclipse** -The entire Moon is now within Earth's shadow, taking on a reddish hue.
4. **Eclipse maximum** -The Moon reaches the center of Earth's shadow, offering the most dramatic view.
5. **End of totality** -The Moon begins to emerge from Earth's shadow, gradually regaining its natural brightness.
6. **End of partial eclipse** -The moon leaves Earth's shadow
7. **End of the partial and penumbral eclipse** – The event concludes completely.



Moon's journey through Earth's shadow during the total eclipse on April 14, 2025 from right to left.

ASPECT OF THE MOON DURING A TOTAL ECLIPSE

During a total lunar eclipse, the Earth blocks direct sunlight from reaching the Moon. However, the Moon does not vanish completely; instead, **it takes on a reddish-orange hue**, which can sometimes appear very dark.

This effect is due to Earth's atmosphere, which scatters and refracts sunlight.

Although sunlight appears white, it actually contains multiple colors, as seen in rainbows. The blue and violet components are more strongly scattered by the atmosphere—this is why the sky appears blue during the day.

When sunlight passes through a greater thickness of the atmosphere, such as during sunrise or sunset, blue, green, and yellow light are gradually scattered and absorbed, leaving mainly red light.

During a lunar eclipse, this red light is refracted by the Earth's atmosphere and projected into its shadow, illuminating the Moon. Instead of disappearing, the Moon takes on a coppery-red color, sometimes very dark. The atmosphere acts like a natural lens, bending the last rays of sunlight toward the Moon.

WHEN AND HOW OFTEN DO LUNAR ECLIPSES OCCUR?

Although the Moon reaches its full phase every 29 days, lunar eclipses do not happen every month. This is because the Moon's orbit is inclined by about 5° relative to Earth's orbit. Most of the time, the Moon simply passes above or below Earth's shadow.

Lunar eclipses occur around the equinoxes (March and September), when alignment conditions are more favorable. Additionally, a solar eclipse always takes place about two weeks before or after a lunar eclipse.

At least two lunar eclipses happen each year, with a maximum of five (though this is extremely rare). However, most of these are only partial eclipses. A total lunar eclipse visible from the same location remains an uncommon event.

UPCOMING LUNAR ECLIPSES

Date	eclipse type	visibility region
September 7, 2025	total	Europe, Africa, Asia, Oceania
March 3, 2026	total	USA, Asia, Oceania
August 28, 2026	partial	Americas

HOW TO OBSERVE LUNAR ECLIPSES

To observe a lunar eclipse, simply start a regular Moon observation.

Observing solar eclipses

Under specific conditions, the Sun, Moon, and Earth align, with the Moon positioned between the Sun and our planet. This alignment causes the Moon to block some or all of the Sun’s light, resulting in a solar eclipse.

- When the alignment is perfect and the Moon is close enough to Earth to fully cover the Sun, a **total eclipse** occurs, briefly plunging parts of Earth into daytime darkness.
- When the alignment is slightly off, only part of the Sun is obscured, producing a **partial eclipse**.
- When the alignment is perfect but the Moon is farther from Earth in its orbit—appearing slightly smaller in the sky—it doesn't completely cover the Sun. This creates an **annular eclipse**, during which a bright "ring of fire" remains visible around the Moon.

A total solar eclipse is often a once-in-a-lifetime spectacle, unmatched by anything else. Even a partial solar eclipse pales in comparison. This is undoubtedly one of the most striking spectacles nature has to offer. However, partial solar eclipses are also rare and remarkable events that are well worth observing.

WHY TOTAL SOLAR ECLIPSES ?

The Moon is Earth's natural satellite, completing one orbit around our planet approximately every 27 days. During each cycle, it periodically positions itself between the Earth and the Sun, marking the phase known as the new moon. However, because the Earth is also moving along its orbit around the Sun, it takes about 29 days for the Moon to realign between the Earth and the Sun. When this alignment is precise, the Moon casts its shadow on Earth's surface, creating the rare and awe-inspiring event of a total solar eclipse.

While the sun is about 400 times larger than the moon, it is also conveniently about 400 times farther from Earth. This natural coincidence results in the discs of the two celestial bodies having nearly identical apparent dimensions when viewed from Earth, allowing us to experience perfect total solar eclipses.

WHEN TO OBSERVE SOLAR ECLIPSES

Although the Moon passes between the Sun and the Earth roughly every 29 days, a solar eclipse doesn't occur each time. This is because the Moon's orbit is tilted by about 5 degrees relative to Earth's orbit, so perfect alignment is rare.

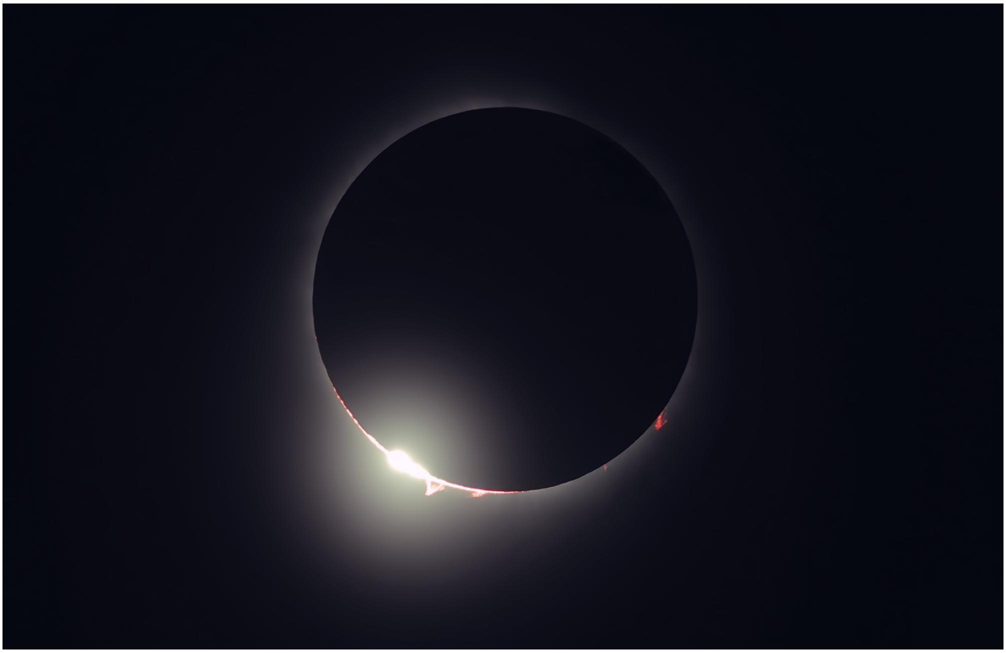
There are only two periods each year when the geometry is right for a solar eclipse to occur. While up to five solar eclipses can happen in a single year, this is extremely rare. Most years see only two, and some of those may be partial eclipses.

Never look directly at the Sun through any optical instrument without proper solar protection, as this can lead to irreversible eye damage.

The only time it is safe to observe the Sun without protection is during the brief moments of a total solar eclipse, when the Moon completely blocks direct sunlight.

UPCOMING SOLAR ECLIPSES

Date	eclipse type	visibility region
September 21, 2025	partial	Antarctica
August 12, 2026	total	August 12, 2026 total Iceland, Spain (partial in Europe)
February 6, 2027	annular	Argentina (partial in South America)
August 2, 2027	total	Spain, Morocco, Algeria, Tunisia, Egypt ...



The April 2024 total solar eclipse observed with Vespera.
(post-processed image)

WHAT TO OBSERVE DURING A SOLAR ECLIPSE WITH VESPERA

PARTIAL SOLAR ECLIPSE

Unlike a total eclipse, a partial eclipse does not noticeably dim the daylight. If you are unaware that an eclipse is happening, you might not even notice the event.

As the eclipse progresses, the Moon slowly nibbles at the solar disk, gradually transforming it into a crescent shape.

TOTAL SOLAR ECLIPSE

When the Moon completely covers the solar disk, it is the only moment when the eclipse can be observed without the need for special filters. Several phenomena can then be observed with Vespera:

- **Diamond Ring**: As the last sliver of the Sun disappears, the bright corona begins to emerge, creating the effect of a soft, glowing ring enhanced by a brilliant flash of light.
- **Baily's Beads**: While the Moon is fully covering the Sun, a few rays of light still sneak through the Moon's deepest valleys along its edge. These rays form a series of fleeting, luminous pearls.
- **Chromosphere and Prominences**: During a solar eclipse, we can observe specific layers of the Sun that are usually invisible from Earth. One such layer is the chromosphere, the Sun's lower atmosphere, which takes on a pinkish hue. Solar prominences, eruptions of matter from the Sun's inner layers, appear to extend from this chromosphere, often in the same pinkish color.
- **Sun's Corona**: The corona is the outermost part of the Sun's atmosphere. Normally invisible from Earth due to its lower luminosity compared to the Sun's surface, it becomes easily observable with the naked eye during a total eclipse. Extending millions of kilometers from the Sun's surface, the corona's intricate structure of filaments becomes visible when observed through a telescope.

HOW TO OBSERVE SOLAR ECLIPSES

Observing a solar eclipse requires special precautions and is conducted through a dedicated mode in Vespera. For more details, refer to the Solar Observations section of this guide.

Observing close approaches and occultations

As they move across the sky, the Moon and the planets regularly pass near each other or close to deep-sky objects. When two celestial bodies appear extremely close together, this is called a **conjunction**.

These events can produce fascinating visual phenomena, such as a close encounter between the Moon and one or more planets, or the passage of a planet or the Moon near a deep-sky object like the Pleiades. In rarer cases, the Moon may pass directly in front of a planet or another prominent object, blocking it from view—this is known as an **occultation**.

Venus passing by the Beehive cluster observed with Vespera.

WHERE TO OBSERVE CONJUNCTIONS AND OCCULTATIONS

Since the Moon and planets follow the path of the ecliptic in the sky (see Understanding the Night Sky for more on this), only celestial objects near this zone can be involved in such events. Aside from planetary pairings, conjunctions or occultations with deep-sky objects generally involve those found in zodiac constellations—for example, the Moon often passes near or even in front of the Pleiades in the Taurus constellation.

WHEN TO OBSERVE CONJUNCTIONS AND OCCULTATIONS

These events can be predicted in advance because the positions of the planets are precisely calculable. You can find this information by consulting astronomical ephemeris data.

When particularly interesting conjunctions or occultations are expected—especially those well suited for observation with Vespera—**they are announced in the Singularity app**, under the ephemerides section in the Space Center.

HOW TO OBSERVE CONJUNCTIONS AND OCCULTATIONS

PLANETARY CONJUNCTIONS

To be observed with Vespera, the planets must be close enough together to fit within the telescope's field of view. Since planetary observation is done in live observation mode, the mosaic mode is not available.

Simply point Vespera at one of the planets. When the Moon is involved, note that the brightness difference between it and the planets is significant, so the image may be over- or underexposed depending on which object you target. If you point at the Moon, the planets may appear underexposed; equally, if you point at the planets the Moon will appear overexposed.

PLANET–DEEP SKY OBJECT CONJUNCTIONS

Here, the brightness contrast is even greater. Because the goal is to observe the deep-sky object, the planet (or Moon) will be overexposed—but this can still result in visually striking images (see example above).

For this type of observation, select the deep-sky object as your target and use a regular observation mode, which enables mosaic mode and a wider field of view if necessary.

OCCULTATION OF A PLANET BY THE MOON

The most interesting part of this event is either the gradual disappearance of the planet behind the Moon or its reappearance. To capture it, simply start a regular Moon observation shortly before the beginning or the end of the occultation.

Introduction to image post-processing

Astronomical image processing is a fascinating yet vast and complex field. This guide is intended to introduce only the basic concepts, help you get started and understand the key principles.

It focuses exclusively on post-processing, the work done after image stacking has been completed, specifically using the stacked output produced by Vespera.

While it is possible to manually stack individual frames yourself, we recommend starting with Vespera's pre-stacked file, especially if you are new to astrophotography.

Understanding what you're doing

You may be familiar with the saying: "Give a man a fish and you feed him for a day. Teach a man to fish and you feed him for a lifetime." This wisdom applies perfectly to image processing.

The internet is full of step-by-step tutorials showing how to apply specific adjustments using various software tools. While this is undoubtedly helpful, there's no one-size-fits-all method that works for every image or scenario. If you blindly follow the steps from a tutorial without understanding the reasoning behind them, chances are the results on your image will be disappointing.

That's why it's essential to go beyond simply memorizing which buttons to press or what values to enter. Try to understand why each adjustment is used and how it affects the image. This knowledge will help you become more autonomous, adapt your workflow to your own data, and achieve better and more consistent results.

Why process your images?

Vespera offers stunning real-time views thanks to its onboard live image processing. However, for even more detailed and personalized results, manual post-processing can reveal additional features and nuances. While Vespera uses a general processing workflow, advanced editing lets you tailor each image to highlight what matters most to you, just like experienced astrophotographers do.

Andromeda Galaxy : Comparing Vespera live image and post-processed image from Vespera's stacked TIFF output file.

Best practices for processing astronomical images

STAYING TRUE TO REALITY

Astrophotography is a mix of art and science, where image processing involves both interpreting the captured data and adjusting it based on your preferences, especially colors. Because of this subjectivity and the variety of tools, no two images of the same object are exactly the same. Each astrophotographer can express creativity or highlight specific features.

While astrophotography is a hobby and you're completely free to manipulate your images as you like, **the most appreciated results tend to be those that remain faithful to the true nature of the celestial objects**. This means avoiding the addition of features that weren't present in the original data. The goal of image processing is to reveal and enhance what's already there, not to fabricate details.

This is particularly relevant in the era of generative AI tools that can drastically alter images with just a few clicks. While they can be impressive, they often stray from reality and can mislead viewers. If using such tools, **it's a good practice to clearly state that generative AI was involved in the final result**.

Specialized astrophotography software also makes use of AI but in a different way. These tools use artificial intelligence to reduce noise or correct background gradients, while preserving the authenticity of the image. They are not generative; their aim is to enhance the visibility of real features, not to invent them.

KNOWING WHEN TO STOP

Processing astronomical images can be exciting, watching details and colors emerge often makes you want to keep pushing further. But **going too far can lead to over-processing, where the result looks unnatural or even unpleasant**.

In general, more natural-looking images are better received. That said, there's a subjective element influenced by professional observatory images, which often use specific color palettes to highlight certain features. These palettes aren't always true to what the human eye would see, but they've shaped our expectations of how space should look.

With time and experience, you'll learn to strike the right balance and recognize when additional edits start to harm the image rather than enhance it. **A good approach is to do a first edit, then step away for a day or two**. When you revisit the image, you'll often see things more clearly and create a version that feels more balanced and satisfying.

ADAPTING TO VIEWING CONDITIONS

When you share your images, keep in mind that they will be seen on a wide range of screens and in different lighting environments—all of which can significantly affect how they're perceived.

For example, if you edit your image in a dark room, your eyes will be more sensitive to faint details. But someone viewing that same image in bright daylight may find the background too dark and miss subtle features like the outer regions of a nebula or galaxy. That's why **aiming for a pitch-black background isn't always ideal**—it can crush the faintest details and create overly harsh contrast.

It's a good idea to check your image under various lighting conditions and on different devices. Adjusting the image to look good in a variety of contexts will help ensure it's more universally appreciated.

Also, don't rely solely on small screen previews—images can appear flawless on a smartphone but reveal defects when viewed full-size on a computer screen. **Always take time to inspect the details**.

Image format suitable for processing

To perform advanced image processing, you need to work from a high-quality image file. For each observation with Vespera, you can save a raw file in TIFF format, which is the most suitable format for post-processing. JPEG files allow only minimal adjustments and are not recommended for astrophotography.

Refer to the section Saving and Managing Images of Your Observations to learn how to save your results in the appropriate format.

WHY USE THE TIFF FORMAT INSTEAD OF JPEG

COMPRESSION

JPEG images are compressed to reduce file size but this compression alters the original data. While the loss in quality may not be obvious at first glance, any post-processing quickly reveals visible artifacts and flaws. TIFF files, on the other hand, are uncompressed, preserving all the original data captured during the observation, making them far better suited for image processing.

DYNAMIC RANGE

JPEGs are encoded in 8-bit, while TIFFs use 16-bit encoding. This difference significantly impacts the image's dynamic range—its ability to represent subtle variations in brightness.
This is especially important in astrophotography, where the contrast

between bright stars and faint nebulae is extreme. A higher dynamic range helps you show more detail in both the bright and dark parts of your image.

VIEWING RAW TIFF IMAGES

Although the TIFF files produced by Vespera can be opened in most standard image viewers, they aren't meant for direct viewing without processing. **When you first open one, you may be surprised to see what looks like an almost entirely black image—but that's completely normal.**

These raw images have a very wide dynamic range to capture the extreme differences in brightness between celestial objects. As a result, only the brightest stars—of which there are few—are immediately visible. Fainter features like nebulae and galaxies are buried in the darkest parts of the image and won't be distinguishable on a typical screen.

To reveal what the image truly contains, the dark tones need to be "stretched" to bring out detail, at the cost of compressing the bright areas. This process is known as **stretching**. You may also encounter the term **linear** to describe the original, unprocessed image, and **non-linear** once the stretching has been applied.

Some processing steps yield better results when applied before stretching. However, since you need to see the effects of your adjustments, most astrophotography software offers a **temporary stretch preview**, allowing you to work with a visible image while keeping the data in its original linear state.

Software Suites for Astrophotography

Astrophotography image processing often requires using multiple software programs or additional plug-ins for specialized features. There are various solutions at different price points, some more popular but with a steeper learning curve.

The best software for you is likely the one you can master effectively. You may achieve better results with a simpler, more intuitive tool than with a powerful, feature-rich solution that is difficult to navigate.

To help you begin your image processing journey, here are three software suite recommendations at different price levels, offering options for every budget.

BUDGET (~USD 75)	MID-RANGE (~USD 200)	ADVANCED (~USD 550)
SIRIL GraXpert Starnet Affinity Photo	SIRIL Affinity Photo NoiseXterminator StarXterminator	PixInsight BlurXterminator NoiseXterminator StarXterminator

SOFTWARE DESCRIPTIONS (ALPHABETICAL ORDER)

AFFINITY PHOTO

Affinity Photo is a general-purpose image editing software available for Windows and macOS. While not specifically designed for astrophotography, it includes some dedicated features such as basic image stacking and background gradient removal. It can natively read FITS images and supports third-party plug-ins like NoiseXterminator and StarXterminator. Additionally, a free astrophotography script collection, created by one of the developers, is available.

Price: USD 75
Official Website
James Ritson's Astrophotography Macros

BLURXTERMINATOR

BlurXTerminator is an AI-powered deconvolution tool designed specifically for astrophotography. It is available exclusively as a plug-in for PixInsight.

Price: USD 100
Official Website.

GRAXPERT

GraXpert is a standalone application for astronomical image processing, available for Windows, macOS, and Linux. It is primarily designed for background gradient suppression but also includes AI-powered noise reduction. Easy to use, it must be combined with other software for a complete astrophotography workflow.

Price: Free
Official Website

NOISEXTERMINATOR

NoiseXTerminator is an AI-based noise reduction tool for astrophotography. It is available as a plug-in for PixInsight, Photoshop, and Affinity Photo.

Price: USD 50
Official Website

PIXINSIGHT

PixInsight is one of the most powerful and comprehensive astrophotography processing software available for Windows, macOS, and Linux. It supports numerous third-party plug-ins and scripts for advanced image processing. However, it has a steep learning curve and an interface that may feel unintuitive. Fortunately, there is a strong user community and a wealth of tutorials available online.

Price: USD 300
Official Website

SIRIL

SIRIL is a free, open-source astrophotography image processing software available for Windows, macOS, and Linux. It covers most astrophotography processing steps and can be extended with plug-ins (e.g., for star removal) and third-party scripts. It also benefits from an active user community, with many tutorials available online.

Price: Free
Official Website

STARNET

StarNet is a tool designed for star removal in astrophotography images, allowing selective processing of nebulae and galaxies. It is available as a plug-in for PixInsight and SIRIL, as well as a stand-alone command-line tool for Windows, macOS, and Linux. A graphical user interface is also available for Windows.

Price: Free
Official Website

STARXTERMINATOR

StarXTerminator is an AI-based tool designed to remove stars from astrophotography images for advanced processing. It is available as a plug-in for PixInsight, Affinity Photo, and Photoshop.

Price: USD 50
Official Website

OTHER NOTABLE SOFTWARE FOR ASTROPHOTOGRAPHY

ASTROPIXELPROCESSOR

AstroPixelProcessor is an astrophotography software available for Windows, macOS, and Linux. It is particularly good in image stacking but also includes a comprehensive suite of post-processing tools.

Price: USD 60/year subscription or USD 165 perpetual license
Official Website

PHOTOSHOP

Photoshop is a general-purpose image editing software for Windows and macOS. While it lacks specific astrophotography features, it can be enhanced with plug-ins such as StarXTerminator, BlurXTerminator, and Astronomy Tools Actions.

Price: USD 20/month subscription
Official Website

SETI ASTRO'S SUITE

Seti Astro's Suite is a relatively new stand-alone software dedicated to astrophotography image processing. Available for Windows, macOS, and Linux, it includes tools for deconvolution, noise reduction, sharpening, and stretching.

Price: Free
Official Website

Typical processing workflow

Astrophotography offers many ways to process images but there are several common steps that are almost always part of the workflow. The following outline provides a starting point that can be customized depending on the results you aim to achieve and your skill level.

THE STARTING POINT

Begin with the pre-stacked image delivered by Vespera or Stellina. Ensure you're working with the 16-bit TIFF file, which contains the raw data needed for high-quality processing.

BACKGROUND GRADIENT REMOVAL

Images frequently suffer from gradients caused by light pollution or inconsistent atmospheric conditions during acquisition. Removing these gradients is essential to achieving a uniform background and overall better results.

Software : GraXpert, Pixinsight, SIRIL

DECONVOLUTION

Astro images often appear slightly blurred due to atmospheric turbulence, optical limitations, and the natural spread of light caused by the optical system itself. This blurring can cause stars to look bloated and fine details to be lost.

Deconvolution works like mathematical un-blurring. It analyzes how that blur occurred and tries to reconstruct what the original (sharper) image must have looked like.

Software : BlurXterminator, Pixinsight, SIRIL

COLOR CALIBRATION

The color in astrophotography can vary depending on the characteristics of the specific sensor and its sensitivity to different wavelengths of light, and how the data was captured. Color calibration adjusts the image to reflect accurate colors by referencing a catalog of known star colors.

software : SIRIL, Pixinsight

STAR SEPARATION

Processing to enhance nebulae can unintentionally affect stars, leading to unwanted artifacts. Separating stars from the rest of the image allows for selective processing of each layer separately .

Software : StarXterminator, Starnet

STRETCHING

Stretching is a mandatory and transformative step in astrophotography. It brings out the hidden details and reveals the full potential of your image.

Software : Affinity Photo, Pixinsight, SIRIL

DENOISING

Reducing noise significantly improves image quality by revealing faint details that might otherwise be obscured. This step also enhances the overall aesthetics of your image.

Software : Affinity Photo, NoiseXterminator, Pixinsight, SIRIL

SHARPENING

In addition to deconvolution, sharpening further enhances the clarity and detail of the image, making structures and features more defined.

Software : Affinity Photo, Pixinsight, SIRIL

COLOR GRADING

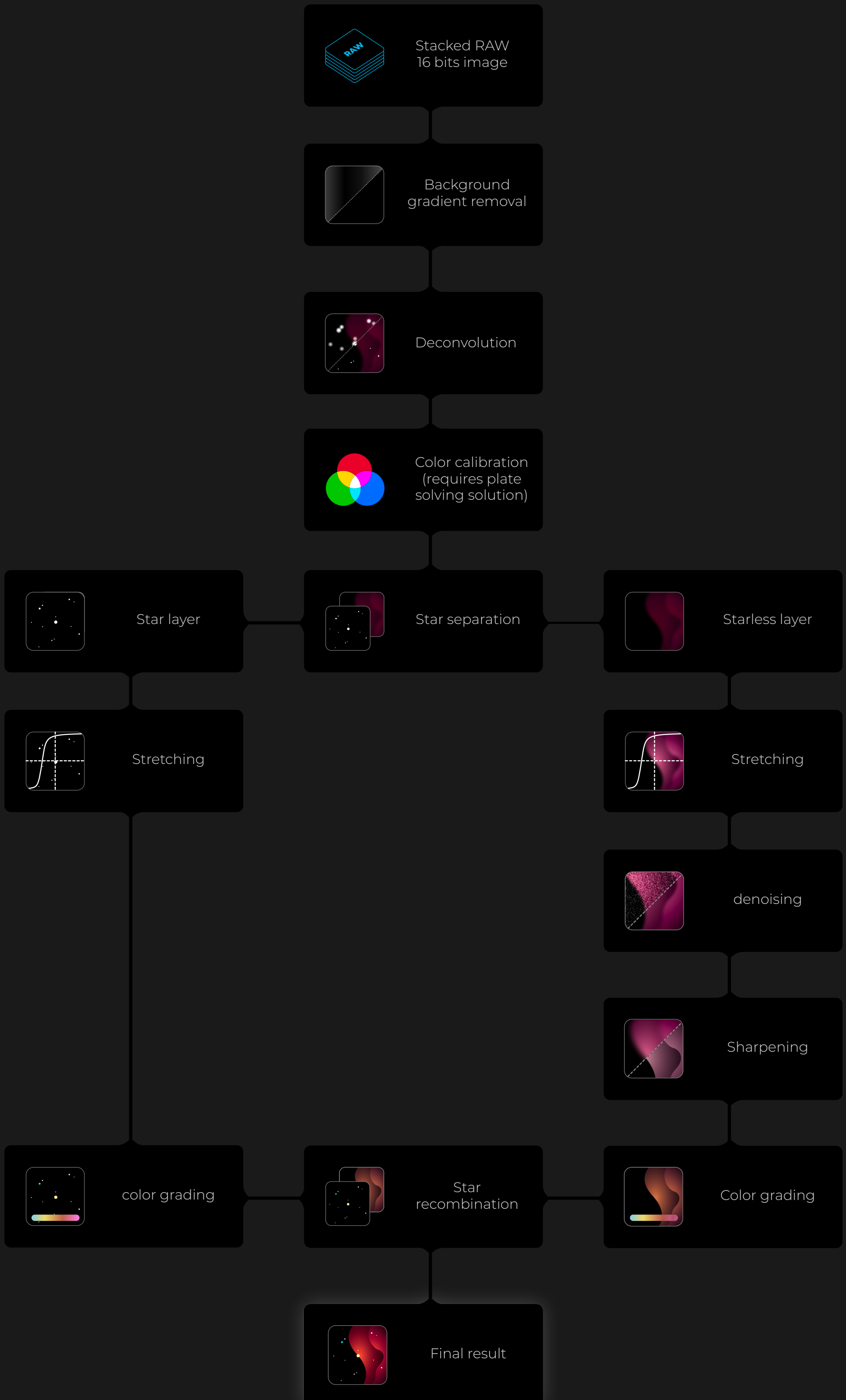
Advanced astrophotography often involves numerous color adjustments. These can highlight specific parts of the object based on its chemical composition, correct color artifacts, or simply enhance the image for aesthetic appeal.

Software : Affinity Photo, Pixinsight, SIRIL

RECOMBINATION AND FINAL STEPS

Once you've processed both the star and deep-sky object (DSO) layers, it's time to merge them, before performing final balancing and adjustments to achieve a polished, stunning astrophotograph.

Software : Affinity Photo, Pixinsight, SIRIL


RAW
Stacked RAW
16 bits image
Background
gradient removal
Deconvolution
Color calibration
(requires plate
solving solution)
Star layer
Star separation
Starless layer
Stretching
Stretching
denoising
Sharpening
color grading
Star
recombination
Color grading
Final result

Maintenance tips for your smart telescope

Using your smart telescope

- While Vespera is safe in light rain as long as the optical arm remains closed, it is not designed to withstand heavy rain. Therefore, if the weather is uncertain, do not leave your telescope outside unattended if it is not sheltered.
- When it is windy, do not install Vespera near sandy or dusty areas to avoid sand grains being blown onto the optics and the shell, or dust being deposited on the lens.
- Avoid exposing the instrument to the sun for too long to prevent the shell from yellowing.
- Before folding the tripod at the end of your observation, dust off the retractable sections of the legs to prevent sand or debris from entering, which could scratch the surface or jam the mechanism.

Cleaning your smart telescope

OPTICAL SYSTEM

Ideally, the front lens should be cleaned as little as possible. In many cases, it's better to leave light dust or faint smudges rather than risk damaging the lens through improper handling. Avoid touching the lens with your fingers to prevent greasy marks and never use abrasive materials that could scratch the surface.

Note: Some dust may be present inside the optical tube. This is normal and does not affect the performance of your smart telescope.

If, despite taking precautions, dust or greasy marks become problematic, here’s how to proceed:

- Ensure the lens is completely dry — there should be no moisture on the surface.
- Gently remove loose dust using a feather brush or a blower (available at most photography stores).

Important: Never wipe the lens while dust is still present, as this could cause scratches.

- If dust is stuck to the lens, apply a few drops of non-calcareous water — preferably distilled water to avoid mineral deposits.
- Once the lens is free of dust, use a soft optical wipe to gently remove greasy residues or smudges. Apply minimal pressure and work slowly and carefully to avoid damaging the coating.

SHELL AND TRIPOD

- You can clean the shell of your smart telescope using a microfiber cloth and an acetone-free household cleaner (such as window cleaner, multi-surface cleaner, or white vinegar).
- Before setup, check the mounting base to ensure there is no debris that could interfere with proper placement on the tripod.
- To maintain smooth operation of the Gitzo tripod legs, you can apply Gitzo tripod grease—available from the Vaonis online store. This helps the legs extend and retract more easily.

Storing your smart telescope

- If moisture is present on the telescope, let it dry in a ventilated area before storing. If you notice moisture on the lens, you can leave the device with its anti-fog system on for half an hour to an hour after your observation.
- If you have to carry it in a crate or bag from your observation site to your home, take it out of the transport crate for a few moments when you get home.
- Following observation in very low temperatures, avoid storing the observation station immediately in a heated area to limit thermal shock and moisture condensation. Leave it for a few moments in a sheltered, unheated and ventilated place.
- When storing the instrument, close the optical arm and use the cover to limit dust deposits on the lens, the connectors and the interior of the telescope.

Travelling with Vespera

Designed for portability and ease, Vespera fits seamlessly into all your observation adventures. Even over long distances, you can travel with it by plane without difficulty.

- When transporting by plane, Vespera must be carried in your carry-on luggage as it contains a battery.
- We recommend using the optional backpack, which complies with the International Air Transport Association (IATA) regulations for carry-on baggage dimensions.
- It is highly likely that the telescope will undergo additional screening at the Transportation Security Administration (TSA) checkpoints at the airport. However, there is no need to worry since agents immediately release the product once its nature is identified.

Securing your smart telescope (Vespera Pro)

The base of Vespera Pro includes a built-in slot designed to accommodate a security cable. This feature allows you to secure the smart telescope—for instance, when mounted on a fixed column or by attaching it to a vehicle or any fixed anchor point.
A combination padlock is provided for this purpose.

HOW TO SECURE VESPERA PRO WITH THE COMBINATION LOCK:

- Open the lock by setting the dials to the default combination (0-0-0) and pressing the side button.
- Thread the lock cable through the security slot on the base of the telescope.
- Pass the other end of the cable through a fixed anchor point, or loop it through another secured cable.
- Close the lock and scramble the dials to secure it.

CHANGING THE LOCK COMBINATION:

While the lock is open:

- Push the small lever beneath the three dials to the right.
- Set your new combination.
- Move the lever back to the left to save the new code.
- Close the lock.

Transferring your Vespera ownership

If you plan to give away or sell your smart telescope, here are the steps to follow to protect your personal data and ensure the new owner can enjoy the instrument:

- Erase Vespera’s internal memory.
- From the Multi-Night screen in the Singularity app, delete any existing Multi-Night projects.
- Send an email to Vaonis customer support including the full contact details of the new owner and the serial number of the instrument.