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NEAF – Origins of Origin // 04.20.24

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origin

INTELLIGENT HOME OBSERVATORY

Celestron Origin was first conceived in 2010, we called the idea the “Eyepiece-less Telescope” at the time. Here are some other things from way back in 2010

iPad first introduced

Instagram launched, and yes, that was the first logo!

Deepwater Horizon explosion and oil spill

President Obama early in his first term

Kobe Bryant and the Los Angeles Lakers won their 16th NBA championship

Taylor Swift became the youngest Album Of The Year winner in Grammy award history at age 20

Corey Lee, now CEO of Celestron, was the VP of Engineering. The following slides are taken directly from his “Eyepiece-less telescope” proposal to Celestron’s Executive Team in 2010.

EYEPIECE-LESS TELESCOPE PROPOSAL

A. OBJECTIVE OF NEW TELESCOPE LINE

To develop a line of computerized telescopes with the capability to image dim objects in the night sky effortlessly. The goal is to redefine the amateur astronomy experience with a “new to the world” product.

B. BACKGROUND OF CONCPETS BEHIND THE PROJECT

The most fascinating objects (faint galaxies, nebulas) in the sky are often the dimmer and harder to see objects. One traditional approach to solving that problem is to use a bigger telescope which increases the size and the cost of the product. Another traditional approach is to take a long exposure image of the objects and view the object as an image on a screen or printed on paper. However, taking images of celestial objects has traditionally been difficult. It requires the user to possess knowledge in multiple area:

EYEPIECE-LESS TELESCOPE PROPOSAL

- Where objects are in the night sky
- Aligning and operating a telescope
- Basics of photography
- “Guiding” if the user is interested in dim objects such as galaxies
- Image processing (i.e. photoshop skills)

Therefore, the interest in the astronomy hobby (aka: size of the astronomy equipment market) may still be limited by the feasibility of owning a large visual instrument, or one’s knowledge of astrophotography. And of course, the cost of the equipments is a big factor. If a new product can be created to make the viewing of the faint objects much easier at a relatively low cost, then we will have a product that can attract more people to the hobby and expand the astronomy equipment market.

EYEPIECE-LESS TELESCOPE PROPOSAL

C. WHAT IS AN “EYEPIECE-LESS TELESCOPE”?

An “eyepiece-less telescope” basically is a hybrid of a camera and a computerized telescope.

The most basic form of an Eyepiece-less telescope is simply to operate, for example, a Nexstar SE in f/2 mode with Starizona’s Hyperstar system and a CCD camera with the following features:

- Computerized telescope mount
- Fast f/2 optics
- CCD camera

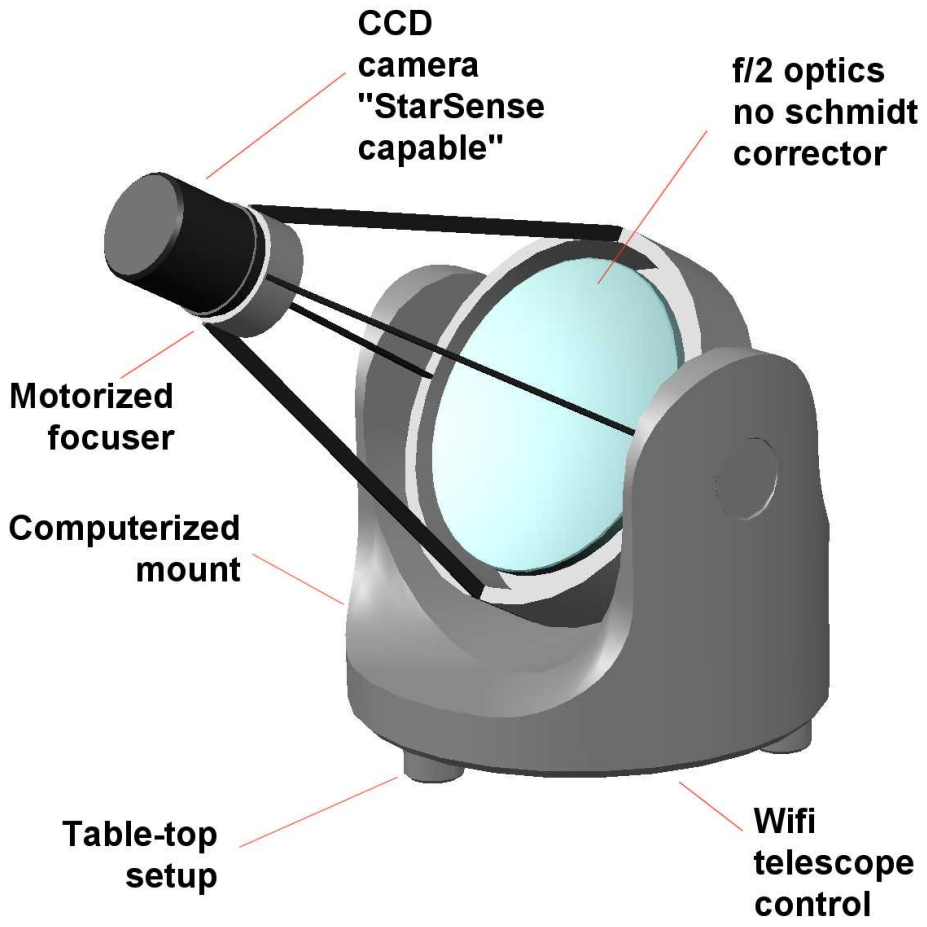
EYEPIECE-LESS TELESCOPE PROPOSAL

To further enhance the experience, the following features (in blue) can be added:

- Computerized telescope mount
- Fast f/2 optics
- Built in cooled color CCD camera
- StarSense automatic alignment technology
- Electronic focusing
- Wifi connection to Laptops or mobile devices for telescope control
- Includes software used for telescope/camera control
- Includes software for fast and easy image processing
- Portable tabletop mount for fast easy setup

EYEPIECE-LESS TELESCOPE PROPOSAL

The resulting product does not need to have any accessories for visual use (eyepiece, diagonal, finderscope, etc.) and can take a form that is very different from a traditional telescope. For example:



Can be controlled by PC or mobile devices

EYEPIECE-LESS TELESCOPE PROPOSAL

D. BENEFITS OF "EYEPIECE-LESS TELESCOPE" TO THE CONSUMER

As a "new to the world" product, the "Eyepiece-less telescope" offers many benefits that are currently not found in products offered by any manufacturer:

- Redefines the amateur astronomy experience
- Easy to setup/breakdown, portable telescope/camera "all-in-one" system
- Sees faint objects digitally that would normally be very difficult to see visually through an eyepiece.
- Create astro-photos to remember the observing experience by and to share with friends and family.
- Easy to get started (StarSense technology and easy image processing software)
- More comfortable to use than conventional telescopes (i.e. can go indoors, comfortably seated, etc.)
- Low cost for an imaging setup, comparing with setup of similar imaging capability of today.

EYEPIECE-LESS TELESCOPE PROPOSAL

E. REQUIRED TECHNOLOGY

1. Computerized telescope technology
2. StarSense Automatic Alignment technology
3. Wifi Telescope control
4. Fast optical system (such as f/2 with Fastar/Hyperstar)
5. Electronic focusing system
6. CCD camera
7. Software for Camera control and for image processing

Green – developed technology

Red – Not yet developed technology that may be the most difficult

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We realized it would take a while to develop all the pieces we would need. So began our journey of developing new technologies products “on the way” to Origin.

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StarSense Technology

First introduced on the SkyProdigy telescope line in 2011, later became our StarSense AutoAlign accessory, which can be used with all Celestron computerized mounts. This allow telescope alignment with no user intervention required via use of an embedded camera and processor.

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WiFi Technology

SkyQ WiFi module and app introduced in 2012, this later evolved into the SkyPortal WiFi module and app, which started our app development partnership with Simulation Curriculum (the makers of SkySafari). This provided wireless telescope control from your smartphone or tablet.

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$LiFePO_4$ Rechargeable Battery Technology

Introduction of the PowerTank Lithium line, which uses perhaps the best battery chemistry available for this application. The Origin uses a similar $LiFePO_4$ battery, ensuring long shelf life without recharging, stable output, and minimal performance degradation over many charge/discharge cycles

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Evolution Mount

Leveraged our experience with altazimuth fork mounts and included integrated WiFi and $LiFePO_4$ rechargeable battery. With some refinements, this later became the Origin mount.

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Rowe-Ackermann Schmidt Astrograph (RASA)

We knew we needed the fastest optical system possible to provide the “almost real time” observing experience we envisioned. We had noted the Fastar development done by Celestron in the late 90’s, and also took note of the popularity of the Starizona HyperStar accessory…but at first we were considering eliminating the Schmidt corrector! After discussing with Dave Rowe, however, we quickly realized that the Schmidt corrector was the key to an extremely fast optical design with little abberations and reasonable complexity.



Interestingly, although we conceived of RASA originally for use in the Eyepiece-less Telescope, we also knew that it had applications for wide-field astronomical imaging and Space Situational Awareness. So, since the Eyepiece-less Telescope still had other technologies needing development, we decided to develop and launch the larger RASA optical tubes first.

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Celestron Focus Motor

Somewhat surprisingly, Celestron did not have a focus motor solution. So we created the Celestron Focus Motor which provides motorized focusing for Celestron SCT/EdgeHD/RASA telescopes. The focus motor in Origin is a variant of this.

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Dew Heater Rings and Smart DewHeater Controllers

This technology was first developed for Origin and then spun off into Dew Heater Rings for all of our Schmidt-Cassegrain/EdgeHD/RASA telescopes. The Smart DewHeater Controllers contain much of the software/firmware that is found in Origin for control of the Dew Heater Ring.

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Imaging Camera

Leveraged our experience in developing previous generations of imaging cameras, including the Nightscape, NexImage, and Skyris astronomical camera lines. Partnered with a leading astronomical camera company to develop the Origin camera. Key to the “almost real time” observing experience is the highly sensitive back-illuminated Sony Starvis CMOS sensor.


```
20:38:52.879  - LED__ Turning ON all LEDs
20:39:00.288 395 - Moved focuser to position: 16965
20:39:00.290 395 - DSA_ sending slew command. destination = 18 rate= 0
20:39:00.290 395 - Task controller is Idle
20:39:00.291 395 - LED__ OriginHardwareSuite set LED Ring by activity: IDLE
20:39:00.291 395 - LED__ request for pattern ALL_ON duration=5000
20:39:20.075 395 - Observation added to imaging session: Rosette Nebula
20:39:20.076 395 - Currently running Task: IDLE  ::   Stage: IN_PROGRESS
20:39:20.076 395 - Schedule new Smart Task: Observing List
20:39:20.076 395 - Cancelling the stacked master cropping
20:39:20.078 395 - Starting Observation List
20:39:20.078 395 - Running current observation
20:39:20.078 395 - Settings WIFI scans pause to true
20:39:20.079 395 - LED__ OriginHardwareSuite set LED Ring by activity: BUSY
20:39:20.079 395 - LED__ request for pattern PLEASE_WAIT duration=1000
20:39:20.167 395 - Performing sanity check on exposure time and iso
20:39:20.887  - LED__ 1 connection(s).  patternWasChanged = true
20:39:20.887  - LED__ starting pattern PLEASE_WAIT  duration= 1000
20:39:23.057 395 - Average brightness: 4710.263207720212
20:39:23.057 395 - Expected at full exposure: 70653.94811580318
20:39:23.057 395 - Dynamic range is too high for high ISO. Default ISO will be used.
20:39:23.067 395 - Sending Error message to user.
```

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Firmware and Software

This is the “brains” of Origin and required more software engineering than any other project ever undertaken by Celestron. We benefited by the rise of the Raspberry Pi, as it provided a low-cost “off the shelf” embedded computer option which made systems integration easier and more flexible.

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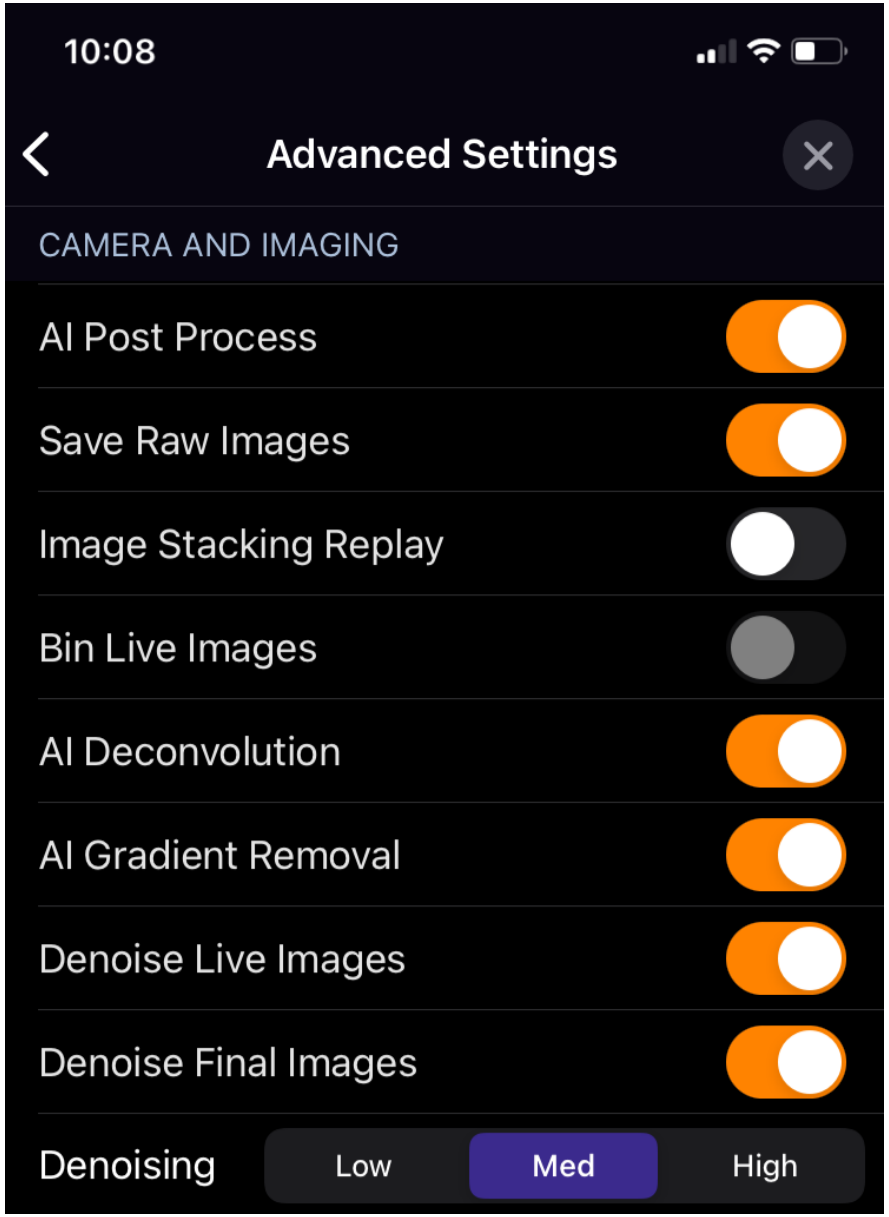
Available on the App Store

Google play

Smartphone not included

Origin App – Powered by SkySafari

Developed in partnership with Simulation Curriculum, this is the user interface for Origin. We had developed the SkyPortal WiFi Telescope Control app and the acclaimed StarSense Explorer app with Simulation Curriculum previously, but this project was much more complex and has taken several years to complete.



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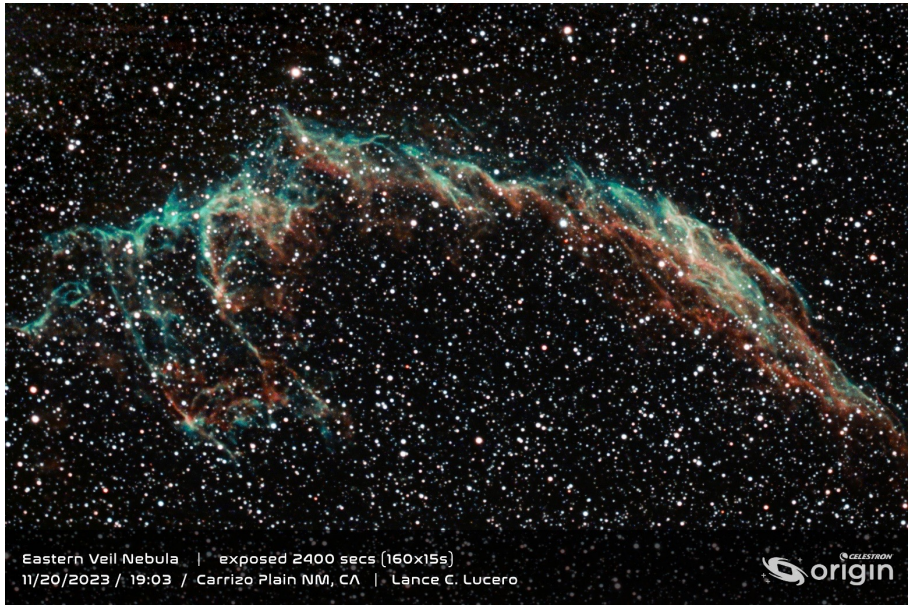
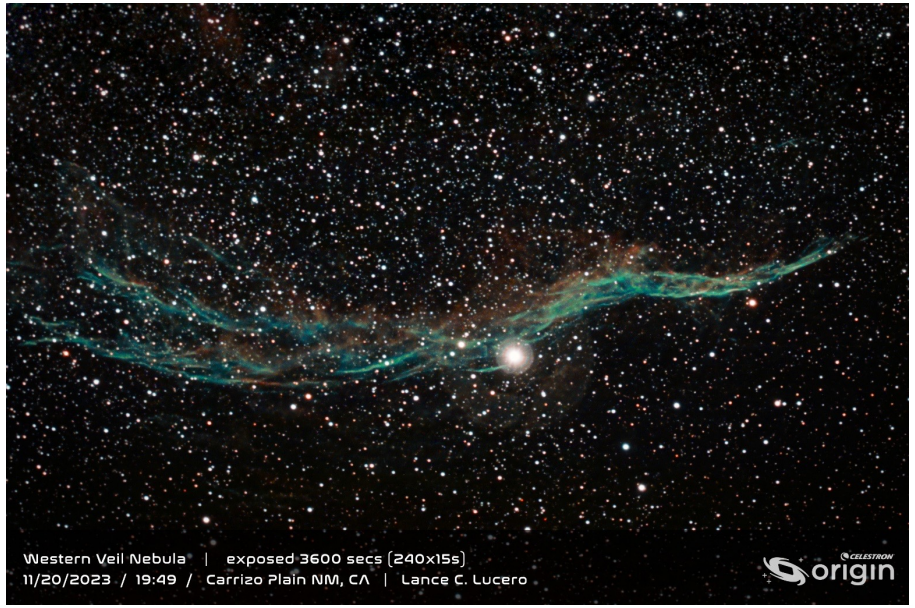
AI Image Processing

Developed by a leading AI firm, the images in the Origin app are automatically post-processed to instantly bring out the best image detail. No data is added, AI just automatically does the work for you. We are not aware of any other true AI astronomical image processing in an app.

All the following images were taken on the same night and processed instantly by AI in the app. With traditional astroimaging and manual image processing, it could literally take weeks to produce similar results.





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Taken with Origin Nebula Filter

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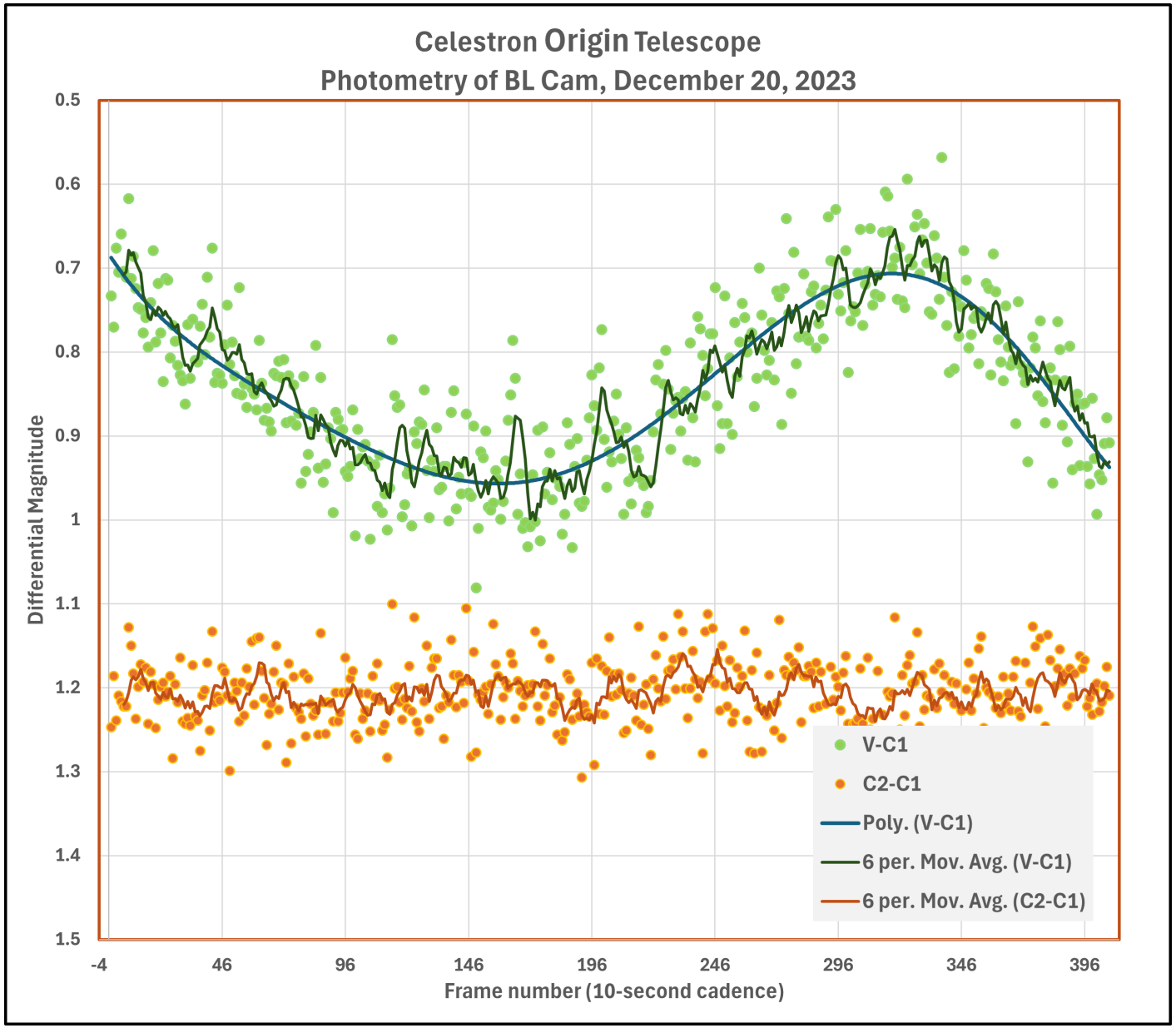
Taken with Origin Nebula Filter



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Science with Origin

This was the easiest light curve I have ever made. The Origin's ability to zero in on the star, track it perfectly for over an hour, and save the data in the FITS format made taking photometry data easy and efficient. As an old-school amateur astronomer, I felt a bit funny operating the Origin at dining room table, but I was also delighted to be taking science data without the hassle.

--Richard Berry

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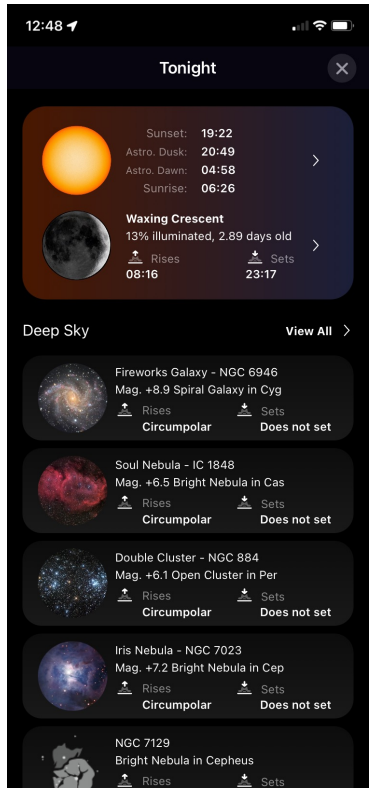
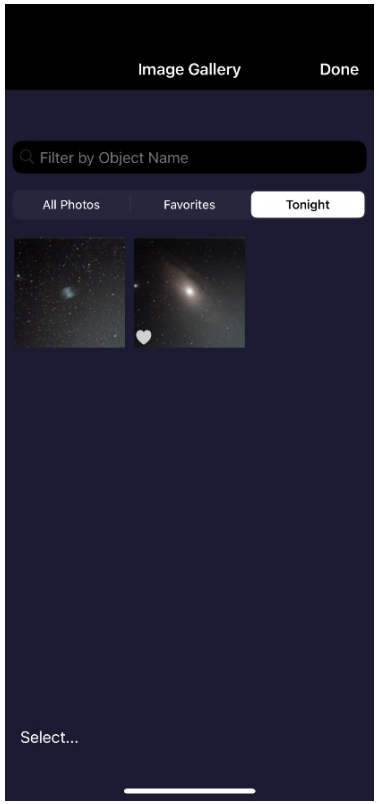


Incredibly Easy to Operate!

1. Power on Origin.
2. Connect your smartdevice running the Orign app to Origin's Wi-Fi network.
3. Once connected, Origin initializes in less than 2 minutes.
4. Select a target from the app's Planetarium View or choose from a list of Tonight's Best objects.
5. Point Origin to the selected object with a button tap.
6. Switch to the app's Camera View and tap the "Start imaging" button. You'll see the first image about 10 seconds after that.



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Incredibly Easy to Operate!

Origin will automatically…

- Focus and align itself to the night sky (initialization)
- Center the selected target using plate solving and precise go-to, tracks the object once centered
- Control the dew heater, applying heat only when necessary to keep the optics free from dew
- Pre-process each sub-exposure using dark frames and flat frames (which are captured and stored beforehand at the factory)
- Stack the subexposures as they are acquired and update the image displayed onscreen (i.e. the “stacked master”)
- Post-processes the “stacked master” using AI and displays it on your device

When you are done imaging, you can save the final stacked image to your device for immediate sharing to your favorite social media platform.

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OPTICS

OPTICAL DESIGN	Rowe-Ackermann Schmidt Astrograph (RASA)
APERTURE	152mm
FOCAL LENGTH	335mm
EFFECTIVE FOCAL RATIO	f/2.2
OPTICAL COATINGS	StarBright XLT coatings throughout
FILTER DRAWER	Integrated, accepts 1.25" or 2" astroimaging filters

IMAGING SENSOR

CMOS IMAGE SENSOR	Sony IMX178LQJ, color, back-illuminated
SENSOR SIZE	8.92mm diagonal
PIXEL SIZE	2.4µm x 2.4µm
NUMBER OF EFFECTIVE PIXELS	6.44M (3096 x 2080)
FIELD OF VIEW	1.27° x 0.85°

INTEGRATED ELECTRONICS

ONBOARD COMPUTER	Raspberry Pi 4 Model B
MOUNT	Computerized GoTo altazimuth mount
DEW PREVENTION	Fully automated heating element integrated into front lens, removable dew shield/lens shade
FOCUS MOTOR	Autofocus or manual control
COOLING FANS	One (1) fan for optics, one (1) fan for electronics, both pull air though vents with wire mesh
LED STATUS RING	Indicates status "at-a-glance"

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PORTS

USB-A	Two (2) on optical tube for accessing raw image files for external processing, one (1) on mount for mobile device charging only
ETHERNET	One (1) on optical tube
AUXILIARY PORTS	Two (2) on optical tube, four (4) on mount

POWER

BATTERY	Integrated LiFePO4, 97.9 Wh, capable of 6+ hours of use
POWER INPUT	12V DC adapter for charging internal battery or running on external AC power

USER INTERFACE

CELESTRON ORIGIN APP	Runs on compatible iOS or Android smartphones and tablets
SYSTEM REQUIREMENTS	iOS 16 or higher, Android 12 or higher

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DIMENSIONS

OPTICAL TUBE	24" x 7" diameter
MOUNT	18" x 12" x 10"
TRIPOD (COLLAPSED)	13" x 12" x 32"
ASSEMBLED SYSTEM	24" L x 26" W x 48" H

WEIGHT

OPTICAL TUBE	10.6 lb
MOUNT	17.0 lb
TRIPOD	14.0 lb
TOTAL SYSTEM	41.6 lb

What makes the Celestron Origin Intelligent Home Observatory so special?

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1. RASA Optical Design

- Origin uses Celestron's patented RASA design, optimized for imaging across the entire sensor
- Origin has a larger aperture and a fast focal ratio, which translates to bright and detailed images in a short amount of time
  - Smaller telescope apertures cannot provide similar resolution, meaning they cannot capture the finer detail Origin does
  - As comparted to F/4 optics, an F/2.2 system provides similar image brightness in about ¼ the time!

2. The Origin App

- App is based on the SkySafari planetarium interface from Simulation Curriculum with features like Compass Mode
- AI image processing in "almost real-time"
- No limits on the objects/coordinates you can image
- Huge database includes all the NGC and IC objects
- Includes object information for even the faintest stars/objects
- Audio presentations for hundreds of the best objects

3. Advanced Functionality for "Growing as You Grow"

- Ability to use any standard 1.25" or 2" imaging filters on the market
- Scheduled observing
- Access to RAW files for stacking and post-processing them using your own software
- Manual camera settings allow you to change exposures and gain independently
- Compatibility with Evolution Equatorial Wedge for taking exposures longer than 30 seconds (Phase 1.1)
- Polar align routine for EQ wedge (Phase 1.1)
- Compatibility with StarSense Autoguider for guiding longer subframes (Phase 1.1)

Post Launch Development Plan

Phase 1.1 – expected by end of 2024

- Wedge functionality
- Polar alignment routine
- SSAG support

Phase 1.2 – sometime in 2025

- Upgrade camera

Phase 2.0 - more speculative (things could change or get added)

- Mosaics
- Identification of all objects in FOV
  - This can also help with AI image processing
- Automatic best camera settings
  - Currently we just use a default of ISO 200 Exp 10 sec. as “auto setting”
  - We envision that Origin can look at the sky and determine best settings by going through a routine
- Region of Interest (primarily to help in low bandwidth scenarios)
- Video capture (primarily for daytime use)

THANK YOU!

For a copy of this presentation, please scan the QR code