Cameron Park Rotary Community Observatory

Project Outline and Budget

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Observatory Operation and Instrumentation Goals

- Facilitate Public Observing Programs.
- Facilitate both visual and digital observing.
- Interface with computer network for remote observing.
- Interface with video distribution system.
- Robotic observing capacity.

Instrumentation Requirements

- Robotic goto mount
- High quality optics
- Scalable and upgradeable
- Meets or exceeds current state-of-the-art for amateur astronomy

Computer requirements:

- Pentium IV Class PC – 1.0 + GHz
- 40 Gigabyte Hard Drive
- 256 RAM
- CD-Rom
- Multi port comm card
- Network card
- 20-inch monitor
- UPS

Facilities requirements.

40'x20' structure with 20'x20' observing room exposed to open sky via a roll-off roof. Facility should include a space to be used as a control room that will house the computer system and other operational electronics. Remaining space can be used for a classroom, storage and display area.

Construction should be conventional (stick and slab) with minimal insulation.

Proposed Instrumentation Packages

To follow are two options for instrumentation, however, pier construction will be designed to allow larger and heavier instrumentation to be installed.

Instrumentation Package A	
2- Custom Pier - 300# Capacity	$1,600.00
2- Celestron C-14 Optical Tube w/ AP-900 dovetail.	$8,000.00
2- Astro Physics G900 German equatorial mount	$16,000.00
Santa Barbara Instruments ST-237 CCD Camera w/ color wheel	$1,694.00
Starizona Hyperstar imaging system C-14	$800.00
Feather Touch focuser	$495.00
Maxim DL Imaging Software	$399.00
Starry Night Pro Software	$129.00
PS164C low lux video camera with adapter	$169.00
Dome camera w/ bracket	$149.99
Tele Vue eyepiece suite	$1,800.00
Contingencies (cables etc.)	$500.00
Estimated Total	**$31,735.00**

Estimate Construction Cost

800 sq. ft. at $50.00 per sq. foot **Estimated Total $40,000.00**

Services and Fee Schedule

Phase 1

- Site Selection
- Determine facility needs
- Identify instrumentation needs
- Create a budget
- Identify outside funding sources

Estimated Total $2,500.00

Phase 2

- Assist in design and generation of architectural plans
- Create an optical instrumentation plan
- Create an IT plan

- Assist in securing outside funding

Estimated Total $5,000.00

Phase 3

- Consult and supervise construction
- Source and install instrumentation

Estimated Total $3,000.00

Phase 4

- Develop and publish a *Policy and Procedures* Manual
- Train staff
- Creation and hosting of an observatory website.
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Estimated Total $1,500.00

Mileage to be billed monthly at $0.33 per mile on Phases 1 through 4 (30@200 miles).

Estimated Total $2,000.00

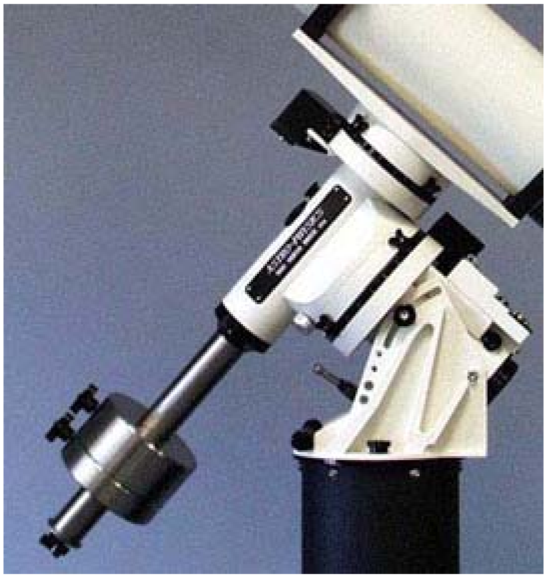
Payments: Phase 1 100% prepaid, Phase 2, 3 and 4 50/50.

Description	Estimated Cost
Instrumentation	$31,735.00
Construction	$40,000.00
NCCAO Fees	$12,000.00
Mileage	$2,000.00
Estimated Total	$85,735.00

Appendix

Suggested Equipment

ASTRO-PHYSICS 900GTO German Equatorial Mount (900GTO)



Stability ... accuracy ... ease of setup ... friendly go-to control interface - these were the primary design goals of the 900GTO. Amateurs today demand a precise mount that will allow them to pursue all aspects of astronomy whether it be observing visually, CCD imaging or photographing with 35mm or 6x7 camera. Many of the finest imagers today have been using our GTO mounts as a solid platform for a wide variety of instruments. The largest of these is our 1200GTO and the next in line is the 900GTO. If your instrument of choice is a medium-sized refractor, Cassegrain, Ritchey-Chretien, Newtonian or astrograph, we invite you to read on.
Since its introduction in 1998, the 900GTO has gained a reputation for both tracking and pointing accuracy, essential to casual visual observation as well as advanced imaging. Quite a few 900GTO and 1200GTO mounts can be found at Mount Pinos in California, favorite observing site of many advanced photographers and imagers.
These mounts are truly a marvel of engineering - maximum strength and rigidity with minimum weight. Our CNC lathes and mills carve out the excess material in both axes of the 900GTO German Equatorial while retaining a heavily ribbed structure for internal strength and rigidity. A unique dovetail was machined into the mating surfaces of the R.A. and Dec axes. This feature allows quick and easy assembly in the field without any tools.

The 900 equatorial is equally at home in a permanent observatory or as a portable mounting for remote star parties thanks to the ease with which the two axes come apart and the reasonable weight of each component; the heaviest is only 25 lbs! Telescopes commonly used include Astro-Physics 155-180mm refractors, 10-11" Schmidt-Cassegrains, 10" Maksutov-Cassegrains and 10-12.5" Ritchey-Chretiens and other scopes of similar size and weight.

The 900GTO mount is built from the ground up to be a precision imaging platform while still being totally user friendly. Consider these advantages and features:

Flexibility

Portable.

Extremely solid, rugged, high payload mount, yet comes apart in two reasonably light-weight components for hassle-free field setup. No tools needed to assemble the mount in the field. Operate with 12V battery. You can take it to the darkest skies and power it with a commonly available 12V battery. In the observatory, we suggest a minimum 5 amp filtered, regulated power supply. External computer not needed.
The keypad is a handheld computer with all of the features, functions and databases you need to tour the

universe night after night. The unique software allows you to precisely polar align your mount in the field, even in broad daylight! The vacuum-fluorescent display with a temperature range of -40 degrees F (and C, they are the same in this instance), allows hardy observers to use this mount on cold winter nights. You can't do that with a PC or PDA device!

All functions of the servo drive can be commanded from a laptop or desktop computer using popular planetarium software. Depending on the features of the program, you can position your telescope, center your image and control tracking rate, remote focusing, reticle brightness and park at the end of your observing session. Examples of currently available software:

- Software Bisque's suite which includes TheSky Astronomy Software, CCDSoft CCD Astronomy Software, TPoint Telescope Pointing Analysis Software and Orchestrate Scripting Software.
- Earth Centered Universe (ECU) by David Lane of Nova Astronomics
- SkyMap Pro 6 by Chris Marriot
- DigitalSky Voice from Astro-Physics by Charles Sinsofsky (included with the 900GTO)

Write your own computer program.

The Astro-Physics GTO protocol is freely available to those who would like to write their own computer program for controlling the mount. While based on the Meade protocol, it has many more features and enhanced precision level which allows pointing and tracking to the 1 arc second level.

Precise Mechanical Fabrication.

Highly accurate mechanics.

Using modern CNC machining techniques, we make all components to a high precision level which results in a final package that is solid and accurate in all respects. The critical angles are accurately machined so that the mount is orthogonal to a very high degree. This results in pointing accuracies well below 1 arc minute for a properly aligned mount.

Critical worm gear accuracy is maintained by special machining techniques developed at Astro-Physics after extensive studies and actual field operation. Our worm accuracies are second to none. With good alignment and PEM training, it is quite practical now to achieve unguided CCD images with today's hi-resolution cameras coupled to a 6" to 12" telescope.

Mechanical Features

- All machined mounting made from aluminum barstock and stainless steel. All fasteners are stainless steel.
- Motors and all electronic components are enclosed
- Ball bearing races.
- Removable 1.875" diameter counterweight shaft.
- Polar and declination axes come apart quickly without tools for light-weight, easy handling and ease of transport
- Fine altitude and azimuth adjustments for quickly and accurately zeroing in on the pole in the field
- Engraved setting circles are Porter Slip Ring Design
- Electronic components rated for industrial and automotive applications
- Base fits into 8" outside diameter pier with 0.125" wall thickness

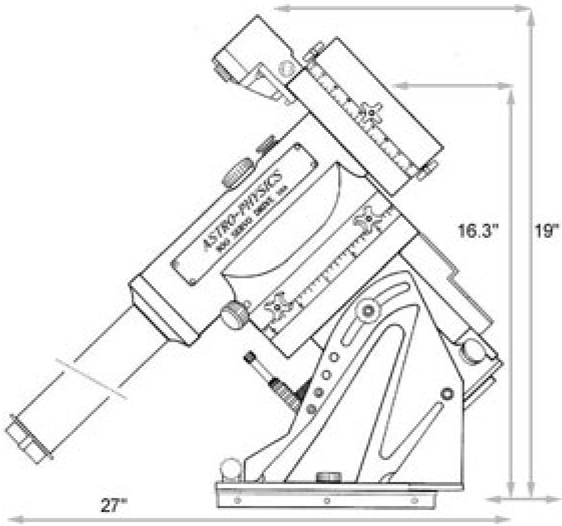
Specifications of Equatorial Head

R.A. worm wheel	7.2" (18.3cm), 225 tooth aluminum
Declination worm wheel	6" (15.2cm), 225 tooth aluminum
Worm gears	Brass
R.A. thrust surface	7.0" (17.8cm)diameter
Declination thrust surface	6.0" (15.2cm) diameter
R.A. shaft	2.2" (5.6cm) diameter
Declination shaft	1.75" (4.4cm) diameter
Latitude range	20 to 68 degrees 0 to 20 degrees with latitude wedge Azimuth adjustment
Azimuth adjustment	Approximately 14 degrees
Setting circles	Porter Slip Ring design, engraved
Right ascension	4 minute increments, pointer, engraved both Northern/Southern
Declination	1 degree increments, pointer
Capacity	Approximately 70 lbs. (31.8kg) scope and accessories, depending on length. Will accommodate Astro-Physics and similar refractors up to 180mm f9, 12" Cassegrains, 12-14" Ritchey-Chretiens Some telescopes are very heavy for their size and will require a larger mount.
Weight of equatorial head	50 lbs (22.2kg), Declination axis is 15 lbs. (6.8kg) right ascension axis is 25 lbs.(11.4kg), counterweight shaft is 10 lbs. (4.6kg)

Servo Motor Drive

The drive system uses a high-quality Swiss DC servo motor controlled by a microprocessor to an accuracy of 0.05 arc-seconds per step. Tracking is very smooth, noticeably smoother than any stepper motor drive or inexpensive servo motor. The system can be accurately controlled over a speed range of 4800:1 which allows 0.25x sidereal for guiding to 1200x sidereal for 5 degree per second slewing. The circuit draws only 0.4 amps when tracking the stars, 2 amps with both motors slewing and requires only 12 volts to operate. The servo drive will satisfy the requirements of the sophisticated, advanced astrophotographer, yet is easy for the casual, visual observer to use. Please refer to GTO Control Box and Keypad for Servo Drive for additional information.

Dimensions



The diagram shows several dimensions that are commonly requested. In addition, if the scope is horizontal and pointing west or south, the measurement from the top of the pier to the middle of the cradle plate is 11.25." Please note that these dimensions will vary somewhat depending on your latitude. We quote them for 42 degrees because that is the latitude of Astro-Physics and all of our equipment is set up that way. It is also a good average value.

CM-1400

The CM-1400 is the largest of Celestron's Schmidt-Cassegrain telescopes, and is most impressive in performance. The large 14" aperture offers 206% more light gathering ability than an 8" telescope does and 96% more than a 10" telescope. Lunar and planetary details are extraordinary when viewed through this instrument, and the large aperture and superb optics of the CM-1400 make for very exciting deep-sky observing of diffuse and planetary nebulae, open and globular star clusters, galaxies and binary stars.

The CM-1400 is a professional quality instrument that's portable enough to transport easily for serious astronomical work, wherever that may take you. The optical performance of this telescope fully supports scientific research and for viewing pleasure, it can't be beat. In addition, some of the finest amateur astrophotographs have been taken with the 14", making this telescope the top choice of many serious astronomers. The mount and tripod supplied with the CM-1400 are the same as those of the CM-1100, with the addition of an extra counterweight for the CM-1400 model.

CM-1400 Specifications:

- 14" (356mm) Aperture
- Focal Length of 3910mm
- Focal Ratio of f/11
- Fastar Compatible Optical Tube
- German Equatorial Mount
- Weight: 164 lbs.
- Made in the U.S.A.

#11065

CM-1400 Standard Accessories:

- Standard 1¼" Accessories Include: Multicoated 26mm Plössl Eyepiece (150x), 2" Mirror Diagonal with 1¼" Adapter and a Visual Back
- 9x50 Finderscope
- Hand Controller Standard
- Rugged Aluminum Tripod

HyperStar

HyperStar is a CCD imaging system, based on Celestron's innovative Fastar optics feature. The revolutionary Fastar optics system allows the secondary mirror to be removed from a Schmidt-Cassegrain telescope and a CCD camera to be placed at the front of the telescope. The result is a much wider field of view and much shorter exposure times.

HyperStar is the actual lens assembly which replaces the secondary mirror. This lens assembly holds the CCD camera and removes the aberrations which are normally taken out by the secondary mirror. HyperStar improves on the original Fastar idea by providing sharper images and even faster speeds than the original Fastar lens.

HyperStar Lens Assembly

How Does HyperStar Work?

With Celestron's Fastar system, removing the secondary mirror is easy. A large ring holds the secondary mirror in its cell in the corrector plate (the glass on the front of the telescope). To use the HyperStar system, this ring is unthreaded allowing the secondary mirror to be removed an placed into a safe holder included with the HyperStar system. The HyperStar lens assembly is then placed into the holder in the corrector plate and the ring is replaced, holding the lens in place. The CCD threads onto the HyperStar lens using the standard T-threads of the CCD (the 1.25" nosepiece is removed from the camera).

CCD Attached with HyperStar

What Are the Advantages of HyperStar?

HyperStar reduces the focal ratio and focal length of the telescope, widening the field of view and allowing for shorter exposure times. Typically, at the back of a telescope, focal ratios of f/10, f/6.3, or f/3.3 are used. HyperStar allows the telescope to operate at f/1.8. This is 30 times faster than f/10 and more than 3 times faster than f/3.3!

However, using an unguided telescope to take images, there is a second advantage. Take the example of an 11" telescope. At f/3.3, the focal length of this telescope is 925mm. At f/1.8, the focal length is only 500mm. Since the magnification is nearly halved, unguided exposure times can be nearly doubled. This means that the real advantage of f/1.8 over f/3.3 is a six-fold increase during a single exposure!

The other advantage of the shorter focal length is a wider field of view, which is almost always advantageous for CCD imaging. Relatively inexpensive CCDs have fairly small chips and therefore narrow fields of view on typical SCTs. By mounting an ST-237A CCD camera to the front of a HyperStar-equipped telescope, the field of view is actually greater than that of an ST-10ME at f/6.3 on the same telescope -- plus equivalent exposures are 12 times shorter with the HyperStar scope!

HyperStar opens up the world of CCD imaging to many more amateur astronomers. High-quality images may now be obtained by casual imagers in a fraction of the time it once took, and for thousands of dollars less!

HyperStar CCD Imaging vs. Film Astrophotography: The left image of the Swan Nebula is a total of 40 seconds of exposure time using the HyperStar system and 11" Celestron SCT. It is an unguided exposure taken from a moderately light-polluted backyard. The image on the right is a 60-minute guided film image taken from a dark site. What used to take hours with film now takes just a matter of seconds!

SBIG ST-237 CCD Imaging Camera

ST-237A CCD IMAGING CAMERA

For several years SBIG has been promoting matching small pixels to short focal length telescopes and camera lenses to achieve wide field CCD images. The earlier SBIG Model ST-5 (Celestron's PixCel 255) achieved much acclaim when used at the f/1.9 prime focus of Celestron's new Fastar SCT telescope. The new Model ST-237A is a new generation CCD imaging camera, with even smaller pixels than the original Model ST-5 and a significantly larger field of view. The camera has 7.4 micron square pixels in an array of 657 x 495 pixels. The very small pixels generate outstanding high resolution images when used with fast focal ratio telescopes, or SBIG's Camera Lens Adapter plus standard camera lenses with focal lengths from 50 to 400 mm. The optical head is only 3.25" in diameter and will accept an optional fully integrated color filter wheel mounted inside the CCD head to support tricolor imaging.

The imaging camera communicates with a PC through a standard parallel port and is supported by the same CCDOPS software that controls the other SBIG imaging cameras. The readout electronics utilize a 16 bit A/D converter and double correlated sampling.

The imaging camera system consists of a thermoelectrically cooled CCD head with a cable that connects to a small separate processor designed to fit nicely underneath a laptop computer in the field. The processor has cables which connect directly to power and the parallel port of a PC. A separate cable connects to the telescope to interface the Autoguider and Track & Accumulate functions.

The ST-237A is ideally suited to the beginner. Its small head, fast focusing update rate and reasonably large field of view make this camera very easy to set up and use on practically any telescope. The ST-237A also has an internal mechanical shutter in addition to the CCD's electronic shutter. This feature is seldom found on cameras in the price range of the ST-237A. A mechanical shutter allows the camera to automatically take dark frames at any time without having to remove the camera from the telescope to cover its detector or manually cover the telescope's aperture. The fact that it appeals to beginners however belies its extraordinary sensitivity. The Texas Instruments TC-237 CCD boasts the highest quantum efficiency of any CCD camera currently available to amateurs costing less than several thousand dollars! With extraordinary sensitivity from UV to Infrared, this camera is a very capable instrument.

Moon. 0.1 second Model ST-237 image taken at the prime focus of a Celestron C-8. *Courtesy Nuno Costa*

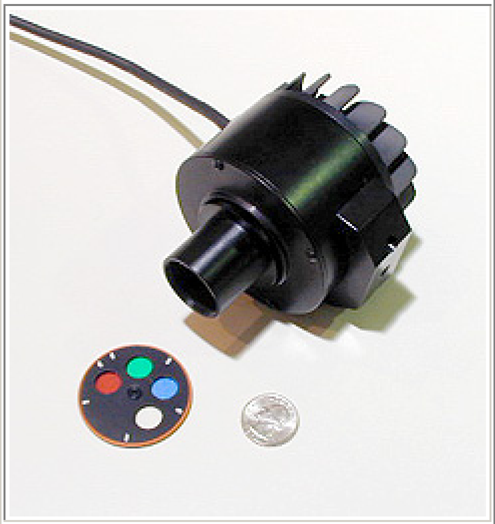
We have received images from customers taken through standard camera lenses of the entire M31 Andromeda Spiral Galaxy, an object with approximately 4 degrees diameter in one axis. Two minute CCD images display dark lanes and structure in the spiral arms equivalent to one hour astrophotographs. The high resolution and small pixels also make the ST-237A an outstanding camera for solar, lunar and planetary images.

Jupiter. Taken in near IR with the ST-237 camera on 12/10/98. *Courtesy Brian Colville*

If you have an interest in wide field searches for near earth asteroids, supernova, etc., the Model ST-237A and the Celestron Fastar SCT will be of great interest to you. If you are interested in very high-resolution planetary imaging where structure and detail are prominent, the Model ST-237A, used with longer focal length refractors or SCT's, is an ideal system. This intermediate priced instrument, that will reach magnitude 14 in one second at the prime focus of an 8", f/10 SCT, is recommended as a "first imaging camera" for those just starting in the field.

F/1.95.

M42. Color LRGB image taken with an ST-237 camera equipped with an internal color filter wheel. Each LRGB frame is an 8 x 15 second Track & Accumulate exposure through an 8" Fastar telescope at F/1.95.
Courtesy Chris Anderson



The internal CFW5C Filter Wheel

With the addition of our CFW5C internal filter wheel, both high resolution grayscale and high resolution color imaging may be performed with one camera. The filter wheel contains custom dichroic RGB filters with high transmission characteristics as well as a clear filter matched in thickness for parfocal operation in optical systems as fast as F/1.95.

Model ST-237A CCD Specifications

CCD	TI TC-237
Pixel Array	657 x 495 pixels 4.7 x 3.6 mm
Total Pixels	307,000
Pixel Size	7.4 x 7.4 microns
Full Well Capacity	20,000e^-
Dark Current	5e^-/pixel/sec at 0° C
Antiblooming	Fixed 100x

Readout Specifications

Shutters (2)	2 Position Wheel, Internal (RGB Ready) Plus Electronic Shutter
Exposure	0.01 to 3600 seconds, 10ms resolution
Correlated Double Sampling	Yes
A/D Converter	16 bits
A/D Gain	0.72
Read Noise - Typical	14e^-
Binning Modes	1 x 1, 2 x 2, 3 x 3
Pixel Digitization Rate	30 kHz
Full Frame Download	10 seconds
Half Frame Download	3 seconds
Quarter Frame Download	1 second
Focus Frame Update Rate	up to 2 frames per second with CCDOPS for Windows ------------------------------ up to 3.8 frames per second with CCDOPS for DOS

Optical Specifications (8" f/10)

Field of View	8.1 x 6.2 arcminutes
Pixel Size	0.8 x 0.8 arcseconds
Limiting Magnitude	Magnitude 14 in 1 second
(for 3 arcsec FWHM stars)	Magnitude 18 in 1 minute

Optical Specifications using FR237 Focal Reducer (8" F/10 parent OTA)

Field of View at F/5.95	13.5 x 10.1 arcminutes
Pixel Size at F/5.95	1.3 x 1.3 arcseconds
Field of View at F/3.75	21.4 x 16 arcminutes
Pixel Sixe at F/3.75	2.0 x 2.0 arcseconds

System Specifications

Cooling	Single Stage Thermoelectric, Active Fan, -25 from Ambient Minimum
Temperature Regulation	±0.1°C
Power	12 V AC/DC 1.2 amps, Transformer included
Computer Interface	Standard Parallel Port
Computer Compatibility	PC - MS-DOS, Windows 95, Macintosh with optional SCSI adapter
Guiding	Autoguiding & Track & Accumulate

Physical Dimensions

Optical Head	3.5" diameter x 3"deep, 7.5 cm diameter x 7.5 cm deep, 1.2 pounds/0.5 Kg
CPU	8 x 10 x 2 inches 20 x 25 x 5 cm 2.4 pounds/1.1 Kg
Mounting	T-Thread, 1.25" included
Backfocus	0.66 inches/1.7 cm