Student Technology Fee Proposal
A Telescope for Astronomy Education at Florida State University

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Department of Physics, College of Arts and Sciences, December 2, 2016
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SUMMARY

This proposal seeks funding to bring the first science-grade, educational telescope to Florida State University (FSU). This state-of-the-art and cost-effective telescope will immediately benefit FSU and its students. The proposed telescope model has been installed and operated by several major US institutions with excellent results. It is commercially available and will be shipped and installed within three months. The recent growth and vibrancy of the astrophysics program means that FSU now has the expertise to expand the scope, depth, and quality of its curriculum for both undergraduate and graduate students. If funded, this high-profile telescope will offer an exciting and profound educational experience for thousands of students every year.

BACKGROUND

In 2009, the FSU Physics Department established a new baccalaureate degree program in astrophysics which now has a full curriculum with ten distinct lecture courses at both the undergraduate and graduate levels. Since then, student interest in the program and in education in astronomy as a whole has grown rapidly. This is evident from the ever increasing enrollment in the astrophysics undergraduate and graduate programs, now reaching a student body of 70, and in its very popular astronomy courses offered to non-science majors, routinely reaching over 1,000 students a year. In response to this growing demand, the university added four new tenure-track astrophysics faculty since 2013.

Observing with a telescope is fundamental to modern astronomy and is one of the most awe-inspiring acts of scientific data collection. Nearly every astronomer started their career path on a telescope, and all remember that experience as a seminal and inspirational moment. In particular, many of the astrophysics faculty members here at FSU began their astronomy training on teaching telescopes hosted by their undergraduate home institutions. While we provide a solid education in the lecture-room environment, observational experience is sorely missing for FSU students. In 2015, the astrophysics group established a strategic plan to strengthen the observational aspect of the students' education. This proposal represents the important first step toward that goal.

PROJECT DESCRIPTION

We request funding for a science-grade teaching telescope which is currently not available for students at FSU. An accessible modern telescope will have immediate, direct and lasting impact on the quality of astronomy education for more than 1,000 non-science majors, the vast majority of physics majors, and every undergraduate and graduate student enrolled in the growing astrophysics program each year.

Figure 1. The left panel shows the PlaneWave 17-inch diameter mirror telescope proposed here. The right panel shows an image of the galaxy M81 (lower left) and galaxy M82 (top right) and a recent stellar explosion, supernova SN 2014J (yellow crosshair), taken with the same PlaneWave 17-inch telescope (credit: James Morse).

The proposed acquisition of a PlaneWave 17-inch telescope will benefit science and non-science majors alike. The telescope along with the mount for pointing/tracking and the camera for recording the observations are all commercially available. This particular system has been installed and operated by several major US institutions, including the University of Miami, University of Louisville, and Texas Tech University, for the purpose of teaching and observing projects. While the system is state-of-the-art, it has been proven to be the most reliable and cost effective option for providing students with observational experience.[1]

The proposed telescope and an actual image taken using the same model are shown in Figure 1. The image demonstrates two important advantages of this model. First, the size of the primary mirror is the most important specification for a modern telescope and determines the amount of light that can be collected from astronomical objects. The relatively large mirror, 17 inches in diameter, makes thousands of deep sky objects available to the students. Second, the wide field capability with negligible distortion is unique to this series of PlaneWave telescopes. This is illustrated with the image in Figure 1, capturing two large angular size galaxies in one shot. These advantages allow a variety of student projects, studying objects as nearby as the asteroids, moons and planets in our own solar system, stars and stellar nurseries in our Milky Way Galaxy, and as distant as violent stellar explosions from other galaxies.

[1] The Department of Physics currently owns several small Celestron telescopes which are being used in the astronomy lab course AST1002L.. They range in mirror size up to 8 inch in diameter. These Celestron telescopes are suitable for many projects in the introductory astronomy lab, but they are not adequate for a more advanced science curriculum.

The telescope will be located on campus to allow students easy access. We are currently examining three sites on campus for air current, darkness, visibility, and accessibility and will select one which will house the telescope permanently. In the meantime, immediate student access will be ensured by the proposed portable pier design that will allow interim telescope operation at a temporary site, if needed.

With a modest investment in a science-grade telescope, FSU students can reap a wealth of educational gains. Such a project will serve our diverse student population that includes non-science majors, physics majors, and graduate students. The project will no doubt offer FSU students the thrill of scientific discovery as well as proper professional preparation.

IMPACT ON INSTRUCTION

For science and non-science students alike, there is nothing more educational or inspirational than operating a telescope, taking observational data, and extracting knowledge about our place in the Universe. The proposed telescope will be central to the astronomy education at FSU, improving instruction on a wide variety of topics, such as telescope optics, astronomical instrumentations, spherical trigonometry, observational and calibration techniques, data reduction, image processing, data analysis, scientific programming and astrostatistics. The hands-on experience cannot be matched by learning the same concepts from a textbook alone.

The introductory astronomy courses for non-science majors, *Planets, Stars, and Galaxies* (AST1002), and the accompanying laboratory course, *Introductory Astronomy Laboratory* (AST1002L) provide students with the basic knowledge in astronomy. These courses fulfill the liberal studies Natural Science and Laboratory requirements, and are some of the most popular Natural Science courses offered at FSU. The observational aspect of astronomy is a major component in the curriculum. In fact, half of the laboratory course is taught outdoors at night, performing observations with naked eyes, binoculars and small Celestron telescopes. The addition of the 17-inch telescope will greatly increase the number of astronomical objects students can observe and enhance their learning experience.

For students in the physics major, the telescope will be a great asset for their professional preparation. The courses, *Observational Techniques* (AST4211) and *Astrophysics Laboratory* (AST3721L) will be most directly impacted by the addition of the telescope. These courses teach the principles and techniques used in obtaining modern astronomical data. Other upper-level astrophysics courses will also benefit from individual observing or computer projects related to the course material. Currently, the student projects mainly rely on telescope data collected from observatories that belong to other institutions. The proposed telescope makes possible a wide range of student projects, while providing the hands-on data collection which is lacking for our students today. Students will also participate in computer software projects to develop upgraded telescope control, automated scheduling, and remote observing capabilities. The depth and the accuracy the telescope provides will afford our graduate students an opportunity to conduct cutting-edge research experiments.

We summarize the number of students who will be impacted by the acquisition of this telescope as follows:

Course	Course Title	Number of students per academic year[2]
AST1002	Planets, Stars, and Galaxies	1200
AST1002L	Introductory Astronomy Laboratory	500
AST4211	Introduction to Astrophysics	25
AST3721L	Astrophysics Laboratory	10
AST4217/PHZ6937	The Physics of Stars	10
PHZ4316/PHZ4513	Nuclear Astrophysics	15
AST4414	Cosmology	12
AST4419	Extragalactic Astronomy	10
PHY4936/PHY5685	Hydrodynamics in Astrophysics	9
AST4722	Observational Techniques	6
PHY8985	Ph.D. Thesis Defense	2

PROJECT PLAN AND TIMELINE

All of the budgeted items have been pre-selected at the vender, Durango Skies, and are available off the shelf and ready to ship immediately upon ordering. The on-site assembly will be provided by the vendor within approximately three months after the order is made. We anticipate that the telescope will be fully operational by July, 2017. The project team is actively preparing lectures and experiments designed around the telescope, and will perform test runs on the telescope, mount, camera, several sites, as well as refine the teaching experiments during the summer months. The telescope will be available to the students starting the Fall semester of 2017.

RELATIONSHIP TO OTHER UNIVERSITY ACTIVITIES

The study of the cosmos captures the imagination of the public and inspires the next generation of students to pursue an education in the STEM fields. The growing FSU astrophysics outreach program includes the FSU Pat Thomas Planetarium and hosts up to 6,000 visitors a year. The new telescope will be an integral part of this effort, and will no doubt reach further into the community and increase the profile of the university and our science education. We will use these resources to present interesting astronomical objects and events, and the latest advances in astrophysics to FSU students, teachers as part of their training, classes from public schools, and the general public.

PROJECT TEAM QUALIFICATION

The project team consists of the faculty members in the astrophysics group in the Department of Physics. We have a wide range of skill set relevant for this project. Our experience includes telescope and instrument development, and thousands of hours of teaching and observing using both small and large telescopes from around the world. The project team will keep the telescope properly maintained and design a full curriculum around it. The Physics department also hosts full machine and electronics shops with expert staff.

[2] The number of students for each course is averaged over academic years 2014/2015 and 2015/2016.

The vendor, Durango Skies, has years of experience assembling telescopes and mounts and has installed the exact proposed system several times in the past at other US institutions. The requested amount includes on-site assembly by the vendor.

BUDGET AND JUSTIFICATION

With recent technological advances, science-grade telescopes and cameras are now commercially available at drastically lower costs compared to only a few years ago.

Component	Amount
Telescope, mount and pier + shipping	$45,872
Dome and enclosure + shipping	$34,325
Total requested	***$80,197***

The Planewave 17-inch diameter telescope mirror will make a large number of deep sky objects available to the students and at the same time provide enough light collection for a variety of scientific experiments. The quoted cost also includes a focuser and assembly necessary to mount an astronomical instrument (an imaging camera in our case), a finderscope for an ultra-wide field of view to find the desired target, a light shroud to block any stray light from entering the optics, and a heater to prevent condensation from forming on the mirror.

The Paramount telescope mount will provide accurate pointing and tracking for long exposures of distant objects, while the telescope control system, including the software and a computer, is budgeted within this item. The computer will host the telescope and dome control systems and future software developments to improve the telescope's capabilities.

For student experiments, a camera is required to collect the data from the observations. The proposed SBIG camera provides enough pixels to match the wide field capability of the PlaneWave telescope, and includes an internal cooling mechanism to keep electronic noise to a minimum. Within this item, filters are included such that the wavelength range of the light collected is known precisely. An eyepiece is also included here for the projects that will require students to observe directly through the telescope.

The fiberglass dome and stainless steel assembly will shelter the telescope from weather and block out stray light and wind during observations. The item also includes a shutter and motor drives. A computerized control system is provided to synchronize the direction of the shutter opening with that of the telescope pointing.

COST OF ONGOING SUPPORT

The ongoing operating cost, such as electricity and upgrades, will be provided by the Department of Physics and other funding sources.

Durango Skies, LLC

Estimate

PO Box 1323
Durango, CO 81302

Name/Address
Florida State University Eric Hsiao

Date	Estimate No.	Project
12/02/15	2015-85	

Item	Description	Quantity	Cost	Total
CDK17	The PlaneWave Instruments CDK17 is a 17 inch (0.43 m) f/6.8 Corrected Dall-Kirkham Astrograph telescope. The CDK17 has a dual carbon-fiber truss design, with 3 cooling fans ejecting air from the back of the telescope. The CDK24 covers a 52 mm field of view without any field curvature, off-axis coma, or astigmatism. The instrument weight is 94 lbs (43 kg). The CDK (Corrected Dall-Kirkham) Optical Design is an innovative solution for unsurpassed astroimaging quality at an affordable price. The CDK telescope design provides excellent imaging with large format CCD cameras while remaining superb for visual use. The CDK design far exceeds the off-axis performance of most commercial telescope designs including the Ritchey-Chrétien design.	1	22,000.00	22,000.00T
200340	The Hedrick focuser designed by PlaneWave is a heavy duty no-slip focuser capable of handling an imaging payload of up to 20lbs. The focus tube runs on 5	1	1,000.00	1,000.00T
			Total	

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	bearings and is driven by a leadscrew so there is no chance of slipping. Focus may be automated through a computer using PlaneWave's EFA Kit add-on. The focuser comes with pre-installed motor that can be controlled with the EFA hand control or PWI PC software. The draw tube travel is 1.3 inch.			
240901	Planewave EFA Kit for CDK17. The EGA kit automates focusing, temperature monitoring, control of accessories and control of fans. The kit comes complete with a 12VDC servo motor, motor mounting bracket and a set of bevel gears. The electronics are integrated into the back plate of the CDK17.	1	1,000.00	1,000.00T
170970	CDK17 Light Shroud	1	150.00	150.00T
600195	Delta T Heater	1	650.00	650.00T
170990	Piggyback Dovetail Assembly - A set of two brackets and a Losmandy style dovetail for mounting accessories on your CDK17 Optical Tube.	1	349.00	349.00T
200399	This adapter slides into the 3.5" Hedrick	1	160.00	160.00T
			Total	

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12/02/15	2015-85	

Item	Description	Quantity	Cost	Total
200985	Focuser and steps the 3.5" opening down to 2" for standard 2" accessories. The adapter also adds some additional spacing to optimize the use of a 2" diagonal so focus is reached with most eyepieces. The finder mounting plate attaches to the back plate of the telescope and the quick release finder bracket attaches to the mounting plate. The finderscope is a Celestron 9x50 with a cross hair.	1	299.00	299.00T
SHIP	Shipping Charge (ESTIMATE)		600.00	600.00
COMMENT	Delivery timeframe is 3-5 months from time of order		0.00	0.00
COMMENT	Telescope downpayment is 50% of telescope order		0.00	0.00
ME-II	The Paramount ME II features a more robust frame than it's predecessor the ME, while retaining the accuracy and performance you expect from a Software Bisque mount. With 8" RA and declination bearings, virtually backlash-free belt-drive and a maximum of 7 arc seconds of	1	15,000.00	15,000.00T
			Total	

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Item	Description	Quantity	Cost	Total
	periodic error before correction, the MEII is a popular choice for the PlaneWave CDK12.5, CDK14 and CDK17 telescopes.			
600132	8" Extension Bar	1	175.00	175.00T
600129	30 lb. Counterweight for Paramount ME	2	350.00	700.00T
600151	The Paramount ME II Large Dovetail is an optional accessory that enables the Paramount ME II's Versa-Plate to accept the Planewave CDK17/20/24 dovetail. The large dovetail is rated to carry 113 kb (250 lb.).		299.00	299.00T
SHIP	Shipping Charge (ESTIMATE)		500.00	500.00
COMMENT	Delivery timeframe is 1-2 months from time of order		0.00	0.00T
ObsProd	Advanced Telescope Systems portable telescope piers meet the exacting requirement of a rigid base for your observing platform while being very portable, extremely solid, easily leveled and impervious to all weather. 36" Height. 550 lb load rating.		2,400.00	2,400.00T
ObsProd	Paramount ME and ME II (ATS Adapter)		350.00	350.00T
			Total	

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Date	Estimate No.	Project
12/02/15	2015-85	

Item	Description	Quantity	Cost	Total
SHIP	Shipping Charge (ESTIMATED)		240.00	240.00
	Out-of-state sale, exempt from sales tax		0.00%	0.00
			Total	$45,872.00

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Date	Estimate No.	Project
12/03/15	2015-89	

Item	Description	Quantity	Cost	Total
COMMENT	15' Standalone Dome Section		0.00	0.00
PD15	The Pro-Dome PD15 model is a complete fifteen foot diameter fiberglass observatory for standalone use. It includes four dome quadrants, rear cover, shutters, dome support ring, 12" high base ring with molded semi-door section, locking hardware and stainless steel assembly hardware. The PD15 also includes electric shutter and dome rotation drives with power supply.	1	18,750.00	18,750.00T
WR15	Fifteen foot diameter wall ring (7 pieces, 12" high) matches the PD15 base ring. One or more wall rings may be stacked to increase wall height of PD15. Includes molded semi-door section and hardware. *** Adding or removing wall rings affects the cost of Pre-Assembly.	3	1,995.00	5,985.00T
DDW	OPTIONAL: Digital Dome Works (DDW) is a computer based automation system which allows you to open and close the shutter, and control the dome azimuth so that it	1	1,950.00	1,950.00T
			Total	

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12/03/15	2015-89	

Item	Description	Quantity	Cost	Total
	matches the telescope position. software that presents all control and operating data to the user. ASCOM compatible.			
COMMENT	Without automation, operators will use the supplied hand controller to move the dome to the telescope position. *** Adding DDW affects the cost of Pre-Assembly.		0.00	0.00
TI-Preassembly	All dome assembly holes are pre-drilled and the dome is completely constructed with all accessories, and then put through a complete series of tests. This work is done at the factory prior to shipping. When disassembled for crating, as many parts as possible are left in place and seams and parts are carefully marked. Cost is 15% of the dome components		4,003.00	4,003.00
CRATE	Crating Charge		835.00	835.00
SHIP	Shipping Charge (ESTIMATE)		1,200.00	1,200.00
TAX	State Sales Tax (ESTIMATE)		1,602.00	1,602.00T
			Total	$34,325