

Original

REQUIRED COVER PAGE**APPLICATION FOR FACULTY RESEARCH GRANT**

**All questions must be completed to be considered for grant award.

Choose one: <input type="checkbox"/> Creative <input checked="" type="checkbox"/> Research	Date of Last FRG Award (Semester and Year awarded): <u>N/A</u>
	Date of ATU Faculty Appointment (Semester and Year): <u>Fall 1997</u>

1. Project Title: NEO-PHA Observations
2. Name of Principal Investigator/Project Director: Dr. Jeff Robertson
3. School (abbrev): PLS 4. Department: Physical Sciences
5. Campus Mail Address: Jeff Robertson, McEver 6. PI/PD Campus Phone: 964 0548
7. Amount Requested: \$ 2,000.⁰⁰ 8. Total Cost of Project: \$ 2,095.⁰⁰
9. Does this project involve: 10. Duration of Project: 30 weeks (~Nov '06-May '07)

Yes No

- ☐ ☒ human subjects?
- ☐ ☒ animals/animal care facility?
- ☐ ☒ radioactive materials?
- ☒ ☐ hazardous materials? We are observing potentially hazardous materials.
- ☐ ☒ biological agents or toxins restricted by the USA Patriot Act?
- ☐ ☒ copyright or patent potential?
- ☐ ☒ utilization of space not currently available to the PI/PD?
- ☐ ☒ the purchase of equipment/instrumentation/software currently available to the PI/PD?

NOTE: If the answer is "yes" to any of the above questions, the investigator must attach appropriate documentation of approval or justification for use/purchase.

SIGNATURESDepartment Contribution (if applicable): \$ 95

Account Number: _____

Jeff Robertson 2006 Sept 12
Chairperson Date

School Contribution (if applicable): \$ 0

Account Number: _____

M. Johnson 9-12-06
Dean Date

This Section to be completed by the Office of Academic Affairs

FSBA Committee Award Recommendation: Yes _____ No _____

FSBA Committee Proposal Rank: _____ of _____ Total Proposals.

Recommendation of VPAA: Yes _____ No _____

Recommendation of President: Yes _____ No _____

Award Date: _____

Near Earth Object, Potentially Hazardous Asteroid Observations

Dr. Jeff Robertson

ABSTRACT

Near-Earth Objects (NEO) are asteroids or comets that have been nudged by the gravitational attraction of nearby planets into orbits that allow them to enter the Earth's local neighborhood, sometimes having Earth-Orbit crossing trajectories that cause them to be labeled Potentially Hazardous Asteroids (PHA). The purpose of the proposed research will be to involve undergraduates in a campaign to gather observations of minor planets. Follow up observations of NEO-PHAs both newly discovered and those with poor orbital elements will be obtained, analyzed and processed to yield celestial coordinates that are then submitted to the Minor Planet Center database at the Harvard-Smithsonian Center for Astrophysics. These coordinates are used to accurately calculate and refine the orbits of these objects and determine their trajectories and earth impact hazard probabilities.

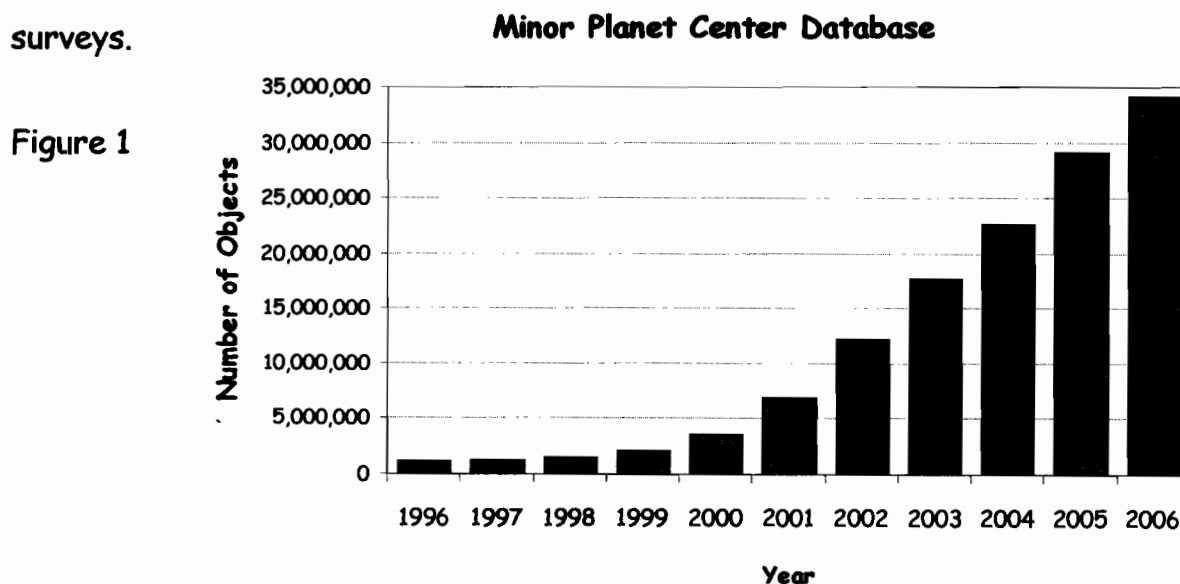
PURPOSE / OBJECTIVES

The primary objective of this research is to provide follow-up observations of minor planets designated NEO-PHA. In short, we'd like to help find the next "dinosaur killer" before it smacks us unawares and ends our time here on earth.

SIGNIFICANCE / NEED

Large collaborative research surveys are finding thousands of targets demanding an increased capability to perform follow-up astrometry. Figure 1 shows the number of known minor planets over the past 10 years. New discoveries are accelerating by the increased size and use of survey telescopes and the increase in technology available to

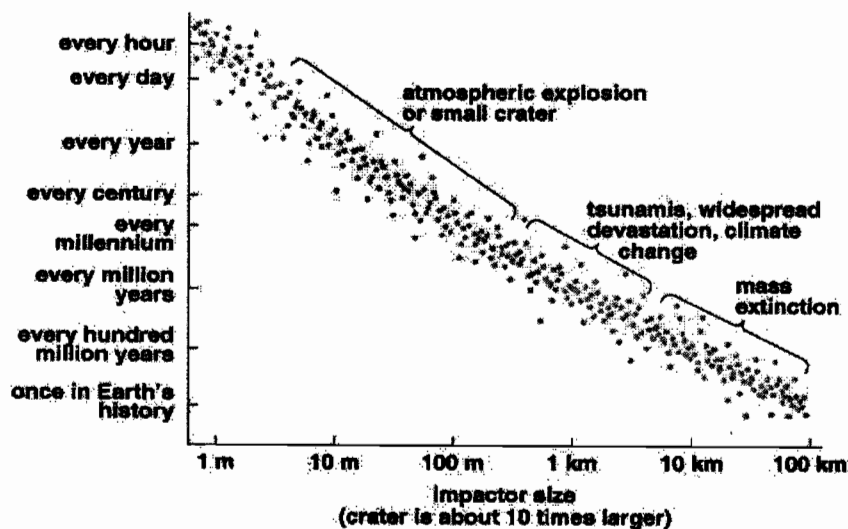
astronomers during this time as Department of Defense technology used by the navy and air force for identifying and tracking high speed ballistic targets in low earth orbit and/or at high altitudes became declassified and put to work in the astronomical community. The trend in figure 1 leads many astronomers to estimate that fully ~75% of these objects are YET TO BE DISCOVERED! Many of the current new discoveries of minor planets are lost within a few days due to the lack of follow-up activity and long-term positional astrometry needed to lengthen the known trajectory paths and to refine the orbits of these objects, some of which may be potentially hazardous asteroids. With enhanced capabilities to recover fainter objects, we will be able to increase the quantity and quality of follow-up observations used to upgrade poorly known orbits of NEO-PHAs that are currently being discovered by these large scale surveys.



Observations submitted by the ATU astronomical observatory will contribute to the development of accurate orbital parameters and trajectory predictions of NEO-PHAs, and reduce the loss of these objects resulting from lack of timely follow-up observations and positional astrometry. Improved accuracy in their predicated orbits will aid NASA in solar system missions and in fulfilling its congressional mandate to

identify potentially hazardous space objects. The probability of a major impact on the Earth is remote, on the order of the likelihood for the typical American to die in a plane crash. However, impacts with the Earth occur daily for particles the size of dust grains to the size of your fist. The history of the Earth shows that the potential hazard from very large bodies has happened in the past and will happen again. Figure 2 illustrates this, showing the occurrence of impacts by asteroids and comets as a function of their size. The potential harm to our environment is catastrophic for large impacts. Over 65 million years ago the dinosaurs probably did not consider large impacts to be any big deal. The isolation and remoteness of Siberia probably kept the last modestly large impact on the Earth at Tunguska (1909) from being very significant, however, no one can deny that if any single fragment of comet shoemaker/levy-9 had hit the Earth rather than Jupiter in 1994, the Earth itself would certainly not be here at all. This research is directing energy at helping to discover and map potentially hazardous asteroids that could harm the Earth's environment in a cataclysmic way. By discovery, classification and predicting their orbits we hope to reduce their potential "impact."

Figure 2



PROCESS FOR ATTAINMENT OF OBJECTIVES / GOALS

The students and I will perform these tasks together in a mentorship fashion. As students learn to utilize the equipment and perform the analysis more and more autonomy will be afforded. Specific skills they will learn and perform are as follows: 1) operation of the telescope instrumentation and observatory dome, 2) use of CCD imaging equipment for collecting images of minor planets, 3) use of software to manipulate astronomical images and extract photometry (brightness) information and astrometry (coordinates), 4) processing and formatting of data for scientific reporting to the Minor Planet Center, 5) production and dissemination of scientific research through presentation and publication.

Gantt Chart: Months after anticipated starting date: November 1 2006

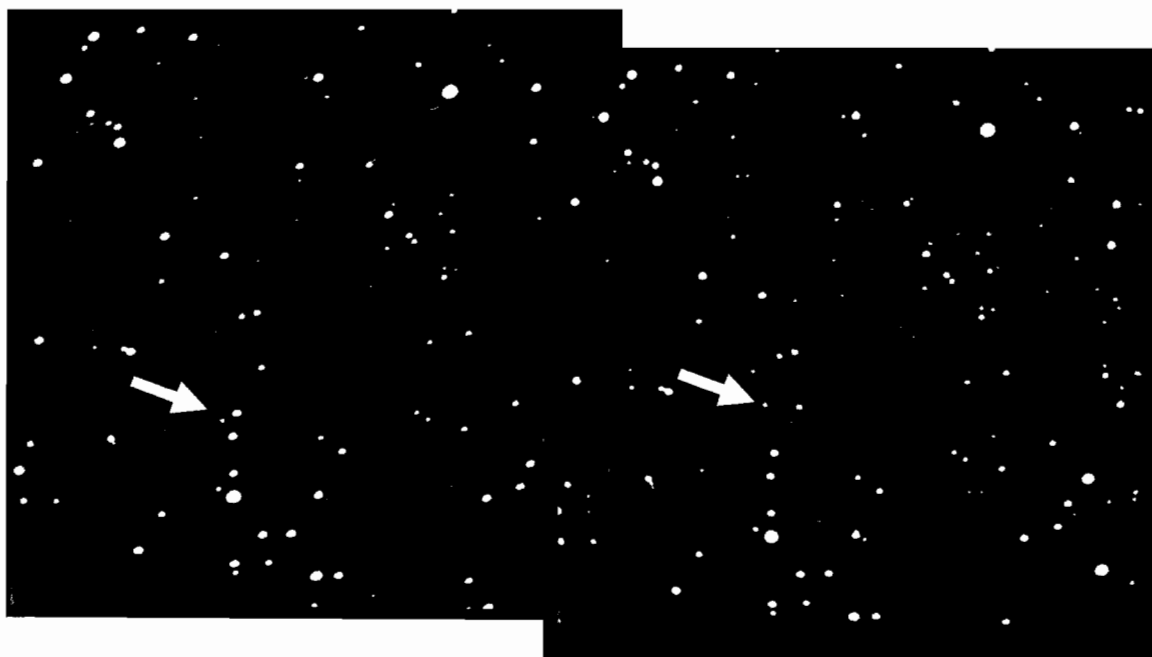
	1	2-3	4	5-6	7
Student Observational Training	XXX				
Telescope/Instrument Training	XXX				
CCD Images of Asteroids	X	XXX	XXX	XXX	XXX
Photometry & Astrometry Training		X	XXX		
Analysis and Astrometry		X	XXX	XXX	X
Colloquium Presentation (ATU)				XX	
Research Presentation (State)				XX	
Research Publications					XXX

DISSEMINATION OF RESULTS

We plan to disseminate results in presentations at scientific conferences such as the ATU undergraduate research and honors symposium, the Arkansas Academy of Science annual meeting and perhaps the annual meeting of the American Astronomical Society. Publication of astrometry results and discoveries is actually automatic for

minor planet observations submitted to the Minor Planet Center (MPC) by an accepted observatory with an observing code through the International Astronomical Union Bulletins. Our initial astrometry of well known asteroids were within the error tolerances of the MPC and we obtained an observatory code (H49) for ATU during the past year as confirmation of our ability to observe NEO-PHAs and obtain coordinates with suitable accuracy. Figure 3 shows a set of images taken on campus by ATU students, capturing the motion of an asteroid over the course of an hour or so. We intend to publish results for any new discoveries or reports on rotational light curves for individual asteroids in the Journal of the Arkansas Academy of Science and/or the conference publication from the annual meeting of the American Astronomical Society.

Figure 3



REPEATED REQUESTS

This is the first request of this kind for a Faculty Research Fund Grant to the ATU Faculty Salary, Benefits and Awards Committee.

BUDGET

Student labor support is requested in the amount of \$375 for the student who will be working on this project. This amount will be assigned as non-work study funds and is based on the assumption that 1) the student will work on average approximately 2 hours/week at \$6.25/hour for the project duration of ~30 weeks and 2) the student will turn in time sheets to the supervisor each month for time spent while working on the project. This research will take place during part of the fall 2006 and the spring semester of 2007. Travel funds of \$250 are requested in order to provide for hotel, registration, mileage, and food of the student and faculty to a scientific conference. This travel is anticipated to be in-state to a symposium such as the Arkansas Academy of Science or the Arkansas Space Grant Symposium to make a presentation of their results and publish them in the meeting proceedings. Standard astronomical imaging filters and a filter wheel (\$1470) necessary for multicolor photometry with the CCD imaging camera and software for processing CCD images for astrometry is requested.

Budget Details

supplies	CFW9 filter wheel w/UBVRI standard filters	\$1,470	1375
travel	scientific conference	\$250	1625.00
student labor	1 student x 6.25/hr x 2 hrs/week x 30 weeks	\$375	-1.00
TOTAL		\$2,095	1624.00

$1375 + 100 = 376$

Faculty Vita

Jeff Robertson, Ph.D.

Arkansas Tech University

Associate Professor of Physical Sciences

Director of the Astronomical Observatory

<http://cosmos.atu.edu/>

EDUCATION

1995	Ph.D. Astrophysics	Indiana University
1991	M.S. Astronomy	San Diego State University
1989	B.S. Physics, B.S. Astronomy	University of Kansas

APPOINTMENTS

1997 - Present	Arkansas Tech University	Russellville, Arkansas
	<u>Courses Taught, Arkansas Tech University</u>	
	Introductory Physics & Physics Laboratories (Serway & Faughn; Halliday & Resnick)	
	Physical Science (physics, chemistry, astronomy, geology) & Laboratories (Shipman 11e)	
	Introductory Astronomy & Observational Astronomy Laboratory (Seeds 7e)	
	Meteorology (Ahrens 4e)	
	Advanced Topics in Physics and Astronomy: Cosmology	
	Optics (Hecht 4e)	
	Remote Sensing and the Environment	
	Distance Learning Courses (Web based): Astronomy, Physical Science, Physical Science Laboratory	
1995 - 1997	Postdoctoral Fellow Indiana University	Bloomington, Indiana
	Software development for unattended data acquisition, reduction and analysis of automated photometry and spectroscopy observations. Assisted in the design and commissioning of instrumentation for a 1.25-m telescope automated for unattended photometry and spectroscopy observations.	
1992 - 1995	Research Assistant; RoboScope Project Indiana University	Bloomington, Indiana
	Observe with and monitor 0.41-m Robotic Telescope CCD detector system. Software development for unattended, automated data acquisition, reduction and analysis of photometry and spectroscopy.	
1991	Research Assistant San Diego State University	San Diego, California
	CCD spectroscopy and analysis of Algol-type and RS CVn-type binaries.	

STUDENT MENTORING

2005	Anthony Tusing: Research Project; <i>Portable Spectrograph for Astronomical Observations</i>
2004	Chris Justice: Research Project; <i>Light Curve Modeling of HH97-79</i>
2003	Scott Ryan: Honors Research Project, <i>Photometric Analysis of the Cataclysmic Variable V1159 Orionis</i>
2003	Daniel and Timothy Ibarra: Research Grant, <i>ATU RoboDome</i>
2001	Bret Taylor: Project, <i>Photometry of the variable star RZ LMi Orionis</i>

- 2001 Tut Campbell: Project, *Photometric Analysis of the Cataclysmic Variable ER UMa*
- 2000 Ed Roberts: Teacher, Pottsville Jr. High, Project ASTRO (Science Ed Workshop Advisor)
- 2000 Mylinda Thomas: Teacher, Morrillton Jr. High, Research Based Science Education Mentor
- 2000 Ed Roberts: Teacher, Pottsville Jr. High, Research Based Science Education Mentor
- 2000 Benji Myers: Project, *Astronomical All-sky Cloud Monitor*
- 1999 Brian Beach: Project, *Astrophotography of the Solar Sunspot Cycle*
- 1999 Benji Myers: Research Grant, NASA-ASGC Kepler Variable Stars
- 1999 Tut Campbell: Project, *SuperNovae Patrol Program*
- 1998 Benji Myers: Project, *Photometry of the Eclipsing Variable Star RW Tri*
- 1998 Albert Martin: Research Grant; NASA-ASGC Satellite Support Observations
- 1998 Tut Campbell: Project, *Large telescope mirror fabrication*
- 1998 Anura Abeywickrama: Project, *Light curve analysis of variable star TT Ari*

PUBLICATIONS

(<http://cosmos.atu.edu/bigjay/abstracts.html>)

- "Newly Discovered Pulsating Variable in Andromeda," **Robertson, J.**, *Journal of the Arkansas Academy of Science*, Vol. 59, (2005)
- "Low-State Flaring Events in AM Herculis," Kafka, S., Honeycutt, K., **Robertson, J.**, Howell, S., *Astronomical Journal*, 129, 241, (2005)
- "A Photometric Study of the Low States of AM Herculis," **Robertson, J.**, Kafka, S., Honeycutt, K., Howell, S., *American Astronomical Society*, Vol. 205, pp 1903, (2004)
- "New Eclipsing Contact Binary System in Auriga," Austin, S., **Robertson, J.**, Justice, C., Campbell, T., Hoskins, J., *American Astronomical Society*, Vol. 204, pp 510., (2004)
- "An Eclipsing Near Contact Short Period Binary in the Field of FS Auriga." **Robertson, J.**, Austin, S., Campbell, T., Hoskins, J., *International Bulletin of Variable Stars # 5536*, (2004)
- "New Eclipsing Contact Binary System in Auriga," Austin, S., **Robertson, J.W.**, Justice, C., Campbell, T., Hoskins, J., *American Astronomical Society*, Vol. 204, pp 510., (2004)
- "Rapid Oscillations in Cataclysmic Variables XVI: DW Cnc," Patterson, Joeseeph, et. al., **Robertson, J.W.**, Publications of the Astronomical Society of the Pacific, 116, 516 (2004)
- "The 2001 Superoutburst of WZ Sge," Patterson, Joeseeph, et. al., **Robertson, J.W.**, 2002, Publications of the Astronomical Society of the Pacific, 114, 721
- Systematics of Superhumps in the Short Supercycle SU UMa Dwarf Nova V1159 Ori," Pitts, M A., **Robertson, J. W.** and Honeycutt, R. K., 2002 BAAS, 201, 40.11
- "Long-term Optical and X-ray Observations of the Old Novae DI Lacertae and V841 Ophiuchi," Hoard, D.W., Szkody, P., Honeycutt, R.K., **Robertson, J.W.**, Desai, V., and Thillwig, T., Publications of the Astronomical Society of the Pacific, 2000, *Astronomical Journal*, 112, 1595
- "Post Common Envelope Binary Stars and the Pre-Cataclysmic Binary PG 1114+187," Hillwig, T.; Honeycutt, R. K.; **Robertson, J.W.**, 2000, *Astronomical Journal*, 120, 1113
- "Old Nova Reconnaissance," **Robertson, J.W.**, Honeycutt, R.K., Jurcevic, J., Hillwig, T., and Hendon, A., 1999, *Astronomical Journal*, 119, 1365

"Unusual Stunted Outbursts in Old Novae and Nova-like Cataclysmic Variables," Honeycutt, R.K., **Robertson, J.W.**, and Turner, G.W., 1998, *Astronomical Journal*, 115, 2527

"Are Z Cam-type Dwarf Novae Brighter at Standstill?" Honeycutt, R.K., **Robertson, J.W.**, and Turner, G.W., 1998, *Publications of the Astronomical Society of the Pacific*, 110, 676.

"Spectroscopic and Photometric Analysis of the Nova-like CV PG1000+667: A New VY Scl Star" Hillwig, T.C., **Robertson, J.W.**, and R.K. Honeycutt, 1998, *Astronomical Journal*, 115, 2044.

"Multi-Year Photometry and a Spectroscopic Orbital Period Search for the VY Sculptoris Type Cataclysmic Variable V794 Aquilae," Honeycutt, R.K., **Robertson, J.W.**, 1998, *Astronomical Journal*, 116, 196

"V446 Herculis (Nova Her 1960) is an Optical Triple: Implications for the Resumption of Dwarf Nova Outbursts Following the Nova," Honeycutt, R.K., **Robertson, J.W.**, Turner, G.W. and Hendon, A.A., 1997, *Astrophysical Journal*, 498, 933

"High-state/Low-state Behavior in the Long-term Light Curve of V Sagittae," **Robertson, J.W.**, Honeycutt, R.K., and Pier, J.R., 1997, *Astronomical Journal*, 113, 787

"RZ LMi, PG0943+521 and V1159 Orionis: Three Cataclysmic Variables with Similar and Unusual Outburst Behavior," **Robertson, J.W.**, Honeycutt, R.K. and Turner, G.W., 1995, *Publications of the Astronomical Society of the Pacific*, 107, 434

"Medium Resolution Spectrograph Design," Honeycutt, R.K., **Robertson, J.W.**, and Pier, J.R., *Proceedings of the 1998 SPIE Conference on Astronomical Instrumentation, Hawaii*