NASA EDUCATION FORUM AT SAO ON

THE STRUCTURE AND EVOLUTION OF THE UNIVERSE

Grant NCC5-706

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Principal Investigator

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SMITHSONIAN INSTITUTION
ASTROPHYSICAL OBSERVATORY
CAMBRIDGE, MASSACHUSETTS 02138

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

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Annual Report
Period of Performance: 9/15/04 - 9/14/05
The NASA Education Forum at SAO
on the Structure and Evolution of the Universe

Grant Number NCC5-706
June 1, 2005

A. Accomplishments for the previous year.

Overview. The past year for the SEU Forum has been a highly productive one and has moved us forward on three major objectives:

- Using the Einstein Centennial to involve the public in the Universe Exploration theme, with emphasis on exciting discoveries about dark energy, cosmology, and black holes.

- Further implementing the recommendations of the Knappenberger Report, in order to strengthen the educational coherence of our collective activities and our collaborations within NASA.

- Developing strategic partnerships with underserved communities and other key customers.

Among our activities for the past year are the following:

Serving the Informal Science Education Communities:

***Inside Einstein's Universe* National Museum Partnership.** More than 144 science museums, planetariums, and other informal science education institutions partnered with the Universe Forum this year to help celebrate the Einstein Centennial in 2005. Our partners received many NASA resources, including those by the Forum and the SEU missions; the materials were designed to help our partners custom-tailor their own programs celebrating the Einstein connection to black holes, cosmology, and other frontiers of astronomy and space science. Approximately 100 space scientists nationwide served as public speakers at these institutions. In addition, 14 institutions are serving as core partners with the Forum. On the basis of written proposals, these partners have received additional resources from the Forum to help develop innovative programs related to the Einstein Centennial and the Beyond Einstein and Universe themes. The work and impact of these partner museums will be described in the next reporting period.

***Cosmic Questions* National Traveling Exhibition.** The *Cosmic Questions* exhibition, which showcases the Universe Exploration theme, continues its highly successful tour; well over a million visitors have enjoyed the exhibition to date. Currently at the Museum of the Rockies in Montana, the exhibition continues its three-

year tour this fall at the Lafayette Science Museum in Louisiana. The exhibit continues to serve as a venue for public talks and events about astronomy and space science. The state of Montana is making the exhibit available to all students in the state, and the exhibit was cited on a recent visit to Montana by Larry Small, the Secretary of the Smithsonian Institution. Because the exhibition is periodically updated as it travels, it has kept pace with key events in NASA space science. Details of the impact of *Cosmic Questions* can be found in the Summative Evaluation Report, online at: http://cfa-www.harvard.edu/seuforum/exhibit/resources/CQ_Exec_Sum.pdf

Night Sky Network. The Forum has worked with the Astronomical Society of the Pacific to develop and test resources for the Night Sky Network, which is a collaboration of more than 100 amateur astronomy clubs nationwide. With ASP, we have developed two kits, one on black holes and the other on telescopes. These materials reach thousands of amateur astronomers, and through them, many thousands of public enthusiasts.

Universe Forum Website Expands. The Universe Forum website provides an introduction to the Universe Exploration theme as well as easy access to the SEU missions. The site continues to grow and improve, with additional resources for classroom and informal education. The following recent letter summarizes its impact:

> My name is Colleen Crowley and I am a 5th grade teacher at St. Agnes School in Arlington. I just wanted to say that I think this website is wonderful! What a great educational tool! Thank you to all who keep it up and running.

Serving the Formal Education (Pre-college) Community:

Professional Development DVD Project. The Forum completed production of *Beyond the Solar System: Expanding the Universe in Your Classroom*—a comprehensive, DVD-based professional development program designed to increase the likelihood that middle- and high-school teachers will address the national education standards for the Universe theme, by increasing teachers' content knowledge, pedagogic skills, and understanding of prior student conceptions. The DVD is informed by prior surveys (reported last year) of the needs of more than 600 teachers in 45 states. The DVD program has both a content strand and an education strand. The content strand includes 7 key concepts needed to understand the structure and evolution of the universe; 4 vignettes discussing how astronomers gather evidence and measure various properties of the universe; and 5 interviews with leading space scientists that present exciting developments in Universe Exploration research. Several new animations are likely to be widely used by NASA scientists and educators generally.

The education strand includes interviews with students which reveal common misconceptions that may hinder students' future learning about the universe; classroom footage of teachers engaged in a variety of activities with students, designed to illustrate useful pedagogic approaches; and extensive, downloadable curriculum materials for use

in the classroom. The DVD will be distributed to 10,000 teachers during the coming year. A website is being constructed to provide additional support for teachers as the community using the videodisc grows.

National Space Science Assessment, K-12. The Space Science Assessment, developed under contract to the Forum, is directly keyed to every one of the National Science Education Standards for space science and astronomy, K-12. The Assessment is a suite of more than 200 multiple-choice questions which have been specifically designed to reveal significant student misconceptions and understandings about astronomy and space science. During the past year, the assessment has been validated with more than 7000 students and teachers in the majority of states in the U.S. Analysis of the very large amounts of data is nearing completion, and the results are currently being written up for publication; they will form one of the most complete and up-to-date snapshots of pre-college astronomy education.

Even the preliminary results provide important information. They show that students score poorly on their understanding of the universe beyond the solar system. (For example, the majority of students place stars within our own solar system.) Teachers perform relatively well, with the exception of certain areas, where professional development will be particularly important. However, teachers greatly overestimate their students' performance.

SEU Missions / Forum Short Course for Teachers. The Forum and missions held a workshop, *Explore the Universe with NASA: What's Out There and How Do We Know?*, for pre-service and in-service teachers at the University of Texas, Dallas. The workshop involved the collaboration of Forum and mission educators and Chandra scientists. The Forum also participated in two workshops at the National Science Teachers' Association conference: *NASA's Search for Origins*, and the Smithsonian Day presentations, which paired a Forum educator and Chandra scientist.

Serving Minority and Underserved Communities:

Boston After-School Program and Online Telescopes. The SEU Forum continued its highly productive collaboration with the MIT / Chandra After-School Astronomy Project, led by Dr. Irene Porro and Dr. Kathy Flanagan. The Forum provided access to MicroObservatory online telescopes, curriculum materials, and Forum staff for training sessions. The program is geared to Hispanic and Afro-American youth at after-school youth centers in the region. Because the program has grown, the Forum is collaborating with MIT on a proposal to leverage NASA funds with additional funds from NSF to expand the pilot program nationally.

The online telescope network is now an official site that receives SWIFT mission alerts; this will enable students to explore afterglows of gamma-ray bursts using the telescopes.

Exceptional Needs Workshop. The Forum participated in the workshop, Exceptional Space Science Materials for Exceptional Students, hosted by the SERCH broker. The Forum's black hole game was an instant hit, and will be used by educators not only for its content but as a team-building activity.

B. Summary of Goals, Plans and Activities for the Year 9/15/05 - 9/14/06.

The SEU Forum's overarching goals for 2006 are:

- To expand public interest and involvement in the Universe theme;
- To broaden the story of Universe Exploration and link seamlessly with NASA's overall story of space- and earth science; and
- To build on the success of the Einstein Centennial partnerships, so as to increase the audience for Universe Exploration.

The Universe and Origins Forums have already started a coherent and collaborative strategic planning process, which will expand in 2006. The reorganization at NASA provides an excellent opportunity for us to move even further in promoting greater coherence and synergy among themes, missions, and divisions at NASA.

Although the Forum will be working on many fronts this year, we will emphasize three areas in particular. One of these (black holes) is a timely target of opportunity for the Universe theme, while the other two are of great importance across the science themes.

Black holes. The planned launch of GLAST in 2007, and the public interest engendered by upcoming NOVA shows and national plantetarium shows on black holes, make 2006 the year to address the public's enormous interest in black holes.

400th anniversary of the telescope. This world-wide celebration in 2008-9 requires immediate planning if NASA is to take the lead in what promises to be an exceptionally important opportunity to focus public attention on our work. A related activity: helping to define the NASA interface to the National Virtual Observatory.

Conditions for life. The public's interest in extra-solar planets and the conditions for life is well-known. Less well-known is the extraordinary story of how the physical universe itself appears to be "fine-tuned" for life. This story has two compelling components: the amazing astrophysical processes that give rise to stars and galaxies; and the underlying physics that makes this possible. NASA needs to be ready with the story of the physics / astrophysics connection in time for the 2007 launch of the new supercollider at CERN, where revolutionary discoveries are expected.

As a result of our conversations with many partners—e.g., science museums and planetariums, professional societies, community groups, and K-12 educators—we plan to focus on the following activities:

Informal science education community:

***Extreme Universe* Planetarium Show.** In collaboration with the National Air and Space Museum (NASM) and SkySkan Inc., we are planning to develop a planetarium show on the high-energy universe. The program will premiere at NASM's Einstein Theater in Washington, D.C., and will be distributed nationally, ensuring a wide audience. The Forum will take the lead on story development, in collaboration with NASA scientists nationwide.

Black Hole National Traveling Exhibition. The Forum's Space Science Assessment has revealed that many students do not understand that gravity is a universal force. (For example, many believe that galaxies are held together by electromagnetism, rather than gravity.) Black holes, one of the most popular topics in astronomy, are an excellent vehicle for enhancing young people's understanding of gravity.

The Forum is planning a national traveling exhibition on black holes. During the coming year, we will work with Chandra, SWIFT and other Universe missions, and with space scientists nationwide, to develop prototypes of key exhibit components. An innovative feature of the planned exhibit is that it will be developed in partnership with members of our target audience: girls, minorities and the underserved. We expect that the resources developed for the exhibition will be useful to black hole researchers and teachers nationwide.

Planning for Coherence: Consolidating Museum Partnerships. The Universe Forum will coordinate with the Origins Forum and other NASA groups in order to consolidate and streamline our partnerships with the museum community. Existing networks include the Forum's *Inside Einstein's Universe* museum partners; the Origins Museum Network; the Mars Visualization Alliance; and others. These partnerships offer an unprecedented reach for NASA's educational products and programs.

Formal education (pre-college) community:

***Beyond the Solar System* DVD: Distribution, evaluation, and teacher support.** The just-completed DVD, designed for the professional development of teachers who address the education standards for the Universe theme in their classrooms, will be distributed to more than 10,000 selected teachers, educators, and curriculum developers nationwide. We will include two important audiences: pre-service teachers and community colleges. A website will provide ongoing support for teachers; additional educational resources; and surveys to help the Forum evaluate the accessibility of the

materials. (Formative evaluations were carried out with teachers during development of the DVD.)

Using the Space Science Assessment. We plan to use the Assessment to evaluate the effectiveness of the *Beyond the Solar System* DVD. An experimental protocol will be developed to determine whether use of the DVD increases students' understanding of the national science education standards related to the Universe theme. The results of the evaluation will be relevant to NASA space science educators generally.

Expanding the NASA Online Telescope Network. The MicroObservatory online telescope network is an important testbed for two major educational opportunities: the National Virtual Observatory, and the 400th anniversary of the telescope. We will develop two kinds of activities this year: activities that involve images across the electromagnetic spectrum (i.e., from Chandra, SIRTF, etc.); and activities in which students can partner (asynchronously) with space scientists, to develop their own investigations. The activities will focus on explorations in the Universe theme.

We plan to install a telescope at a southern hemisphere site, possibly in partnership with NASA's Telescopes in Education program and with the Gemini South program. This will help expand our ongoing partnership with the Hispanic and Afro-American communities who are using the telescope network.

NSTA Program. We are participating in the NSTA program on National Level Professional Development Opportunities for Teachers. The Origins Forum is serving as the lead contact on this project.

Frameworks for Space Science Education. With NASA Headquarters and the Frameworks partners, we will actively participate in developing the NASA Frameworks for Space Science Education. The results of this project will be of importance for NASA space science educators general, and will help guide our future education efforts.

Coherence Planning with the Universe Missions. A prior retreat, facilitated by West Ed Associates, was considered highly effective by the SEU missions. We will work with West Ed again to build consensus and coherence among the missions and Forum.

C. Interactions with the Space Science Community.

The SEU Forum routinely works with space scientists for virtually every project it undertakes. Examples of scientist involvement in the Forum's projects this past year:

***IEU* Speakers' Bureau.** Approximately 100 space scientists participated in the *Inside Einstein's Universe* speaker's bureau, giving public talks at science museums, planetariums, and related organizations.

Scientist Interviews for Professional Development DVD. Five leading space scientists were interviewed for the *Beyond the Solar System* DVD. The five video segments provide a glimpse of the frontiers of astrophysics, as well as vignettes of how and why the researchers went into science.

Scientist involvement at *Cosmic Questions* venues. More than a hundred scientists were involved in the production of the exhibition, *Cosmic Questions*, and it continues to serve as a venue for public talks by space scientists as it travels. The Forum also works with other members of the Support Network to line up regional scientists for these public engagements.

Facilitating Scientists' EPO Proposals. The Forum worked with more than two dozen scientists in giving guidance on fruitful areas for EPO proposals

Scientist Participation Working Group. Forum staff participate in the Scientist Participation Working Group, and have presented posters and talks at scientific conferences designed to increase scientists' involvement in education and outreach.

D. Coordinating with the Forums and Brokers, Missions and Headquarters

Headquarters.

NASA Strategic Planning Committees. The Forum director served on the Universe Legacy Roadmap committee, and also as ex officio education liaison on the NASA Universe Exploration Strategic Planning Committee. Contributions included writing the education and public outreach section for the reports from both committees, and presenting an education update to the Strategic Planning Committee.

Missions.

In addtion to joint projects cited above, the Forum coordinates many activities and services with the missions. This coordination includes product review, data entry into EDCATS, participation in scientific and education conferences, and contact between missions and brokers, as well as direct participation in mission activities. The Forum hosts monthly teleconferences and periodic meetings with the missions during the year.

Brokers.

The SEU Forum routinely works with the other Brokers and Forums, and the power of this network can be seen in the examples below.

De Paul - Chicago Teachers' Advisory Group. The Chicago Advisory Group consulted on the Forum's *Beyond the Solar System* professional development DVD, and identified a master teacher and class, who were filmed and are an integral part of the DVD.

PROPOSAL BUDGET SUMMARY

FROM: September 15, 2005 - September 14, 2006 (Year 3)

TITLE: NASA Education Forum at SAO on the Structure and Evolution of the Universe

P.I./INSTITUTION: Roy R. Gould/Smithsonian Astrophysical Observatory

NASA USE ONLY

	A	B	C
1. Direct Labor (salaries, wages, and fringe benefits)	$592,670		
2. Other Direct Costs:			
a. Subcontracts	236,000		
b. Consultants	0		
c. Equipment	25,000		
d. Supplies	29,695		
e. Travel	60,080		
f. Other	337,712		
3. Indirect Costs	318,843		
4. Other Applicable Costs	30,000		
5. Subtotal--Estimated Costs	1,630,000		
6. Less Proposed Cost Sharing	0		
7. Carryover Funds (if any)	0		
a. Anticipated amount	0		
b. Amount used to reduce budget	0		
8. Total Estimated Costs	$1,630,000		XXXXXX
APPROVED BUDGET	XXXXXXX	XXXXXXX	