**"A Big History of the Universe for Secondary Education"**


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<u>Summary Overview</u>


Over the last decade, world history and astrophysics have become more and more similar in the way they examine the origins of the universe. Principally, world historians and social science educators have come to realize that the origin of our universe is the beginning of our human story. Though the incorporation of these ideas into secondary curricula is not yet widespread, well respected efforts such as "World History for Us All," a project of the National Center for History in Schools at UCLA, have strongly advocated for the incorporation of the history of the universe in world history curricula. As put forth by books like David Christian's *Maps of Time: An Introduction to Big History* (2005), these ideas will no doubt become a more significant part of both history and science instruction in secondary schools in the near future, and make instruction in both areas more interdisciplinary.

In scientific fields, of course, the importance of the origins of the universe has long been understood. Bringing us to a new level of understanding on the subject of these origins, UCSC Professor Joel Primack and Nancy Abrams have recently introduced a number of new ideas about the connections between advanced scientific theories and the historical importance of the origins of the universe as discussed in their book, *The View From the Center of the Universe: Discovering Our Extraordinary Place in the Cosmos* (2006). The authors incorporated a significant amount of ground-breaking cosmological research done by co-author Joel Primack and his colleagues, and this research represents some of the most important work being done in astrophysics today. Abrams and Primack also tied in fundamental discoveries in other aspects of astronomy, evolutionary biology, geology, archaeology, and other fields.

This proposal brings together the cutting-edge scientific theories and research discussed in *The View from the Center of the Universe* and the themes of "Big History" that are becoming more important all the time in world history education at the secondary level. Specifically, three half-hour videos would be produced for classroom use at the secondary level, in various science and world history classrooms. These videos would incorporate visual data from simulations conducted by Joel Primack and his colleagues through the NASA AMES supercomputer in order to provide junior high and high school students with access to some of the most up-to-date visual information available about the universe. In addition to these videos, ancillary, standards-based curricular materials would also be developed by a team of teachers from Pacific Collegiate School, recognized by all available measures as one of the nation's best public, college-preparatory high schools.

Introduction

To help fulfill NASA's goal of sharing "the story, the science, and the adventure of NASA's scientific explorations of our home planet, the solar system, and the universe," the work of this proposal centers on the creation of secondary level curricular materials that harness the very latest developments in the field of cosmology. Bringing these developments to secondary level students through engaging curricula will not only educate, engage and inspire them, but will also teach them more about their own personal connection to the greatest events in the history of the universe, and about their place in the universe as it is today.

The universe beyond earth is often portrayed as cold and distant. We call it "outer space" or "the void of space," as if it's a bleak and distant place that we're not a part of. Ironically, modern science has brought the universe closer than ever to us—we can now watch the universe in crystal-clear, high definition images, as if it were a TV show. And yet, in personal terms, the universe is farther away from most people than it's ever been. Three thousand years ago, when Egyptians looked up to the heavens, they saw a cosmic drama that included them *personally*. Ancient humans knew that they were connected to the earth, the sun, and the universe beyond…they just didn't know quite how this connection worked scientifically. Today, when most people stare at the heavens, what they see is a chilly emptiness, a grim reminder of how alone and isolated humans are in the void of space. Today, most people imagine the earth as a contained sphere of human activity, and the universe beyond as a separate domain. This feeling of disconnection is uniquely modern, and though in some ways it is a disconnection that has been fostered by modern science, it is scientifically inaccurate.

Recently, steps have been taken by those in the field of astrophysics and the field of history to bridge this divide between our world and the universe which lies beyond, and because of these efforts, we now have the ability to make the universe a friendlier and more familiar entity. For instance, proponents of "Big History" have taken the human story all the way back to the Big Bang, seamlessly weaving together the history of the universe with human history, long seen as discrete and separate modes of thinking about time and space. The historians who are developing this area of world history have made a strong case that our history does not start with writing, nor even with the development of modern humans, but rather with the origin of the universe. In what is widely acknowledged to be the most elegant work of "Big History" yet attempted, David Christian has argued the validity of this interdisciplinary approach to history in *Maps of Time: An Introduction to Big History*. Another book, *Big History: From the Big Bang to the Present* by Cynthia Stokes Brown, has also recently created a stir among historians who have thought on a much smaller scale for many years. And, though these ideas are quite new, already a number of secondary level world history textbooks at least allude to the evolution of the universe and our planet as part of their overall narrative. As world historians continue to draw conclusions based on large-scale patterns across time and space, this component of our human history will become more and more integrated into the way we can view ourselves. Accordingly, the aim of this proposal is to bring this new way of viewing ourselves to all levels of secondary students by creating appropriate and engaging curricular materials for students of science and history in particular.

Objectives:

Specifically, the key, central objectives of this proposal include the following:

- To develop three, one-half hour long videos and accompanying curricular materials that are developmentally appropriate for all levels of students in grades 7-12;
- To engage students of all levels in high-level scientific and historical thinking;
- To bring cutting-edge cosmological and technological innovations and discoveries into the classroom;
- To develop stand-alone, standards-based curricular units that are meaningful, relevant, and engaging for students;
- To tap into different learning styles by using audiovisual materials, hands-on lab activities, and math-based approaches to understanding the universe;
- To bring together world history, physics, biology, environmental science, astronomy, and mathematics to demonstrate the interdisciplinary relevance of recent cosmological discoveries;
- To provide professional development resources that allow teachers to help students fully understand the concepts and meanings of new developments in cosmology, both in scientific and historical contexts; and
- To inspire students to pursue top level research of the type that university researchers are performing.

The three videos that the team would produce would focus on three separate but linked topics in order to allow teachers of certain subjects to be more specific in the way they used the curriculum. The short length of the videos has been very deliberately chosen so that teachers can introduce students to high-level, ground-breaking new ideas in an engaging and meaningful fashion without pushing aside too much of their existing curriculum. Teachers will no doubt be more inclined to incorporate the videos into their curriculum because of their short length, especially if they received training and professional development specifically targeted towards using the curriculum both effectively and concisely.

The first video would be designed primarily for secondary level physical science, theoretical physics and earth science courses, and would include the most recent simulations performed by top scientists in the field of astrophysics along with the implications of these simulations. Essentially, our view of the universe over the last ten years has changed radically because of new methods of looking at the deepest parts of space, and new ways of conceptualizing the makeup of the universe. These methods and ideas belong to the "Double Dark Theory," a means of explaining the evolution and composition of the universe. Breakthroughs which occurred as part of the development of this theory ten years ago allowed astrophysicists to assemble a new picture of the universe, and all the data that has been collected over the last ten years support the legitimacy of this view. These concepts easily correspond with the state science standards in many states around the country. The state of California, for example, requires that its 8th graders enrolled in Physical Science study the structure and composition of the universe, including stars and galaxies and their evolution (Standard 4)—in particular, students are expected to know the appearance, general composition, relative position and size, and motion of objects in the solar system, including planets, planetary satellites, comets, and asteroids (Standard 4e). California also requires that its students to take Earth Science at some point during their 9-12 grade years, and as part of these standards, students are to learn about how "astronomy and planetary exploration reveal the solar system's structure, scale, and change over time" (Standard 1) as well as how "earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time" (Standard 2). Standard 2 syncs up even more clearly with the objectives of this particular proposal in its detailed sub-standards. According to the state, all students should be given the opportunity to learn that "accelerators boost subatomic particles to energy levels that simulate conditions in the stars and in the early history of the universe before stars formed" (Standard 2e), that "the evidence indicating that the color, brightness, and evolution of a star are determined by a balance between gravitational collapse and nuclear fusion" (Standard 2f), and that "the red-shift from distant galaxies and the cosmic background radiation provide evidence for the "big bang" model that suggests that the universe has been expanding for 10 to 20 billion years" (Standard 2g). All of these various standards would be clearly addressed by the curriculum that the team would be assembling, and the material would extend into similar standards in other states besides California.

The second video would focus primarily on the biological ramifications of these new discoveries in cosmology, including the potential for life on other planets, the rarity of the type of cosmic materials that can create life forms, and the conditions required for a planet to be habitable. According to the California State Standards, in 7$^{th}$ grade life science, students learn about "Earth and Life History," and specifically about how life on earth is connected to the universe beyond it. For instance, according to Standard 7.4b, students are expected to know that "the history of life on Earth has been disrupted by major catastrophic events, such as major volcanic eruptions or the impacts of asteroids." Standard 7.4d also says that they are also expected to know "that evidence from geologic layers and radioactive dating indicates Earth is approximately 4.6 billion years old and that life on this planet has existed for more than 3 billion years," and the videos the team seeks to produce would help contextualize the evolution and development of life on earth as a part of the evolution of the universe. As noted above in the discussion of science standards for 9$^{th}$ through 12$^{th}$ grade, California does not specify when exactly students take certain science courses, but they are required to take a more advanced life science course at some point in their high school career. The standards for this course that could be supported by use of the curriculum that the team would develop include the standards around cell biology (Standard 1), ecology (Standard 6), and evolution (Standard 7 and 8). The AP Biology course also provides opportunities to include the proposed curriculum, particularly as it focuses on evolution, molecular biology, diversity of organisms, and ecology. Alternatively, the weeks after the AP Biology test is administered would be a great place to include this curriculum, since the defined curriculum ends with the administration of the AP exam, and there are usually several weeks to fill with the kinds of thought-provoking and interdisciplinary concepts that the proposed curriculum would offer. Many AP Biology teachers are constantly on the lookout for stimulating and engaging material to use in their classrooms for the remainder of the school year, especially since they are basically operating at that point with complete curricular freedom.

The third installment would focus on the place of cosmology in world history, and how the new cosmological ideas developed by Ms. Abrams and Professor Primack can better help us to understand both the past and the present. This video would highlight different developments in the history of science that have led us to where we are today in our understanding of the universe, the nature of different cosmological worldviews throughout history, and how the place of discovery in which we find ourselves today is unique and truly exciting. Though "Big History" is too new to have traveled into the social science standards directly, there are many places in which teachers could use these videos and curriculum to expand on the standards that exist. For instance, in California, 7th grade teachers of Medieval World History should "Detail advances made in literature, the arts, science, mathematics, cartography, engineering, and the understanding of human anatomy and astronomy" during the Renaissance, according to Standard 7.8.5, and they should "analyze the historical developments of the Scientific Revolution and its lasting effect on religious, political, and cultural institutions," according to Standard 7.10. In explaining the cosmological frameworks that existed before, during and after these two intellectual movements as this video would do, students would not only better understand the significance of the scientific developments that occurred during the Renaissance and the Scientific Revolution, but they would understand why those developments are relevant today, a major goal of all history teachers as they attempt to connect the past with the present. The 10th grade social science standards in California also require teachers to explain how scientific discoveries contributed to the changing world in modernity; for example, standard 10.3.2 mandates that students "Examine how scientific and technological changes and new forms of energy brought about massive social, economic, and cultural change" to 19th century Europe, and the final standard, 10.11, says that students will "analyze the integration of countries into the world economy and the information, technological, and communications revolutions (e.g., television, satellites, computers)." Since the means of understanding the universe in the way that we are now able to could certainly be described as a "technological revolution," this standard would be another place in which to situate the curriculum that the team wishes to develop. Finally, in the AP World History course, one of the fastest growing courses in the College Board's retinue of AP offerings, this type of big picture, comparative view would be particularly useful to teachers and students. By connecting scientific views of the past with the scientific views of the present, teachers would be fulfilling five of the central "habits of mind" developed as part of the AP World History curriculum:

- Seeing global patterns and processes over time and space while connecting local developments to global ones
- Comparing within and among societies, including comparing societies' reactions to global processes
- Considering human commonalities and differences
- Exploring claims of universal standards in relation to culturally diverse ideas
- Exploring the persistent relevance of world history to contemporary developments.

Throughout the AP World History curriculum, mythology, scientific developments and technological advances are repeatedly emphasized, and there would be numerous places for teachers to use this type of curriculum. Also, as is also the case with AP Biology, AP World History teachers frequently have very little in the way of specific content delivery that they need to accomplish after the AP test. The materials that the team proposes to create constitute an important and relevant curricula that could easily be used to generate discussions and projects about related topics—such as "Big History" and its historiographical merits and legitimacy—that teachers may not be able to explore quite as fully during the "AP year" due to the vast amount of material that needs to be covered, and would consider to be very appealing teaching units once the AP test has been administered.

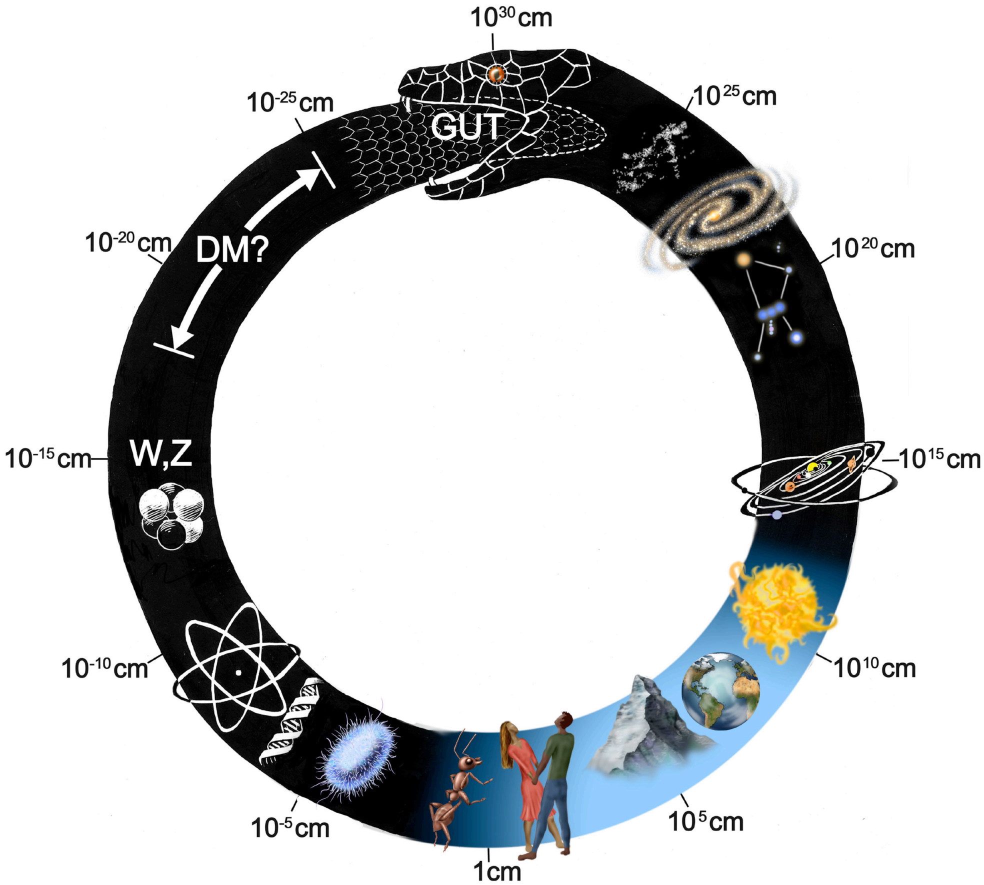
As discussed more fully below, each of these videos would be tested on diverse student populations, and the materials (and perhaps even the content of the videos themselves) would be differentiated in order to reach the full spectrum of students.

Methods and Techniques Proposed:

Using both the students at Pacific Collegiate School as well as students from other local schools with different demographic compositions, the team would develop and test materials based on the work done by Professor Joel Primack, Nancy Abrams and Professor Primack's colleagues in astrophysics. The scripts would be largely developed by Tara Firenzi (PI), Professor Primack (Co-I), Ms. Abrams (Co-I), Darrell Steely (Co-I), and Zoe Buck (Graduate Student Researcher), bringing together a powerful combination of educators and scientists. Audiovisual simulations generated by the NASA supercomputers that represent the most innovative work available on the structure of the universe and the visualization of dark matter would figure prominently into the videos. These videos would be aided by some of the graphics used by Abrams and Primack to clearly and engagingly explain complex cosmological concepts in *The View from the Center of the Universe*. The illustrations in this book have received much acclaim, and could easily provide students at the secondary level with the tools to more effectively understand the nature of the universe.

One of these images, the cosmic urboros, is one of the many innovative illustrations that Ms. Abrams and Professor Primack use in their book to demonstrate our central place in the universe. Abrams and Primack have adapted this image from both an ancient symbol and from an idea developed by the Nobel Prize winner Sheldon Glashow, and they use it to show the spectrum representing size scales from the very smallest particles in the universe to the very largest. As can be seen below, the image compellingly demonstrates that humans occupy the center of this range. The smallest particles in the universe—dark matter that may or may not be super-symmetric particles—measure in at about $10^{-25}$ cm, and the very largest object—the visible universe itself—is nearly $10^{30}$ cm. At approximately 1-2 meters, or $10^{2}$ cm, humans are almost at the exact midpoint of these two extremes. It is this type of compelling imagery and visualization of a complicated concept that will help students at the secondary level better understand how new developments in astrophysics have given us a new understanding of our place in the universe.

The cosmic uroborus is also a useful image with respect to this proposal because the concept of the uroborus comes from the ancient world, and has been used for millennia to represent different ways of thinking about the universe. With respect to the link between the new cosmological views put forth by Ms. Abrams and Professor Primack and their connection to different cosmological views throughout history, this particular image clearly demonstrates that scientific developments today can be to us what early interpretations of the cosmos were to ancient Greeks, for instance.






The videos would be developed primarily by Joel Tarbox, (Co-I) a respected graphic designer, painter, and teacher of video productions at Pacific Collegiate School. Though the project would be overseen at every level by Mr. Tarbox, students would be involved in the creation and planning of the video so as to increase its appeal to students in secondary education. To have students working on the project at the ground level is an opportunity that we should embrace, as students are much more likely to engage with material that their peers find interesting and valuable than what well-meaning adults often develop; educational research has proven this time and again. Because Pacific Collegiate School is a charter school with high enough test scores to allow teachers flexibility in designing a meaningful curriculum, not only would students be able to help with the development and production of the videos, but students in theoretical physics classes, AP Biology and AP World History courses, and ancient world history courses would be able to test them out and give feedback that would help to improve the materials. In fact, this last course—ancient world history—offers a unique opportunity to try out the videos in a historical context, since the course takes the cutting-edge, "big history" approach that many world historians would like all schools to move more towards. Pacific Collegiate School is in a very strong position to develop this curriculum as it has the flexibility to incorporate it into the curriculum even in its most incipient forms. Finally, Solana Pyne (Consultant), a graduate of the UCSC program in science journalism and a former associate producer for NOVA, would provide consultation services to ensure that the best practices of professional documentarians were observed throughout the process.

The development of the accompanying curricular materials would be developed primarily by Darrell Steely and graduate student researcher Zoe Buck. These materials would include computer-based labs that incorporate some of the technology demonstrated in the video, and other labs that would specifically focus on secondary level physics, biology and mathematics standards adopted by numerous states. They would also include discussion questions, plans for student projects, and worksheets that teachers could use as companions to the video, and provide lists of internet resources that could be used for further development of these topics. Teachers would also be provided with assessments that were linked to state standards so that they could measure the impact of the curriculum on overall student learning, and rubrics to help them better assess how much their students had learned. Finally, the team would develop a companion website that would house further materials for students, and resources for professional development.

The UCSC Department of Education has already been consulted on the best way to develop these materials as well, and has volunteered their assistance in testing the materials in various settings so as to ensure that the material is accessible and interesting for students of all levels. Part of the budget for this proposal includes stipends for teachers in lower-income districts nearby to the university in order to compensate teachers for their involvement in field testing the materials. In particular, Mr. Steely, Ms. Firenzi and Ms. Buck would be developing curricula with ELL populations in mind, making sure to include resources for teachers that will help them engage students who struggle with the English language. The team would construct assessments which, once administered to test populations of students, would produce data showing what changes needed to be made to the curriculum. These assessments would be especially helpful in allowing the team to determine whether or not the materials were not reaching diverse populations of students. To help with this side of the project, Collaborator Doris Ash would bring her expertise to the table as a faculty member of the UCSC Department of Education, and she would also be supervising and guiding the work done by Ms. Buck in her role as Ms. Buck's advisor.

With respect to the distribution of materials, we would be focusing primarily on making the videos and curriculum available through our companion website (as NASA has done very successfully with the Stromatolite Explorer website, for instance), but we would also be producing 1,000 hard copy DVDs and accompanying hard copy materials for distribution to teachers that would prefer to not use a web interface. Producing DVDs would also allow for us to provide higher quality images to teachers. Once the DVDs were produced, we would sell them at a very low cost (under $10, including shipping) through filmbaby.com and curricular catalog services that target secondary education teachers (the Social Science School Service catalog, which is known as the primary source for social science curricular materials, is an example of this kind of distribution resource). Finally, PI Tara Firenzi and Co-I Darrell Steely would both attend conferences in their respective fields during the third year of the project to promote the curriculum among their peers. Ms. Firenzi would attend the World History Association Conference, which targets both university and secondary level educators in the field of world history, and Mr. Steely would most likely present the materials at the National Science

Teacher's Association conference. Tara Firenzi would also present the materials at the California Charter School Association Conference as part of a subject specific seminar, as charter schools have more flexibility and room for innovation in their approach to teaching than traditional public schools do and therefore might find the curriculum particularly appealing. Pacific Collegiate School is well known among this community and would be able to have an unusually high degree of influence on other schools attending the conference, having won the association's 2006 California Charter School of the Year award, and also having won recognition from the *U.S. News and World Report*'s annual rankings as the top charter school in the nation for the past two years in a row.

Additionally, in the third year of the project, the team would firstly seek a collaboration with the COSMOS program hosted through UCSC in order to promote the materials and use them among a target population of students who are very motivated in the field of science (Darrell Steely is a long-time teacher in the program). Secondly, that year, the team plans to host a conference for secondary education professionals who are interested in the curriculum, and this conference would be hosted through the new High Performance AstroComputing Center at UCSC. This center, which does not yet actually exist, has just been funded through the University of California, with Professor Primack as its director. Though not the primary goal of the center, one of its central aims is outreach and education, and because of Professor Primack's connection to this proposal, we could use this new center as yet another way of bringing this project to more people. The center will also act as a "one-stop-shop" for the world's best "astromovies," a resource that would be invaluable to this project, as those are the types of visual data that form the basis for much of the curriculum. Finally, Professor Primack has also submitted a proposal to NASA for the outreach component of the 2009 ROSES Opportunities in Education and Outreach solicitation; if funded, this other project would result in the creation of even more videos that could be employed in the creation of the materials we hope to create through this proposal.

<u>Significance:</u>

The significance of these educational materials would be tremendous, and would have a far-reaching impact on students of all levels. The depictions of the universe that kids everywhere have long embraced through popular media like the *Star Wars* movies can now be shown as they *actually* exist—and in their fullest glory. The simulations made possible by the NASA supercomputers take viewers billions of light years into the past to the very outer edges of the universe, defying our imaginations. The images are hypnotizing, powerful, and highly educational—most students have no idea what the universe looks like, nor the ramifications of this new level of understanding. In fact, some students who live deep in America's largest cities barely know what stars look like because of the ambient light that disguises the beauty of the night sky. Seeing these simulations would truly open up entirely new ways of thinking about the universe and science in general for them, and could easily inspire them to pursue careers in related fields later on in their lives. Developmentally, it could also capture young minds at a moment when they are still open to thinking about the universe in new ways; as we grow older, it becomes more and more difficult to think about the universe in new ways, and we tend to lose some of our imaginative capacity and thus our ability to be inspired in the way that young people can. Finally, to discover that such knowledge of the universe is possible is inspirational in and of itself, but to explain why this research is meaningful holds even more exciting possibilities for student engagement and interest in the sciences.

An article appeared in the July 2009 issue of National Geographic about the powerful telescopes that bring us the images we would be using in these videos. The article begins with the following statement:

> When you start stargazing with a telescope, two experiences typically ensue. First, you are astonished by the view—Saturn's golden rings, star clusters glittering like jewelry on black velvet, galaxies aglow with gentle starlight older than the human species—and by the realization that we and our world are part of this gigantic system. Second, you soon want a bigger telescope. (Ferris, 2009)

Bolstering the claim that firstly, we can feel a much stronger connection to the universe by experiencing the images and visualizations made possible through NASA's supercomputers, this quote further demonstrates the addictive quality of this process of astronomical discovery. By bringing the images of a much, much "bigger telescope" to students through this curriculum, there is certainly a strong chance that these students might also follow the typical pattern that this author describes; they might want to continue exploring in this field by pursing careers in science which allow them to build and work with bigger and bigger telescopes later on in their lives.

Another pertinent example of the relevance of this project lies in the recent discovery of the SN2008ha junior supernova, an astronomical peculiarity that has many astronomers puzzling over why it defies easy categorization as either a nova or a supernova. The reason that this discovery is especially relevant to this proposal is the simple fact that the SN2008ha was first observed by a fourteen year old in New York, the youngest person to ever discover a supernova of any kind. The young woman, Caroline Moore, was recently interviewed on the Rachel Maddow Show, and attributed her fascination with the sky to the data and images made available by the Hubble Telescope. And so, perhaps even more significantly than the discovery itself, her discovery proves without a doubt that the images and ideas that the team proposes to use are capable of inspiring students at the secondary level to explore the universe, seeing it as a friendly and approachable entity rather than a distant and removed body that is completely disassociated with us here on earth. Alex Filippenko, the leader of the UC Berkeley supernova group said this about the discovery: "Coincidentally, the youngest person to ever discover a supernova found one of the most peculiar and interesting supernovae ever. This shows that no matter what your age, anyone can make a significant contribution to our understanding of the Universe." By bringing images like the ones that inspired Ms. Moore to students across the country, how many more young people will be inspired to make new and important discoveries, and feel that much more connected to the universe around us?

Furthermore, as noted earlier, the ramifications of these simulations and their implications certainly transcend astronomy and astrophysics. They extend into many scientific fields, including astrobiology, and biology in general, helping us to answer the basic question, "what does it take for a planet to be habitable?," and the perennially interesting question, "if certain factors have allowed for life on this planet, do what are the chances that they could exists on other planets that might also sustain life?" Furthermore, the chemical composition of the universe plays a major role in the analysis done by Professor Primack and Ms. Abrams, allowing students who enjoy the mathematical precision and logic of chemistry to find value in these new ideas. Finally, grasping even the lowest level of the mathematics involved in these scientific endeavors can help students to understand the relevancy of math, and some of the more beautiful ideas that mathematicians work with, such as fractals.

Beyond the clear significance of these ideas in various scientific and mathematical fields, teachers and students of world history would also benefit hugely from these materials. The work of Joel Primack and Nancy Abrams aims to demonstrate not only the usefulness of cosmology today, but also how cosmologies have changed throughout time, and the different roles that they have played in civilizations. On a small scale, in using this perspective on cosmology to tell the human story, a world history teacher can communicate to students how social science can be intertwined with laboratory sciences, and how similar methodologies can be applied. However, on a bigger scale, getting students to think about *their place* in the universe has even more significance—to have a sense of why we matter, and how we can make a difference in our own future has tremendous potential to shape the views of young people in a profound and meaningful way. Even more than that, using big history as a framework for understanding ourselves can allow us to see the commonalities between us rather than all the many divisions that have existed among humankind throughout history; as David Christian said in his book, *Maps of Time* (2005),

> In a world with nuclear weapons and ecological problems that cross all national borders, we desperately need to see humanity as a whole. Accounts of the past that focus primarily on the divisions between nations, religions, and cultures are beginning to look parochial and anachronistic—even dangerous. So, it is not true that history becomes vacuous at large scales. Familiar objects may vanish, but new and important objects and problems come into view.

More and more, the world needs to understand that not only do we share a common history, but that we need to embrace that shared past in order to work together to preserve our planet and make the world habitable for many millions of years to come. This project aims to raise awareness of these issues, and will ably serve the goals of the EPEOSS mission.

General Plan of Work

Timeline for construction of videos and curricula:

Year 1:

- Start date: January 1, 2010
- By April, 2010: Preliminary scripts completed for all three videos
- By May, 2010: Storyboards constructed for all three videos, incorporating visual materials and simulations
- By December, 2010: Preliminary filming finished

Year 2:

- By February, 2010: Preliminary editing finished
- By June, 2011: Field tests conducted at three sites: Pacific Collegiate School, which targets a college-bound population of highly motivated students; a school with a significant Latino population, such as Watsonville High School; and one other school with a more varied population of students
- By August, 2011: Areas that need editing/adjustment based on field tests are identified, and plans are set to fix these issues
- By November, 2011: Final edits finished

Year 3:

- By April, 2012: Development of curricular materials finished
- By September, 2012: Companion website up and running

The management structure would be as follows:

The PI, Tara Firenzi, would make sure that all necessary work was being completed in a timely fashion, and would manage the progress of the project to ensure both quality and productivity. She would be responsible for monitoring the budget and for communicating with the funding agency. She would also be involved at all levels of the development of the videos and their accompanying curriculum, and would assume primary responsibility for developing content pertinent to the historical contextualization of this material.

Co-I Joel Primack would provide the scientific expertise required for the development of the videos, and would provide the simulations for the videos as well.

Co-I Nancy Abrams would provide guidance on the scripts and storyboards, and identify ways to incorporate elements of the book that she and Professor Primack wrote about the place of humankind in the universe.

Co-I Darrell Steely would work primarily on the writing of scripts, the creation of ancillary curricular materials, the creation of professional development materials, and the content of the website.

Co-I Joel Tarbox would work primarily on the production and editing of the films, and would manage all student participation in their creation as well. He would also be responsible for the design and upkeep of the companion website, and the design of the ancillary curricular materials.

Collaborator Doris Ash would provide guidance to GSR Zoe Buck as she develops materials and assessment tools for the project, and would advise on best practices in the development of educational materials for secondary students of all backgrounds.

GSR Zoe Buck would provide research assistance on the scripts, help with the writing of the scripts, and be responsible for field testing the

Consultant Solana Pyne would provide feedback and guidance about the presentation of the material in the videos.