

Helioseismic and Magnetic Imager for Solar Dynamics Observatory



Concept Study Report

Appendix N

Education & Public Outreach Plan

**SU-HMI-S018
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**Stanford University Hansen Experimental Physics Laboratory
and
Lockheed-Martin Solar and Astrophysics Laboratory**

The cover of the NASA 1984 report "Probing the Depth of a Star: The Study of Solar Oscillations from Space" featured Hirschhorn's the Pomodoro Sphere. That report led to the helioseismic study of the global Sun. Pomodoro's Cube at Stanford symbolizes HMI data cubes for investigation of localized regions in the Sun.

HMI Education and Public Outreach Program

June 2003

I. Overview:

The SDO mission provides a singular opportunity to engage the public in scientific exploration and to work with educators and museums to improve the teaching and understanding of science, math, and technology. Using public interest in SDO as a “hook”, we intend to improve science literacy and public understanding of the Sun’s role in the Earth’s environment. By combining HMI funds and resources with those of related solar-science E/PO projects, we expect to deliver a dynamic and extensive E/PO program with national impact. Our ultimate mission is to improve science literacy by inspiring and engaging people’s imagination.

Understanding the Sun, its heliosphere, and their effects on planetary environments as a single connected system is the goal of the NASA’s Sun-Earth Connection Division. SEC has a large and successful E/PO program, including their Sun Earth Connection Educational Forums and the Living With a Star programs. We intend to participate in SEC educational and theme activities such as the yearly Sun-Earth Days. To avoid duplication, we will collaborate and coordinate our programs with those of the SEC, LWS, SECEF, and GSFC in particular, to take advantage of each other’s expertise and materials and assure that projects are leveraged and serve as enhancements to each other.

The E/PO efforts of the HMI team at Stanford will be split into two periods: a) pre-launch, where we will focus primarily on formal and informal science education, and b) post-launch where the emphasis will be on mission-specific press releases and public outreach. This split was adopted to reflect the changing roles in E/PO over the lifetime of the SDO mission as well as the current need to increase understanding of solar science.

In the pre-launch phase, E/PO efforts will focus on formal education, to highlight the science of the Sun-Earth connection, increase scientific literacy through teacher and student training and resources, and build enthusiasm and anticipation for the launch of SDO and its results to come. To most effectively take advantage of returns from the mission, students need to be “brought up to speed” on the concepts of the Sun as an active, unpredictable star that can have important effects on the Earth system. The science necessary to increase this understanding already exists; getting it into the K-14 programs is the challenge. The highlights of pre-launch will focus on a collaborative program with Stanford’s Haas Center for Public Service, partnerships with various science and technology museums that provide science resources and training to teachers and K-14 groups, and leverage realized by coordinating E/PO efforts with other grants and programs. In all programs, the key target will be students, teachers, schools, and role models that primarily serve under-represented populations. Planned programs are extendable and designed to have nation-wide distribution and relevance.

Post-launch, as mission data are gathered and analyzed, we will advertise these to the press and general public, using them as hooks to enhance public interest in, and understanding of, the vital role our Sun plays. Results from the mission will be presented in publicly appealing and understandable ways, including vivid graphical imagery and video. Special efforts will be made to develop relationships with the scientific press, to provide them with suitable background material, including current live images of the Sun and on-line resources providing high-resolution imagery and graphics designed to emphasize key concepts to the public. Focus will shift from K-14 formal education to informal education, working more directly with science and museum partners, providing expertise and current information about the Sun-Earth connection, and encouraging museums to procure NASA-developed and other displays relating to the Sun and Sun-Earth connection. As in the pre-launch phase, efforts will be leveraged by combining resources with other grants and programs.

II. Pre-launch Phase – Focus on Formal K-14 Education and Solar Science Literacy

a. Partnership with Stanford’s Haas Center for Public Service; Undergraduate Students as Outreach Partners

During the pre-launch phase of operation we will rely heavily on Stanford’s Haas Center for Public Service to magnify the effect of our E/PO efforts. The Haas Center, top-ranked amongst university-based public service programs, is collaborating with the HMI team to develop a program to involve undergraduate students who are interested in communicating science to a broader audience. Students in the fields of physical science, engineering and technology, math, journalism, education, film-making, and other fields will be selected to participate in a program that teaches them the techniques of communicating science to K-14 students and the general public. Using this knowledge, our “Science Fellows” will participate weekly in programs already administered by Haas. Examples include Upward Bound, a program designed to encourage minority students on to college, and EPASA (East Palo Alto Stanford Academy), a yearlong academic enrichment program for middle-school students in Stanford's neighboring community, East Palo Alto. The science fellows might also work with established student-run science and engineering outreach projects such as Henry's Place, The Science Bus, and SEPO (Scientists and Engineers for Public Outreach).

Due to the diversity of Stanford’s student body, the undergraduates that Haas will recruit should be able to work with a diverse community, speaking native languages to the students and providing role models to encourage careers in science and technology. The Haas students should continue being effective role models after graduation and engagement through their careers.

Science Fellows will work directly with HMI scientists and staff, as well as experts from the science education field, to learn appropriate inquiry-based,

hands-on, and standards-related activities, curricula, and techniques to apply in working with students in communicating science. Target audiences will include K-14 schools and community programs that serve minorities and under-represented students. Weekly seminars in solar science, science education, educational development, and public service given by HMI researchers, science educators, and Haas Center staff will provide Science Fellows with the training, information, and resources they need.

Design and documentation of a portable student service-learning program is a key goal. Our newly-designed Science Fellow project is amongst the first in the nation. The program will be initially tested in the San Francisco Bay Area, then expanded into communities served by Co-I institutions, including rural schools, inner city environments, and economically-disadvantaged rural and suburban areas. Science Fellows at Co-I institutions will be invited to summer schools held both on the Stanford campus and at other institutions. Periodic on-site exchanges with Co-I Science Fellows will assure each student receives experience in multiple environments.

The Haas partnership also includes collaboration with the Stanford School of Education, which has a specialty in assessment techniques. The School of Education will direct and advise the HMI E/PO team on appropriate assessment tools for both determining the validity of all E/PO programs as well as assessment of student learning goals for materials.

The Haas program will continue through the pre-launch phase, at which point it is expected to be able to function and broaden on its own, without further support from HMI.

Outcomes and products of the joint HMI-Haas student service-learning program:

1. Documentation of a model science-outreach, community service student program, with the goal of making the program adaptable to a variety of environments. Once the program at Stanford has been developed and assessed, and the program tried through Co-Is host institutions, the program, including how to set up and administer it and how to work with various under-served target audiences, will be fully documented and made available to any interested host institutions. Haas has experience in exporting public service programs to other locations. It is hoped that a program bearing the Stanford and Haas “seal of approval” will prove of interest to a multitude of other sites.
2. Training of hundreds of Stanford and participating Co-I institution undergraduates in the appropriate techniques for educating and exciting students and the public about science. Undergraduates will represent fields relating to science education, such as science, math, engineering, journalism, education, film-making, organization management, and the like.

Undergraduates are expected to learn in the program that, no matter what their eventual professions, public service is a key life-long responsibility.

3. Outreach by the Science Fellows to thousands of under-served students in K-14 schools throughout the nation. Services including science teaching and demonstrations, mentoring and advising, involvement in long-term science research projects, teacher training and workshops, participation in community groups, provision of materials relating to science discovery (e.g. simple spectrometers), solar-science based portable planetarium presentations, and opportunities for exploring science and science-related career opportunities.
4. Design and production of solar-science-based educational materials appropriate for K-14 audiences, especially adapted to and targeted for environments serving under-represented students.
5. Professionally-designed assessments of the effectiveness of HMI E/PO programs as well as evaluation of desired student outcomes from activities and materials.
6. The cadre of Science Fellows that we train will provide additional leverage to the E/PO efforts of HMI research scientists. Science Fellows may work directly with researchers in preparing and presenting teacher workshops, developing materials for museums, developing and maintaining solar-science websites, presenting public presentations on Sun-Earth connection issues, and the like.

b. Science and Technology Museum, Planetaria, and other Community Partnerships

The Stanford team has arranged liaisons and partnerships with most of the science museums and technology centers in the Bay Area. These include the Exploratorium in San Francisco; Chabot Observatory and Science Center, federally-funded and jointly administered by the Oakland School District; The Tech Museum in San Jose; Morrison Planetarium of the California Academy of Sciences; the Lawrence Hall of Science, UC Berkeley; and the Chabot Community College Planetarium in Hayward. In addition, the HMI team has partnerships and collaborations with the Astronomical Society of the Pacific's Project Astro and Family Astro programs, the Alameda County 4-H Program, the Castro Valley School District Science Initiative, and other educational and community groups.

Partnerships will be leveraged to jointly distribute resources and information, provide teacher and master teacher training forums, provide expertise and resources to museums in expanding their Sun and Sun-Earth connection coverage, develop and adapt solar planetarium programs to various audiences, and host special public events such as Sun-Earth Day and Astronomy Day.

Outcomes and products of the museum partnership program include:

1. Teacher and master-teacher workshops and materials for educating students about the Sun and Sun-Earth connection. We anticipate developing 1 new topic teacher workshop per year, with presentation of 2 workshops per year per museum. Materials will be drawn from existing NASA, NSF, and related projects as well as new materials adapted specifically to serve the needs of the SDO program. For the workshops, Stanford will provide a researcher, a supporting Student Fellow, materials, and content. The partner museums will provide facilities, communications, teachers, and teacher-stipends. All teacher workshop materials will be designed to be exportable to Co-I and other sites.
2. Joint development of real-time solar displays to show various aspects of the state of the current Sun in multiple formats. Although these will be less exciting during solar minimum, the techniques and technology need to be developed and well-tested to become valuable and exciting to the public during solar maximum. The HMI team will work closely with GSFC E/PO staff to assist museums in developing and setting up access to web-based real-time solar imagery and data. Real-time solar displays will, of course, be made available to anyone on the web.
3. Incorporation of a solar-based, interactive planetarium program focused on the Sun and Sun-Earth connection. (Details below.)
4. Education of museum staff in the Sun and Sun-Earth connection information relevant to the Earth systems. Staff have especially asked for current, daily web resources providing them with high-resolution, printable and displayable information and imagery of current solar events that can easily be incorporated into planetarium programs and public displays. They would also like web-based training tutorials and resources related to the solar science necessary to understand the Sun-Earth connection. Both HMI researchers and Science Fellows will collaborate with museums on providing web-based current, daily, information about solar events, their causes, and their impacts.

c. Collaborative Efforts with other Funded Education and Public Outreach Programs

The funds available from HMI are not sufficient in themselves to support the dynamic and extensive E/PO program as proposed. However, by coordinating efforts with programs and personnel from other projects, we hope to highly leverage our talents and skills to multilaterally produce programs and materials of high quality and potential national interest. We are arranging collaboration and support from a collection of other funded grants and programs, including:

- The NSF-funded Center for Integrated Space-Weather Modeling (CISM)
- NASA's Living With a Star (LWS) program
- NASA's SEC and SECEF programs and activities
- The Lawrence Hall of Science
- Rice University's Solar Planetarium project
- Stanford's Radio Telescope Group's HAIL project to establish ionospheric monitors in high schools worldwide.

- A NASA-funded IDEAS grant to the Exploratorium, in partnership with SECEF and Stanford, to develop a space-weather public-oriented website and associated webcasts.
- SOHO's MDI E/PO team, consisting primarily of Stanford and Lockheed personnel and resources.
- The NASA and NSF funded-Wilcox Solar Observatory E/PO program
- NSF's funded program with Chabot Community College, a minority-serving institution, to develop an Integrated English, Math, and Science (IEMS) program specifically designed for encouraging developmental (i.e. remedial) students to continue their college education.

In addition, we will coordinate plans with GSFC and other SEC E/PO efforts to avoid duplication, take advantage of each other's expertise, and assure that projects are leveraged and serve as enhancements to each other.

A multitude of high-quality student and public science-related materials including posters, low-cost spectrometers, and space weather packets have been, and will continue to be, developed by various agencies and groups within NASA, NSF, and others. We will work closely with GSFC to build on existing materials relevant to the SDO mission, using our researchers, Science Fellows, and museums/partners to adapt and enhance these products to specific needs.

Outcomes and products of the coordinated, leveraged outreach program include:

1. A Solar Planetarium Program for small, interactive planetaria.
In coordination with NASA's Living With a Star (LWS) program, NSF's Center for Integrated Space-Weather Modeling (CISM), and the Lawrence Hall of Science (LHS) at UC Berkeley, we will develop a solar-based planetarium program suitable for presentation in small, interactive planetaria such as the portable Starlabs. This planetarium program will include information about the Sun and Sun-Earth connection as well as projection of current, or near current, images of the Sun. LHS will collaborate with the HMI team on the development of a PASS (Planetarium Activities for Student Success) Guide that will be distributed nation-wide by Learning Technologies, Inc., maker and distributor of the Starlab portable planetariums.

Rice University, partially with CISM support, is developing a full-projection, large dome planetarium program based on solar science and space-weather issues. Although immersive-projection is not currently available to the smaller planetariums because of high cost, we are looking into techniques and products currently in use by the entertainment industry to provide low-cost alternatives that would then allow us to share imagery, graphics, animations, and videos developed for the larger program. We are also working with Rice personnel to coordinate content so that the shows can complement each other.

2. Development of a Solar Weather Monitoring System for high school and community colleges.

Jointly with CISM, the HMI team is developing a low-cost Solar Sudden Ionospheric Disturbance (SSID) Monitor and Magnetometer system that can be readily installed and used by high school and/or community college students. Initial SSID prototypes, essentially VLF receivers, were designed and are in use by the American Association of Variable Star Observers (AAVSO) to monitor the impact on the Earth's ionosphere by solar events. NASA's Radio Jove project has a similar VLF receiver that directly monitors solar activity.. The existing systems are complex, difficult to assemble and debug, and less than optimally sensitive. By working with Stanford's Radio Telescope Group, led by Umran Inan, we expect to develop a more appropriate instrument that can be easily installed and managed by students and can produce reliable and accurate data useful not only for solar observations but night ionospheric work as well.

By adding a low-cost magnetometer to the project, students will be able to study both the CME and the particle emission affects of solar activity. Existing magnetometers are either too costly or too complex for student use. The CISM and HMI teams are looking into designing an effective but still low cost instrument appropriate for use in schools.

Educators at Chabot Community College have agreed to work with the HMI team to design educational activities around the Solar Weather Monitoring System and incorporate those activities into astronomy and related courses. They will also experiment with using the Solar Weather system in their NSF-funded program to offer integrated science-math-English basic courses to developmental students.

3. HMI team members have joined with the Exploratorium and SECEF in a NASA IDEAS grant to develop and maintain a public solar-weather website and webcast series. Stanford's role is to identify public misconceptions about the Sun-Earth connection. The HMI team will leverage off this effort not only to identify misconceptions, but develop materials and tools to address and correct these misconceptions. These materials will be incorporated into the solar planetarium program, the Science Fellows training, teacher workshops, and museum exhibits.
4. Personnel and students supported through the Wilcox Solar Observatory have agreed to coordinate efforts by jointly producing teacher workshops and related materials for training teachers and master teachers in Sun-Earth science concepts.
5. SOHO's MDI team consists principally of researchers from Stanford and Lockheed. This group already has a track record of developing successful materials in solar science, including award-winning websites, webcasts, posters, low-cost spectrographs, and other educational material. By combining efforts with the MDI team, HMI will be able to collaborate on the

production of educational materials, a webcast series, and informational websites.

d. Involvement of PI and Co-Is and Their Institutions

The PI for HMI is particularly committed to E/PO programs and has had significant experience in designing and supporting both formal and informal outreach efforts. He has agreed to serve as a key advisor for the HMI E/PO and coordinated programs. The budget explicitly includes 10% FTE of a solar scientist to focus on E/PO. In addition, the goal is for each Co-I on the team to donate 1-3 days per year to education and outreach program activities. While team members have individual choice over their particular projects, the targets include the following:

- Involvement of Co-Is in training Science Fellows, especially in helping them understand the solar science behind the educational materials they will be working with. Training opportunities will arise both at the host institution and the summer schools planned for Science Fellows.
- Implementation of Science Fellow programs at Co-I institutions. Focus will be on outreach to rural environments, tribal schools and similar groups not readily available in the Stanford area. Experience addressing the needs of various groups will be incorporated into planning and development of both the Science Fellow program itself as well as the educational materials it creates and uses.
- Implementation of Solar Weather Monitoring system at or through Co-I institutions.
- Acquisition of Starlab planetaria and testing of the solar planetarium program in under-served communities in the institution's environment.
- Involvement of Co-Is with science museum partnerships, including providing expertise for solar exhibits, public presentations, developing materials, and being involved with the real-time solar imagery designed for the public.
- Involvement of Co-Is with the Exploratorium's and MDI's webcast series.

Outcomes and products of pre-launch PI and Co-I involvement:

1. Direct and timely access to solar scientific expertise by science museums.
2. Direct access to scientific expertise by our student Science Fellows.
3. A Science Fellow program that has been field-tested in a variety of environments, all focusing on outreach to minority and under-represented populations.
4. Testing of the Solar Weather Monitoring system in different environments and by different groups.
5. Field-testing of the solar planetarium program, assessing and adapting its usage to various inner city, rural, tribal, and other environments.

III. Post-launch Phase – Focus on Press Relationships and Information Public Education

Experience with the SOHO mission has shown that the effective use of press releases with their related imagery and background support is critical to spreading information about research findings and igniting public enthusiasm in the mission results. Thus after launch we will shift focus from student programs and K-14 education to providing information to the press and public about the background science necessary to understand and interpret mission results.

Because many of the necessary programs and materials will be in place from pre-launch efforts, HMI funding for E/PO activities after launch is roughly half that of pre-launch.

a. Press Relationships and Resources

Appropriate and enthusiastic press support is crucial to NASA's missions and continued funding. The Space Science Updates (SSU) format has proven exemplary in addressing press's, and ultimately, the public's needs to become involved with, and understand, NASA research results. However, for SSUs to be most effective, appropriate background information must be easily available, understandable, and provided in publishable formats to press representatives. Thus extensive efforts are necessary to develop and provide high quality, intriguing imagery and information to support the content of research results. E/PO efforts after launch will primarily focus on providing resources, information, real-time imagery, data visualizations, and videos useful to the press and their role of informing the public.

Outcomes and products of the Press Support program include:

1. Support for one major (SSU-format) and one minor (locally issued) press release per year after launch and initial research results come in.
2. Web-based, DVD, and/or other media-based background information provided for each press release, including high-resolution imagery appropriate for print media, movies and videos for TV and film coverage, and enough science background to adequately inform the press and, eventually the public, on the meaning and impact of research results.
3. Provision of a 24-hour "hotline", web-based, where science reporters can receive daily, up-to-the-minute high-quality imagery and information about current solar events and their impacts, and access to solar science expertise..

b. Partnerships with Science Museums, Observatories, and Planetariums

Partnerships nourished during the pre-launch phase will be continued. Once data from the mission start coming in, HMI scientists will work with interested museums in providing live feeds of solar imagery and activity to the public. The hope is to provide these not only in a strictly scientific context, but also to incorporate the displays into art-based, music, and other experimental media. Evidence of unusual usage is already coming from artists and musicians taking

advantage of SOHO data and imagery (see <http://solar-center.stanford.edu/art.html>). Experience has shown that such activities are intriguing hooks to encourage the public to become interested and involved in science-related pursuits.

By launch, some partner museums, like Chabot Observatory and Science Center, will already have live feeds from resident telescopes and instruments. HMI team members will work with them to incorporate comparison data and imagery from the SDO mission into their live displays.

The HMI E/PO team will also work with partner museums and planetaria to provide web-based resources for incorporating high-resolution live, or near-live, imagery and data into current planetarium programs and other scientific presentations.

Outcomes and products of the post-launch museum partnership program:

1. Live feeds of solar imagery in sufficient format for large-scale display in science museums, observatories, and planetaria nationwide.
2. Web-based live and archived imagery, frequently updated, for immediate incorporation into planetaria and other science presentation programs.
3. A collection of posters, family packets, CDs/DVDs, and other educational material to be widely-distributed through science museums and observatories throughout the world.

c. Collaborative Efforts with other Programs and Funded Projects

After launch, the Haas student Science Fellow program should be sufficiently mature as to continue without additional HMI funding. It is expected that other Stanford departments and groups will develop similar science communication outreach programs and Haas will have extensive experience upon which to draw. The program will have been exported to other Co-I institutions and become successfully incorporated there.

Though unfunded by HMI, Haas will continue to provide Science Fellows to the mission. However, in the post-launch phase the Fellows will direct their energies to public outreach more than K-14 activities. Potential projects include development and maintenance of a solar-science-oriented E-zine, or web-based public online magazine similar in content to “Scientific American” but focused on the Sun-Earth connection and current solar events.

Stanford and Lockheed will continue to jointly develop public outreach materials such as posters, quick-reference sheets, and packets. In the pre-launch period, those materials focused primarily on formal education and teacher needs. Post-launch, the materials will be adjusted to reach a broader audience, be distributable through the science museum partnerships, and be particularly supportive to the press.

Key projects such as the Space Weather Monitor and solar planetarium program will be completed and in use nationwide. However, the HMI team will explore additional opportunities to coordinate and leverage E/PO programs.

Outcomes and products of the post-launch collaborative efforts:

1. The Science Fellow program developed jointly between Haas and the HMI team will be successful enough to continue without HMI funding. The model will have been exported and tested at Co-I and other institutions. During post-launch phase, the programs should mature into university-sponsored ongoing programs. Science Fellows will work with mission scientists to develop approaches and materials to support the public outreach nature of the post-launch phase.
2. The Solar Space Weather Monitor and solar planetarium programs will have been released and will be in common use nation-wide. Mission Co-Is will continue to serve as sources of expertise and encouragement.
3. The Exploratorium's Space Weather website and webcast series will be in full operation and providing timely and relevant information to the public on Sun-Earth connection topics. HMI scientists will continue our role in providing information and resources.

d. Involvement of PI, Co-Is, and Research Scientists

Because of the critical nature of helping the press and public to develop the appropriate background “structure” for understanding mission results, Co-Is will be deeply and directly involved in press opportunities relating to their research areas. Stanford will begin by setting a precedent of fully-supported press releases with impressive imagery and appropriate background information and supporting materials. The PI will encourage Co-Is to take their press responsibilities equally seriously and help assure that adequate resources are available to the press and public.

Co-Is will also be expected to develop relationships with their local press, serving as mentors and “translators” of technical knowledge into readily understandable concepts. Relationships with museums and science centers will continue to be emphasized as well.

Outcomes and products of the post-launch PI and Co-I involvement:

1. The national and international press will come to rely on HMI researchers as the primary source for information relating to the Sun and Sun-Earth connection. A positive and productive relationship will increase press background knowledge to allow them to be better communicators of solar science concepts to the public.
2. Science museums and planetaria nationwide will have direct access to solar researchers and their data, for use in understanding and presenting solar science to the public. Museums and the general public alike will have direct

access to live imagery of the Sun and current solar events, plus mechanisms for understanding that imagery and relating it to their daily lives.

3. A more solar-science-literate press and public will have a deeper understanding of the Sun-Earth connection and why knowledge about it is so important.

IV. Summary

The HMI Education and Public Outreach efforts described here represent a highly-leveraged and coordinated program building upon the strengths not only of HMI researchers but other NASA and NSF projects as well. Our program initially focuses on formal education, to highlight the science of the Sun-Earth connection and increase scientific literacy. After launch, we will emphasize efforts with our partner museums and the press to highlight the results of the SDO mission and make them exciting, intriguing, and understandable to the public. Working with collaborators and partners such as the Haas Center for Public Service, NASA's GSFC and SEC Division, NSF's Center for Integrated Space-weather Modeling, and similar programs, we expect to be able to multilaterally produce programs and materials of high interest and potential national impact.