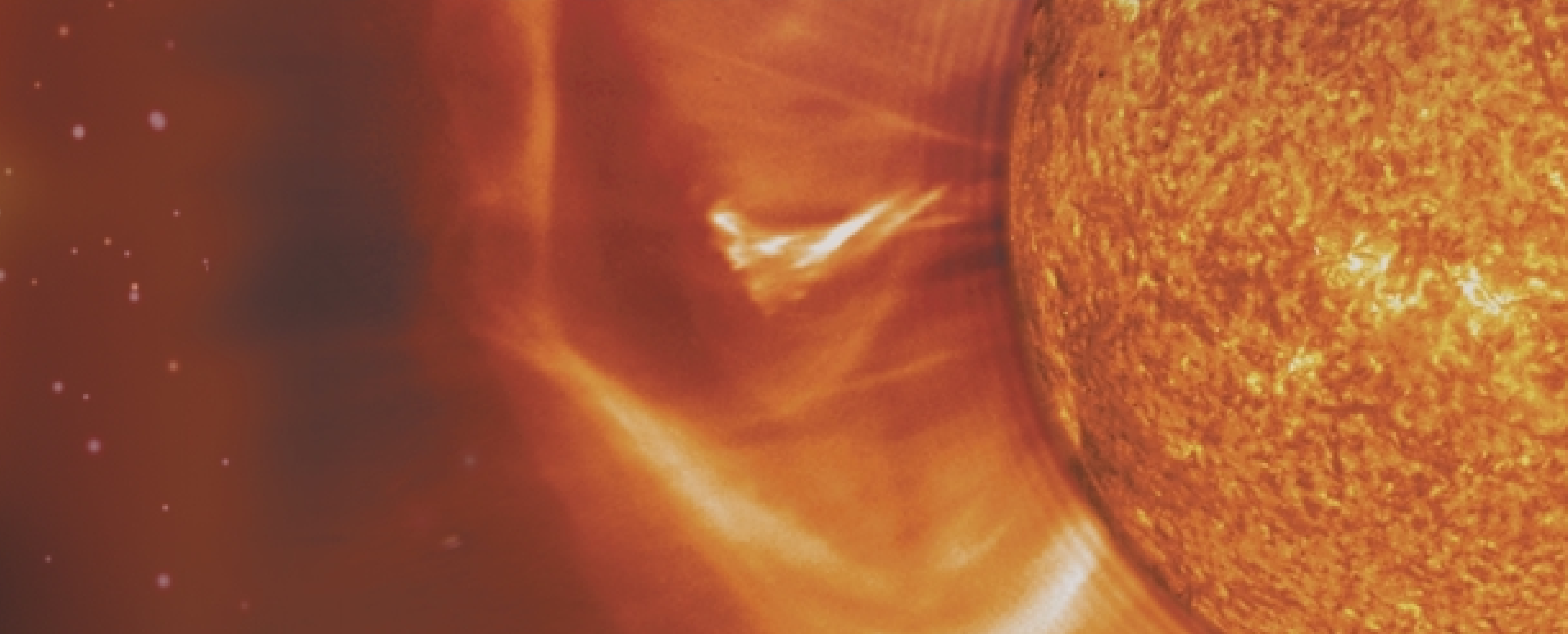
COVER STORY

NEW LIGHT

ON THE SUN

A CONSORTIUM LED BY NJIT MOVES AHEAD WITH PLANS FOR A RADIOTELESCOPE DEDICATED TO THE STUDY OF OUR STAR



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THE SUN HAS BEEN SHINING FOR A LONG TIME, NEARLY FIVE BILLION YEARS. HUMANITY'S INSTINCTIVE RECOGNITION THAT THE SUN IS THE SOURCE OF ALL LIFE ON EARTH MADE IT AN OBJECT OF RELIGIOUS VENERATION FOR MANY ANCIENT CULTURES. BEGINNING WITH TELESCOPIC OBSERVATIONS BY GALILEO AND THOMAS HARRIOT IN 1610, THE SUN HAS ALSO BEEN SCRUTINIZED WITH INCREASINGLY SOPHISTICATED OPTICAL TELESCOPES AND INSTRUMENTS THAT HAVE YIELDED INSIGHTS INTO THE SUN'S COMPOSITION THROUGH SPECTRAL ANALYSIS. IN THE 20TH CENTURY, RADIOTELESCOPES WERE ADDED TO THE MIX OF INSTRUMENTATION AVAILABLE FOR SOLAR RESEARCH.

PHOTO: CRAIG WALLACE DALE; ART: COURTESY OF SOLAR AND HELIOSPHERIC OBSERVATORY (SOHO), A PROJECT OF INTERNATIONAL COOPERATION BETWEEN THE EUROPEAN SPACE AGENCY (ESA) AND THE U.S. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

Now, NJIT is the lead institution in a study to design and ultimately build a powerful radiotelescope that will be used to investigate solar phenomena in the radio spectrum and how such phenomena affect the Earth. The proposed facility has been named the Frequency Agile Solar Radiotelescope, or FASR (pronounced FAY-ser, like the device ubiquitous in the *Star Trek* series). The project reflects the rising interest in solar radio physics among scientists as well as advances in electronics that make this dedicated facility both technically and economically feasible. Joining NJIT in the FASR effort are Lucent Technologies, the National Radio Astronomy Observatory, the University of Maryland and the University of California at Berkeley.

FASR is funded by the National Science Foundation (NSF), and NJIT has already received funds for detailed design and site selection. NSF anticipates that the cost of building and initially operating FASR for five years will be approximately $60 million. Results expected from FASR are so potentially significant that the National Research Council (NRC) has ranked the project at the top of solar research efforts to be carried out over the next decade. Established in 1916, the National Research Council has become the chief operating agency of the National Academy of Sciences and the National Academy of Engineering.

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At the solar forefront

New Jersey Institute of Technology has played a significant role in solar research since 1997. That’s when the optical telescopes at Big Bear Solar Observatory and the radiotelescope array at Owens Valley Radio Observatory, both in California, were transferred to NJIT from California Institute of Technology.

“FASR solidly positions NJIT at the forefront of solar investigation,” says NJIT Professor of Physics Dale Gary, principal investigator for the FASR project and director of the Owens Valley array. Gary joined NJIT from Caltech when the transfer of the Owens Valley and Big Bear observatories was initiated by Distinguished Professor of Physics Philip Goode, who is director of NJIT’s Center for Solar-Terrestrial Research. Goode had earlier brought Caltech researcher Haimin Wang to the NJIT physics department, two years prior to the transfer. In addition to working on FASR, Wang is associate director of the Big Bear observatory. Recently, the FASR team at NJIT grew when physicist Louis Lanzerotti joined the Center for Solar-Terrestrial Research as a distinguished research professor of physics. (See sidebar on opposite page.)

Commenting on NJIT’s prominence in the field Goode says, “Big Bear Solar Observatory and the solar array at Owens Valley are world-class facilities built by Caltech. The transfer gave us a great opportunity, and we have improved the facilities and made them more productive. It is our response to the opportunity that has enhanced the status of NJIT. It is fair to say that NJIT is now among the leading universities in the U.S. in solar physics — the study of our star and how it affects us.”

Ready with the right instrument

The dedicated FASR array promises to be the right instrument for gaining new insights into solar phenomena that are still mysterious. While it’s known that the Sun, like all stars, consists mainly of gaseous hydrogen and releases energy through nuclear fusion, many questions have yet to be answered. Still to be determined are why certain regions of the corona, the diffuse luminous material that extends outward from the Sun, get much hotter than the photosphere, the visible surface of the Sun. Scientists are also not sure how or to what extent variations in the Sun’s energy output, over long periods, affect the Earth’s climate. Other questions involve the nature of the solar wind, the stream of charged particles that emanates from the Sun and permeates the solar system.

Much is still not known about solar flares and coronal mass ejections (CMEs), violent phenomena associated with the Sun’s magnetic fields that can cause sudden, intense fluctuations in the solar wind and serious consequences on Earth. Solar-flare and CME activity that intensifies the solar wind can result in terrestrial magnetic storms that are far from harmless.

From cell calls to flight safety

Magnetic storms disrupt electric power grids and communications systems on Earth, posing an especially serious problem for the fast-growing number of people who depend on cell phones and other wireless technologies. Electronic components on satellites orbiting the Earth can be irreparably damaged. People on aircraft flying at high altitude over the Earth's poles risk exposure to increased levels of potentially dangerous radiation, a problem that's much more acute for crews on the Space Shuttle and the International Space Station. As critical as these consequences are for human activities, researchers do not have a clear understanding of how such solar-induced events occur or how they can be predicted to minimize their damage.

Areas of investigation already on the FASR agenda include the nature and evolution of coronal magnetic fields, transient energy phenomena and the solar atmosphere. FASR researchers will be looking into processes such as the storage and release of magnetic energy in the corona, plasma heating and electron acceleration, formation and destabilization of large-scale solar structures, coronal heating and the origin of the solar wind.

"Many researchers with a wide range of interests compete for time on the world's major optical telescopes and radiotelescopes, and time on an instrument typically has to be scheduled months in advance," says Gary. "You can't schedule a solar flare or CME. They're unpredictable, transient events, and you have to be ready with the right instrument at the right time to capture as much useful data as possible."

A hundred receiving dishes

Compared to the seven receiving dishes at Owens Valley, FASR will consist of a hundred dishes ranging from two to five meters in diameter situated on up to 6900 acres, depending on the geographic distribution of the dishes. Wang says that various locations in the United States are under consideration, with the primary requirements being a dry climate and a site that's "radio quiet," free from radio interference. A dry climate is preferable because moisture in the atmosphere can attenuate signals on the frequencies being observed and radio quiet is the radio astronomer's equivalent of freedom from local light pollution.

Observation of the Sun in optical portions of the electromagnetic spectrum, such as the research at the Big Bear observatory, will continue to be an important aspect of solar investigation. For example, staff members at Big Bear have done ground-breaking research into the Sun's magnetic fields by observing the infrared region of the spectrum with special digital cameras of their own design. However, studying the Sun via its radio emissions yields complementary data, as well as information not accessible with optical telescopes on Earth. This is especially true of the Sun's corona, particularly the regions where strong magnetic disturbances occur. While significant research in the radio spectrum has been carried out at Owens Valley, FASR will provide substantially greater capabilities for this work.

FASR will be much more sensitive than the Owens Valley facility, making it capable of producing images in the radio spectrum with substantially greater resolution. It will also cover a wider range of frequencies — from 0.1 to 30 gigahertz (GHz) compared to 1 to 18 GHz for Owens Valley. Further, the frequency agile instrument will be able to scan these frequencies far more quickly, in milliseconds rather than seconds. This agility in the radio spectrum is needed to mine the most information from solar phenomena — phenomena that can be as brief as they are sudden.

The design and site-location phase of the FASR project is expected to last about two years. If all goes according to plan, the new radio solar observatory could be in operation by 2010, advancing a scientific agenda that may lead in unexpected directions. "It's an instrument with tremendous potential," says Gary. "It's not unreasonable to expect that such an increase in our capacity to understand the Sun will result in completely unanticipated discoveries." ■

Visit http://www.ovsa.njit.edu/fasr for more information about the FASR project.