

Space Sciences
Universities Space Research Association
Columbia, Maryland 21044

The report covers the period from January 2002 – September 2003.

I. INTRODUCTION

The Universities Space Research Association (USRA) is a private non-profit corporation, formed in 1969 under the auspices of the National Academy of Sciences. The Association was chartered for the purpose of establishing and operating cooperative institutions and other programs that serve to further the advancement of research and education related to space science and technology. USRA was vested in a university membership, now consisting of ninety-four institutions, that oversees all activities, thus inherently ensuring to the government that activities undertaken serve to benefit the broader community and not any particular institution. In fulfillment of its charter, USRA operates a number of institutes and programs in eleven locations throughout the United States. USRA has established institutes and programs in atmospheric science, applied mathematics and computer science, earth sciences and earth system science education, lunar and planetary science, microgravity materials and applications, space astronomy, space physics, space life sciences, space technology and advanced concepts. Each of these activities includes requirements for the participation of scientists in programs with the National Aeronautics and Space Administration (NASA) and the Department of the Navy.

For over three decades, USRA has fostered harmonious and productive collaborations between government agencies, the academic community, and industry

II. SOFIA

Flying at and above an altitude of 12.5 km (40,000 ft) where the typical atmospheric water vapor column is less than 10 μm , the Stratospheric Observatory for Infrared Astronomy (SOFIA) will consist of a specially-modified Boeing 747-SP aircraft carrying a 2.5-meter telescope designed to make sensitive infrared measurements of a wide range of astronomical objects. SOFIA represents a collaborative effort between NASA and the German space agency DLR. It will be a premier observatory for infrared and sub-millimeter astronomy for the next two decades.

In 1996 USRA was awarded a contract to design, assemble, test, and operate SOFIA. USRA heads a team that includes United Airlines, L-3 (formerly Raytheon Systems Company), University of California, the SETI Institute, and the Astronomical Society of the Pacific. Contract management is performed at NASA's Ames Research Center (ARC).

The telescope is a Cassegrain design with a Nasmyth focus and has a focal ratio of f:19.6. It will operate primarily in the infrared (1-600 microns) region of the spectrum, with capabilities spanning 0.3 to 1,600 microns. The primary mir-

ror, with a focal ratio of f:1.28 and an effective aperture of 2.5 m, was cast by Schott Glasswerke of Mainz, Germany; its light-weight blank weighs only 880 kg. REOSC, a prominent optical fabrication company located near Paris, France, completed the polishing of the mirror in April 2001. The telescope itself was constructed by a consortium of German contractors under DLR including MAN-T and Kaiser-Threde.

The scientific instruments to be used with the SOFIA telescope are being developed by the U.S. and German science communities. Nine instruments are currently in various stages of construction or development, including three Facility-class Science instruments (FSI), five Principal Investigator-class instrument (PSI) and one Special Purpose Principal Investigator-class Science instrument (SSI). The three facility instruments scheduled for operation are FLITECAM (a 1-5 micron imager; P.I. Ian McLean, UCLA), FORCAST (a 5-40 micron imager, P.I. Terry Herter, Cornell) and HAWC (a 50-240 micron bolometer camera, P.I. Al Harper, U. Chicago/Yerkes Observatory).

SOFIA will be operated out of the SOFIA Science and Mission Operations Center (SSMOC) located in Hangar N211 at NASA Ames Research Center, Moffett Field, California. Modifications to the N211 structure began in 1999 and include new offices, laboratory space, and a mirror coating facility, which incorporates a mirror stripping room and a specially constructed vacuum chamber. The mirror coating facility was completed in 2002. The remaining modifications to Hangar N211 are nearly completed and the SOFIA staff will occupy the building beginning in spring 2004.

SOFIA is expected to operate for at least 20 years, with flights originating primarily from Moffett Federal Airfield, but occasionally from other bases around the world, particularly in the Southern Hemisphere. Flight planning and logistics, as well as the daily operation of SOFIA will be accomplished under USRA's direction by United Airlines. Over the first three years of operations SOFIA will ramp-up to about 140 science flights per year of at least 8 hours duration.

SOFIA is now nearing the final stages of development. The modifications to the aircraft are continuing at L-3 in Waco, Texas. The telescope assembly and the primary mirror arrived in Waco in September 2002. The assembly was installed in its compartment aboard the aircraft in February 2003, and the primary mirror was installed in July 2003. The first test flights of the aircraft are expected to take place in early 2004. Transfer of the aircraft to Moffett Field is expected in late 2004. The first science flights are expected to occur in early 2005.

Mr. Tom Bonner is the USRA Project Manager for SOFIA, overseeing aircraft modification activities ongoing at Waco, and integration, test and verification activities be-

tween U.S. and German contractors. Dr. Eric Becklin is the USRA Chief Scientist and SOFIA Observatory Director designate. The scientific staff consists of Dr. Jacqueline Davidson (USRA SOFIA Project Scientist), Dr. Sean Casey (SOFIA Instrument Scientist), Dr. Goeran Sandell and Dr. William Vacca (USRA SOFIA Senior Scientists). Ms. Maureen Savage is the Science Instrument Manager. Patrick Waddell is the USRA Mission Operations Scientist. Dr. Dana Backman is SOFIA's associate director for Education and Public Outreach, with activities subcontracted through the SETI Institute and the Astronomical Society of the Pacific.

The status of the SOFIA aircraft, telescope, and science instruments is updated regularly at the following web site: <http://sofia.arc.nasa.gov/>.

III. LUNAR AND PLANETARY INSTITUTE

The Lunar and Planetary Institute (LPI), established in 1968 as the Lunar Science Institute, is a focus for academic participation in studies of the current state, evolution, and formation of the solar system. The Institute is housed in the USRA Center for Advanced Space Studies (CASS), and includes a computing center, extensive collections of lunar and planetary data, an image-processing facility, an extensive library, education and public outreach programs, resources, and products. The LPI also offers publishing services and facilities for workshops and conferences.

Current major LPI research topics include the origin and evolution of the early solar system, petrology, and geochemistry of planetary materials and volatiles, planetary interiors, volcanism, and tectonism, and impact cratering. Research interests range from Venus to Pluto and the icy moons of Neptune.

The scientific staff of the LPI consists of approximately 10 staff scientists and a number of long-term visitors. LPI is a Broker/Facilitator in the "Education Ecosystem" of NASA's Office of Space Sciences.

For further information and for extensive on-line scientific and education services, visit the LPI website at: lp@cass.jsc.nasa.gov

IV. RESEARCH SCIENTISTS PROGRAMS

a. Cooperative Program in Space Science (at GSFC)

USRA is working with the NASA/GSFC through a cooperative agreement known as the Cooperative Program in Space Sciences (CPSS). It involves activities within three of the four Goddard Space Flight Center's Space Science Laboratories: the Laboratory for High Energy Astrophysics, the Laboratory for Extraterrestrial Physics, and the Laboratory for Astronomy and Solar Physics.

The mission of the CPSS is to conduct space science research and leading edge instrumentation and technology development, enable research by the space sciences communities, and to expedite the effective dissemination of space science research, technology, data, and information to the educational community and the general public.

To fulfill this mission, USRA recruits and maintains a staff of scientific researchers, operates a series of guest in-

vestigator facilities, organizes scientific meetings and workshops, and encourages various interactions with students and university faculty members.

While not limited to these, the primary scientific areas for research, community support, and education/outreach include:

- Astrochemistry
- Cosmic Ray Astrophysics
- Extraterrestrial Physics
- Gamma Ray Astrophysics
- Gravitational Physics
- Infrared Astrophysics
- Instrument Development
- Interplanetary Physics
- Planetary Systems & Magnetospheres
- Solar Physics
- Space and Plasma Physics
- UV and Optical Astronomy
- X-ray Astrophysics

Research activities under the CPSS fall within three categories: 1) analysis and interpretation of data obtained from competitive guest investigator awards, from observations utilizing operational satellites, and from archival data; 2) the development of flight hardware for future missions, and 3) theoretical and/or modeling investigations related to Space Science.

USRA/CPSS scientists are integrally involved in almost all of the major programmatic activities within the GSFC Laboratory for High Energy Astrophysics - the Lab where most of the CPSS activities currently take place. They support both space-flight projects, such as the SWIFT, and balloon-borne instruments, such as NIGHTGLOW. Other scientists work on instrument development projects, including the thin-foil x-ray mirrors and micro-well detectors. Within the LHEA's Office of Guest Investigator Programs (OGIP), USRA scientists provide a wide range of products and services to guest observers and investigators.

Four USRA scientists are also working in the Laboratory for Extraterrestrial Physics, and another in the Lab for Astronomy and Solar Physics.

The CPSS is also quite active in running scientific meetings - when there is a direct tie to the scientific research activities of our scientific staff.

For further information and updates, visit the CPSS website at <http://phoenix.seabrook.edu/cpss>.

b. National Space Science and Technology Center (Huntsville Alabama)

USRA Astronomers at the National Space Science and Technology Center (NSSTC) in Huntsville, Alabama pursue research in high-energy astronomy in collaboration with researchers from NASA/MSFC and the University of Alabama. This work is mainly in the areas of x-ray and gamma-ray astronomy. USRA scientists also support the Chandra

X-ray Observatory (CXO) Project Science efforts at MSFC, and support calibration work at the MSFC X-ray Calibration Facility.

Ongoing observational programs in X-ray astronomy include investigations of galactic populations in nearby galaxies, studies of rotation-powered an accretion-power pulsars, and investigations of soft gamma-ray repeaters and anomalous x-ray pulsars. These programs use observations from the CXO, and the Rossi X-ray Timing Explorer, with correlative data from other wavelengths. Observational programs in the gamma-ray include studies of millisecond and radio pulsars, and searches for polarization in gamma-ray bursts, using data from the INTEGRAL spacecraft.

USRA scientists at the NSSTC are supporting optics development and testing for Constellation-X and the High Energy Replicated Optics (HERO) programs. The MSFC lead HERO program is developing focusing mirrors for hard X-ray optics. These have already been demonstrated in a balloon flight that detected the Crab Nebula and Cygnus X-1. Preparations are currently being made for a second balloon flight. USRA scientists are also involved in the development of pixelated CdZnTe detectors for use in the focal plan of hard X-ray optics.

c. Naval Research Laboratory, Washington, DC

Research is conducted within the Space Science Division and focuses on the fields of solar physics, solar-terrestrial physics, ionospheric and thermospheric research, and high energy astrophysics. Scientists are working on developing a new class of x-ray detectors using properties of superconducting materials at low temperatures. Three scientists are analyzing data from the LASCO and EIT experiments on the SOHO mission, specifically coronal mass ejections. One scientist is now involved in the next generation of solar coronagraphs for the STEREO mission. One scientist is developing multilayer mirror coatings for space-based telescopes.

USRA provides logistics and travel assistance for speakers in the E.O. Hulbert Colloquia Series in the Space Science Division at NRL.

d. U.S. Naval Observatory, Washington, DC

USRA research at the U.S. Naval Observatory (USNO) in Washington, DC is focused within the Astrometry Division. Scientists are involved in support of the Navy Prototype Optical Interferometer (NPOI) Project, a joint NRL and USNO effort to construct an optical interferometer at Anderson

Mesa in Flagstaff, Arizona. Scientists and engineers have worked on the optical testing of components to be used on the interferometer, the environmental chamber for the beam alignment system, and the design of the spectrograph. Development of optical aperture synthesis imaging algorithms, optical and infrared imaging of surfaces and environments of evolved stars, determination of orbits of spectroscopic binaries, and reduction of astrometric data from the instrument are being done at the USNO.

e. U.S. Naval Observatory Flagstaff Station, Arizona

USRA research at the U.S. Naval Observatory Flagstaff Station, Arizona is related to astrometry. Data analysis and reduction of infrared sources in the Galaxy are being done. Advanced IR cameras for photometry and astrometry are being developed. Work on the radio-optical reference frame is being done at the USNO. Observations of more than 400 extragalactic sources have been reduced to establish a link between the radio VLBI system and the ESA HIPPARCOS satellite catalog, representing the future optical system. Analysis of data observed with the astrometric telescope at the Cerro Tololo Observatory in Chile continues. Two catalogs have been produced from this data. Several scientists are working on software development needed for the data reduction of the instruments on future astrometric satellites.

More specific areas of research are:

- Development of advanced gamma-ray detectors
- Data analysis of solar flares
- New instrument development for solar physics space missions
- Development of multilayer mirror coatings for high-resolution spectrographs
- Analysis and reduction of solar data from the LASCO and the EIT instruments on the SOHO
- Optical interferometry
- Measurement of stars at optical wavelengths
- Optical astrometry and photometry
- Data reduction and analysis of infrared sources in Galaxy
- Observations of extragalactic sources

f. Publications

Over 150 papers were published in refereed journals, conference proceedings, and chapters in books during 2002 and 2003.