SPACE SCIENCES CENTER
Founded in 1978 by Prof. Darrell Judge, Director: 1978-2013
Current Director: Prof. Leonid Didkovsky

- Space Science Missions investigating the Heliosphere, Solar System, the Sun-Earth Connection, Earth’s Atmosphere and Ionosphere;
- Space Flight Missions, from Pioneer 10/11, through Space Shuttles and SOHO, to SDO;
- Development of Unique Space Flight Instrumentation;
- Research disciplines include Astrophysics, Solar Physics, Atomic and Molecular Physics, and planetary atmosphere investigations

Photo of 2005. (left to right) Sitting are: Dr. Wu, Dr. Judge; Standing are: Dr. Jones, Dr. Gangopadhyay, Dr. Didkovsky, Mrs Lin, Dr. Peters, Mr. Harmon, Mr. Ghadimi, Mr. Wieman
PIONEER 10/11

Interstellar Wind

Pioneer 10

Jupiter

Saturn

Earth at 3/3/72 and 4/6/73

Pioneer 11

Heliopause ~ 100AU; All not to scale

• Pioneer Missions Included SSC’s UV Photometer Instrument (above)
• Study of Heliopause using Pioneer 10/11 data performed at SSC (Judge and Gangopadhyay) in collaboration with ASTE (Gruntman and Kunc), and MSU (Baranov and Izmodenov)
SOUNDING ROCKET FLIGHTS
Apogee: > 300 km; Duration at altitudes > 100 km: about 425 s;
Payload is safely returned for multi use

SSC has a long (>40 years) history of successful flights (15+);

Sounding rocket flights provide a testbed for evaluating new space instrumentation, and a scientific platform for obtaining solar EUV, X-Ray, Visible, and IR above & through the Earth’s atmosphere. These flights also provide periodic calibration verification for existing space missions.
SPACE SHUTTLE MISSIONS
The instruments flown are IEH-1, 2, and 3, see www.usc.edu/dept/space_science/missions.html

International Extreme ultraviolet Hitchhiker (IEH–3) on orbit, Nov 1998 (left); a plaque with astronauts picture after the successful flight of IEH-3 onboard the Space Shuttle (right).
Solar Extreme ultraviolet Monitor (SEM) has been successfully working onboard the NASA/ESA SOlar and Heliospheric Observatory (SOHO) since Dec 1995.

SEM (PI Prof. Judge) provides a major contribution to the EUV solar variability studies. Calibrated EUV data at http://www.usc.edu/dept/space_science/sem_data/sem_data.html are extensively used by the Solar and Space Weather Communities to predict satellite drag, Earth ionosphere changes, and as proxy for solar models, e.g., NRLEUV, SOLAR-2000, etc.
SDO/EVE/ESP

Extreme ultraviolet SpectroPhotometer (ESP) is a part of the Extreme ultraviolet Variability Experiment (EVE) onboard the Solar Dynamics Observatory (SDO); launched February 2010.

ESP (PI Prof. Didkovsky) is an advanced version of SOHO/SEM. It has three EUV spectral channels and a soft X-ray channel. ESP has been providing high accuracy observations of the solar Extreme Ultraviolet variability with 0.25 s cadence since it was commissioned in April 2010.
DEGRADATION FREE SPECTROMETERS

Optics Free Spectrometer (OFS)
The Degradation Free Spectrometers (DFS) project includes a series of sounding rocket flights (36.263 in July 2012, and 36.289 in July 2014) for the qualification of two novel instrument designs which are not susceptible to the modes of degradation common to EUV Spectrometers.

With the OFS, one of the two DFS instruments, energy analysis of photoelectrons from ionization of a neon target gas by incoming EUV photons produces a solar spectrum without the use of mirrors, reflective gratings or thin film filters.

OFS response to monochromatic EUV radiation at four different wavelengths measured at the NIST Synchrotron Ultraviolet Radiation Facility (SURF) using a 380 MeV synchrotron beam at 140 mA.
With the DGS, one of the two DFS instruments, incoming EUV photons are diffracted twice before reaching detectors providing excellent rejection of out of band (i.e. visible) photons, thus isolating specific EUV bands without the use of thin film filters.

Above, DGS raw response vs wavelength is shown for several incident beam angles within +/- 0.25 degrees of the instrument optical axis measured using the NIST SURF synchrotron beam line 9. These “off-axis” response profiles are used to establish the DGS response to solar photons which are more divergent than the highly collimated synchrotron beam.
DIFFERENTIAL SCANNING CALORIMETER

SSC developed a laboratory prototype Martian soil encapsulation and differential scanning calorimetry system as part of a Strategic University Research Projects (SURP) collaboration with NASA JPL and the USC Viterbi Department of Computer Science.
NEW SSC PROJECTS
A study of large-period (10 – 160 hours) solar EUV pulsations in the Chromosphere and Transition Region.

An example of SEM (30.4 nm; solid line) and SORCE (121.6 nm; dash-dot line) de-trended fluxes
NEW SSC PROJECTS
Laboratory Simulation Studies of EUV-VUV Photolysis of Cosmic Icy Systems

A typical chromatogram of the organic residue produced after UV/EUV (4-20 eV) photolysis of the C10H8+H2O+NH3 = 1:1:1 mixture at 15 K for a dosage of about 1020 photons. Thirteen amino acids have been identified.
NEW SSC PROJECTS
High resolution fluorescence spectrometry

Rotational-resolved fluorescence excitation spectrum (FES) produced through photoexcitation of N2 with resolution 0.0014 nm. Relative absorption intensity (upper curve), observed and resolved FES features (bottom curve) are shown.
FUTURE SSC INSTRUMENTATION
Future SSC instrumentation that is currently in conceptual or early phase development includes (below, clockwise from upper left): a Lunar based Helioseismic imager, a UV/Visible off-axis telescope sized to fit a 1U CubeSat bay, a miniaturized pair of off-axis telescopes for observing ozone layer density profiles and Earth IR emissions, and a solar coronagraph and space debris monitor.