Natural Radio

News, Comments and Letters About Natural Radio

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On September 1, 1859, amateur English astronomer Richard Carrington, who made the first observations of solar flares in 1859 by sketching details of sunspots, noticed two white light emissions as he made his daily observations. Eighteen hours later, telegraph lines around the world were overflowing with current and operators were disconnecting their batteries. Later that night, brilliant auroral displays were observed as far south as Florida and Havana. Carrington made the connection between the white-light solar flare he had observed and the ensuing geomagnetic storm. His claims were promptly dismissed and ridiculed by scientists of the day, but this was the beginning of modern astronomy and the study of the earth-sun connection.

The white-light flares that Carrington observed are not common occurrences, and up to this point had been poorly understood. Recently, however, a joint Japan-United States research team has identified the origin of the white light emission in solar flares. An X-class solar flare, that occurred at 22:09 UT on Dec. 14, 2006, was observed by two successive, solar-observing satellites: Hinode and the NASA RHESSI satellite. The observations were later analyzed by Dr. Kyoko Watanabe, an aerospace project researcher at the Japan Aerospace Exploration Agency, and his team.

The Solar Optical Telescope, aboard Hinode, recorded the white light images, allowing researchers to accurately study the white light intensity and how it varies over time. The RHESSI satellite at the same time recorded hard X-ray emissions, an indicator of non-thermal electrons that were accelerated by solar flares. The team found significant correlation between the white light emissions and the hard X-ray emissions. The energy of the white light emissions is equal to the energy supplied by the electrons that had been accelerated to above 40 keV or about 40 percent of light speed. This finding indicates that the observed white light emissions are caused by highly accelerated electrons.

So, 150 years after Carrington's ground-breaking observation, we finally have some insight into the mechanism of white light solar flares.

Satellite Data, Part II – Here is the second half of the satellite information which completes the list begun last month. As mentioned then, the information presented here is just an overview, condensed from the NASA and NOAA data, so you'll need to go to the web for the details. Also, be aware that on many of the satellites that carry multiple instruments, there maybe different groups operating each instrument and each instrument may have its own website. The satellites are presented in alphabetical order.

SDO (Solar Dynamics Observatory)
http://sdo.gsfc.nasa.gov/

Mission – SDO was launched on February 11, 2010. The Solar Dynamics Observatory (SDO) is the first mission in a fleet of NASA missions to study our sun and is part of a NASA science program called Living With a Star (LWS). SDO will study how solar activity is created and how space weather results from that activity. Measurements of the sun's interior, magnetic field, the hot plasma of the solar corona, and the irradiance will help meet the objectives of the SDO mission.

Instruments – HMI (Helioseismic and Magnetic Imager), AIA (Atmospheric Imaging Assembly), AIA (Atmospheric Imaging Assembly). This set of instruments does the following: (1.) Measure the extreme ultraviolet spectral irradiance of the Sun at a rapid cadence. (2.) Measure the Doppler shifts due to oscillation velocities over the entire visible disk. (3.) Make high-resolution measurements of the longitudinal and vector magnetic field over the entire visible disk. (4.) Make images of the chromosphere and inner corona at several temperatures at a rapid cadence. (5.) Make those measurements over a significant portion of a solar cycle to capture the solar variations that may exist in different time periods of a solar cycle

Data – Images are currently available on the website, although the instruments are still being configured. Watch the website for future developments as the satellite should be fully operational by June 2010.

SOHO (Solar and Heliospheric Observatory)
http://sohowww.nascom.nasa.gov/

Mission – SOHO was launched on December 02, 1995. SOHO, the Solar and Heliospheric Observatory, is a project of international cooperation between ESA and NASA to study the Sun, from its deep core to the outer corona, and the solar wind. Together with two other ESA missions, Cluster and Ulysses, SOHO is studying the Sun-Earth interaction from different perspectives. SOHO's easily accessible, spectacular data and basic science results have captured the imagination of the space science community.

Instruments – SOHO has 12 instruments onboard. **CDS** (Coronal Diagnostic Spectrometer); **CELIAS** (Charge, Element, and Isotope Analysis System); **COSTEP** (Comprehensive Suprathermal and Energetic Particle Analyzer); **EIT** (Extreme ultraviolet Imaging Telescope), **ERNE** (Energetic and Relativistic Nuclei and Electron experiment); **GOLF** (Global Oscillations at Low Frequencies); **LASCO** (Large Angle and Spectrometric Coronagraph); **MDI** (Michelson Doppler Imager); **SUMER** (Solar Ultraviolet Measurements of Emitted Radiation); **SWAN** (Solar Wind Anisotropies); **UVCS** (Ultraviolet Coronagraph Spectrometer), **VIRGO** (Variability of Solar Irradiance and Gravity Oscillations). Each instrument has its own website if you are interested in more detailed data and information.

Data – SOHO has been the prime sources of solar images and movies since its launch 15 years ago. The image and other archives is a great source of historical data and the satellite continues to provide a wealth of data. It's worth spending some time on the website.

STEREO (Solar Terrestrial Relations Observatory)
http://stereo.gsfc.nasa.gov/

Mission – STEREO was launched on October 25, 2006. STEREO (Solar TErrestrial RElations Observatory) is the third mission in NASA's Solar Terrestrial Probes program (STP). This two-year mission will provide a unique and revolutionary view of the Sun-Earth System. The two nearly identical observatories - one ahead of Earth in its orbit, the other trailing behind – will trace the flow of energy and matter from the Sun to Earth as well as reveal the 3D structure of coronal mass ejections and help us understand why they happen. STEREO will also provide alerts for Earth-directed solar ejections, from its unique side-viewing perspective adding it to the fleet of Space Weather detection satellites.

Instruments – The following four instrument packages are mounted on each of the two STEREO spacecraft: Sun Earth Connection Coronal and Heliospheric Investigation (SECCHI); STEREO/WAVES (SWAVES); In-situ Measurements of Particles and CME Transients (IMPACT); and PLAsma and SupraThermal Ion Composition (PLASTIC)

Data – There is a variety of data and images on the various instrument websites. Of particular interest to Natural Radio listeners might be the SWAVES data, which provides daily plots of Solar Radio bursts in the 2.5kHz to 16 mHz range.

THEMIS (Time History of Events and Macroscale Interactions during Substorms)
http://themis.ssl.berkeley.edu/

Mission – THEMIS was launched on February 17, 2007. THEMIS answers longstanding fundamental questions concerning the nature of the substorm instabilities that abruptly and explosively release solar wind energy stored within the Earth's magnetotail.

Instruments – The five spin-stabilized (spin period = 3 seconds) THEMIS probes carry the comprehensive packages of plasma and field instruments needed to determine the cause of geomagnetic substorms. The instruments being flown are: Electric field instruments (EFI); Fluxgate magnetometers (FGM); Search coil magnetometers (SCM); Electrostatic analyzers (ESA); and Solid state telescopes (SST)

Also, a dedicated array of THEMIS ground observatories (20 all-sky imagers and 21 ground magnetometers) covers North America from Eastern Canada to Alaska, providing the information needed to place THEMIS probe observations within their global context. These instruments are: All-sky white light imagers (ASI) and Fluxgate magnetometers (GMAGS).

Data – Data and plots are readily available on the websites but would probably appeal more to the serious researcher than the casual hobbyist.

TIMED (Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics)
http://www.timed.jhuapl.edu/WWW/index.php

Mission – TIMED was launched on December 07, 2001. Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED) explores the Earth's Mesosphere and Lower Thermosphere (60-180 kilometers up), the least explored and understood region of our atmosphere. It is known that the global structure of this region can be perturbed during stratospheric warmings and solar-terrestrial events, but the overall structure and dynamics responses of these effects are not understood. The science payload is allowing scientists to look, for the first time in detail, at composition changes in the upper atmosphere; acquire unique measurements of atmospheric cooling as gases radiate energy back into space; measure the primary energy that's deposited into the MLTI region; and measure the speed and direction of winds in this region.

Instruments – TIMED's instruments are the: Global Ultraviolet Imager (GUVI); Sounding of the Atmosphere using Broadband Emission Radiometry (SABER); Solar Extreme Ultraviolet Experiment (SEE); and the TIMED Doppler Interferometer (TIDI).

Data – Current and archived data is available, but it will take a bit of work to find what you are looking for.

TRACE (Transition Region and Coronal Explorer)
http://trace.lmsal.com/

Mission – TRACE was launched on April 01, 1998. The objective of the Transition Region and Coronal Explorer (TRACE) satellite is to explore the three-dimensional magnetic structures which emerge through the visible surface of the Sun -- the Photosphere -- and define both the geometry and dynamics of the upper solar atmosphere - the Transition Region and Corona. The magnetic field geometry can be seen in images of solar plasma taken in wavelengths emitted or absorbed by atoms and ions formed in different temperature ranges. The transition from the 6000 degree K Photosphere, where magnetic fields and plasma are in rough equipartition (low beta), to the multi-million degree Corona, where the magnetic fields dominate (high beta), is extremely difficult to model. Many of the physical process that occur here -- plasma confinement, reconnection, wave propagation, plasma heating -- arise throughout space physics and astrophysics. And to date, no images have ever been collected that show the required temperature range nearly simultaneously with both high spatial and temporal resolution.

Instruments – TRACE has a single instrument, the 30 cm aperture TRACE telescope, which uses four normal-incidence coatings for the EUV and UV on quadrants of the primary and secondary mirrors. The segmented coatings on solid mirrors form identically sized and perfectly coaligned images. Pointing is internally stabilized to 0.1 arc second against spacecraft jitter. A 1024 x 1024 CCD detector collects images over an 8.5 x 8.5 arc minute field-of-view (FOV).

Data – The TRACE site has images and movies of a variety of solar events.

TWINS A & B (Two Wide-Angle Imaging Neutral-Atom Spectrometers)
http://twins.swri.edu/index.jsp

Mission – TWINS A & B were launched on March 13, 2008. The Two Wide-angle Imaging Neutral-atom Spectrometers missions, TWINS-A and TWINS-B, provide a new capability for stereoscopically imaging the magnetosphere. By imaging the charge exchange neutral atoms over a broad energy range (~1-100 keV) using two identical instruments on two widely spaced high-altitude, high-inclination spacecraft, TWINS will enable the 3-dimensional visualization and the resolution of large scale structures and dynamics within the magnetosphere for the first time. Stereo imaging, as done by TWINS, takes the next step of producing 3-D images, and will provide a leap ahead in our understanding of the global aspects of the terrestrial magnetosphere.

Instruments – The TWINS instrumentation is essentially the same as the MENA instrument on the IMAGE mission. This instrumentation consists of a neutral atom imager covering the ~1-100 keV energy range with 4°x4° angular resolution and 1-minute time resolution, and a simple Lyman-alpha imager to monitor the geocorona.

Data – A variety of images and plots are available. A user manual is available to help you navigate your way through the data.

Voyager
http://voyager.jpl.nasa.gov/index.html

Mission –The twin spacecraft Voyager 1 and Voyager 2 were launched by NASA in separate months in the summer of 1977 from Cape Canaveral, Florida. As originally designed, the Voyagers were to conduct closeup studies of Jupiter and Saturn, Saturn's rings, and the larger moons of the two planets.

Voyager's primary mission was completed in 1989, the space craft are now in a new mission, the Voyager Interstellar Mission (VIM). This mission is to extend the NASA exploration of the solar system beyond the neighborhood of the outer planets to the outer limits of the Sun's sphere of influence, and possibly beyond. This extended mission is continuing to characterize the outer solar system environment and search for the heliopause boundary, the outer limits of the Sun's magnetic field and outward flow of the solar wind. Penetration of the heliopause boundary between the solar wind and the interstellar medium will allow measurements to be made of the interstellar fields, particles and waves unaffected by the solar wind.

Instruments – Five of the original ten instruments are currently supported: Plasma Science (PLS) Properties and radial evolution of the solar wind (ions 10 eV - 6 keV, electrons 4 eV-6 keV); Low-Energy Charged Particles(LECP) Energy spectrum of low-energy particles (electrons 10-10,000 keV, ions 10-150,000 keV/n); Cosmic Ray Sub-system (CRS) Energy spectrum of high- and low-energy electrons (3-110 MeV) and cosmic ray nuclei (1-500 MeV/n); Magnetometer (MAG) High (50,000 - 200,000 nT) and low (8-50,000 nT) magnetic field intensity; Plasma Wave Subsystem (PWS) Electrical field components of plasma waves in frequency range of 10 Hz to 56 kHz

Data – Data is available from a variety of sites. You can find a list of locations at: http://voyager.jpl.nasa.gov/science/Voyager_Science_Data.html

Wind
http://pwg.gsfc.nasa.gov/wind.shtml

Mission – Wind was launched on November 01, 1994 and was positioned in a sunward, multiple double-lunar swingby orbit with a maximum apogee of 250Re during the first two years of operation. This will be followed by a halo orbit at the Earth-Sun L1 point.

The Wind spacecraft is the first of two U.S. missions of the Global Geospace Science (GGS) initiative, which is part of a worldwide collaboration called the International Solar-Terrestrial Physics (ISTP) program. Wind, together with Geotail, Polar, SoHO and Cluster, constitute a cooperative scientific satellite project designated the International Solar Terrestrial Physics (ISTP) program that aims at gaining improved understanding of the physics of solar terrestrial relations.

The primary science objectives of the Wind mission are: Provide complete plasma, energetic particle and magnetic field for magnetospheric and ionospheric studies; Investigate basic plasma processes occurring in the near-Earth solar wind; Provide baseline, 1 AU, ecliptic plane observations for inner and outer heliospheric missions.

Instruments – (1.) The Wind Magnetic Field Investigation (MFI) is composed of two fluxgate magnetometers; (2.)WIND Solar Wind Experiment (SWE) Faraday Cup - Ion Data; (3.) WIND Solar Wind Experiment (SWE) Electron Data consisting of two electrostatic analyzers, the vector spectrometer (VEIS) and the Strahl spectrometer; (4.) Wind 3D Plasma Analyzer consisting of six different sensors. There are two electron (EESA) and two ion (PESA) electrostatic analyzers. There are also a pair of solid state telescopes (SST) that measure electrons with energies up to 400 keV and protons with energies up to 6 MeV; (5.) Wind SMS Suprathermal Particle Data composed of three separate instruments. The SupraThermal Ion Composition Spectrometer (STICS); the high resolution mass spectrometer (MASS) and finally, The Solar Wind Ion Composition Spectrometer (SWICS) determines mass, charge, and energy for ions in the energy range of 0.5 to 30 keV/e. (6.) Wind EPACT High Energy Particle Data consisting of multiple telescopes. (7.) Wind WAVES Radio and Plasma Waves Data is composed of the RAD1, RAD2 and Thermal Noise Recivers (TNR), measures electric fields in a wide range of frequencies. (8.) Wind KONUS and TGRS Data consist of two gamma-ray instruments.

Data – There is a vast amount of data here and you'll want to check out the website for the specific instrument you are interested in. Plots of the WAVES data may be of particular interest to Natural Radio listeners.