

EURD: FIRST YEAR RESULTS

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Abstract. EURD (Espectrógrafo Ultravioleta extremo de Radiación Difusa), one of the instruments onboard the Spanish satellite MINISAT-01, is a spectrograph specially designed to detect diffuse radiation, covering the wavelength range of 350-1100 Å, with a spectral resolution of 6-8 Å. Its main scientific objectives are the detection of the emission line spectrum from the hot phase of the interstellar medium and the spectrum of the upper atmospheric airglow. In order to reduce geocoronal noise, EURD always observes in the anti-sun direction and only when the satellite is in orbital eclipse. After more than one year of observation we have obtained the best spectrum of the upper atmospheric nightglow in this wavelength range, the spectrum of 15 OB stars and the spectrum of the full Moon throughout the year.

1. The observations

EURD is a collaboration between the University of California, Berkeley, and the Instituto Nacional de Técnica Aeroespacial (INTA). It is on board the Spanish satellite MINISAT-01, launched from the Canary Islands on April



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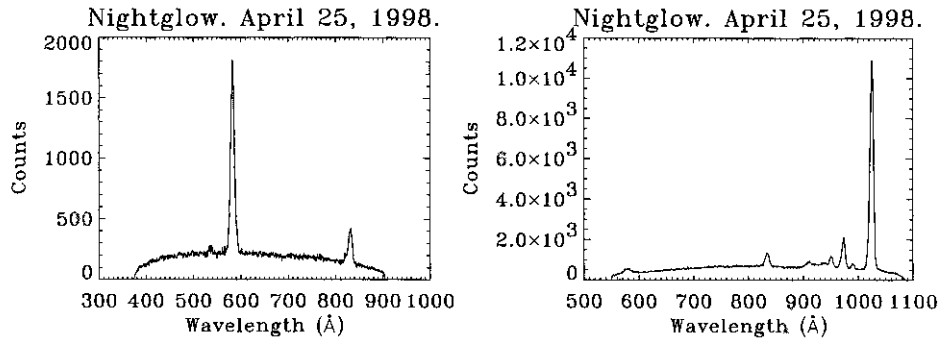


Figure 1. Typical spectra of one day of observation.

21, 1997, which has a circular orbit at 595 Km altitude and 151 degree inclination. INTA's Satellite Tracking Station at Maspalomas is the facility used for MINISAT-01. Once per day MINISAT memory is downloaded and technical data are transmitted to the INTA's Headquarters in Torrejón de Ardoz (Madrid) where the Satellite Operations Center is located. Scientific data are transmitted to the Laboratorio de Astrofísica Espacial y Física Fundamental in Villafranca del Castillo (Madrid) the site of the Scientific Operations Center (SOC). The SOC allocates daily the observing time for the three instruments and processes and distributes the scientific data to their respective scientific teams.

EURD consists of two spectrographs optimized respectively for short (350-800 Å) and long (550-1100 Å) wavelengths. The detector is a stack of low noise multichannel plates, and the holographic grating yields a spatial resolution better than 0.1° and spectral resolution of 6 to 8 Å. With its large field of view of $26^\circ \times 8^\circ$, it is specially designed to detect diffuse radiation. A detailed description of the instrument can be found in Morales et al. (1996) and Bowyer et al. (1997).

2. Scientific Objectives

There are five scientific objectives for this project: the detection of the emission line spectrum from the hot phase of the interstellar medium and of the upper atmospheric airglow, the detection of a line that would be produced by neutrino decay, the spectrum of OB stars in the far ultraviolet, and the full Moon spectrum.

It is generally believed that the Solar System is inside a bubble of extremely tenuous and hot gas, called the Local Bubble. The temperature of this gas, obtained from indirect observations, is estimated to be between 10^4 and 10^6 K. Therefore it should have a very rich line spectrum in the extreme and far ultraviolet (Landini Fossi, 1990). However, due to the very low density (0.01 cm^{-3}) of the interstellar medium inside the bubble we estimated that at least 2000 hours of observing time are needed to detect these lines with EURD.

The neutrino decay line, originally proposed by Denis Sciama (1990), should appear in the wavelength range of EURD (Sciama, 1998, Bowyer et al. 1995) but even longer integration times may be needed for its detection.

The spectrum of the full Moon that covers the whole range of the two spectrographs has been used to improve the ground calibration in wavelength and flux. Simultaneous observations of the full Moon have been taken with EURD and the EUVE satellite, and an absolute inflight calibration has been obtained (Edelstein et al., in preparation).

3. First Results

In order to reduce geocoronal noise, EURD was intended to always observe in the anti-sun direction and only when the satellite is in orbital eclipse. However, due to the wealth of lines which could potentially be detected from the upper atmospheric nightglow, we extended the observing time five minutes before and after the eclipse to get the very interesting airglow emission spectrum of the dawn and dusk.

MINISAT-01 flies at an altitude of 595 Km, where the atmosphere is basically composed by oxygen, atomic hydrogen and helium, hence we detect the brightest lines of these three elements that can be seen in Fig. 1, where we show a typical spectrum of one day of observation. The lower panels shows the detected images by the two spectrographs, and in the upper panels the extracted spectrum.

After more than one year of observations we have already obtained the best spectrum to date of the nightglow in the ultraviolet (López Moreno et al. 1998), detecting for the first time the complete Lyman series of hydrogen, several lines of the Lyman series of helium and two bright lines of oxygen at 834 Å and 898 Å , as well as the oxygen recombination continuum at 911 Å . We are studying the behavior of these lines with observing zenith angle and with latitude, as well as the mechanism that excites the upper atmosphere and produces the emission.

The second important result is the detection of OB stars spectra in the far ultraviolet. Very few stellar observations have been made in this wavelength range, with very discrepant results regarding absolute fluxes

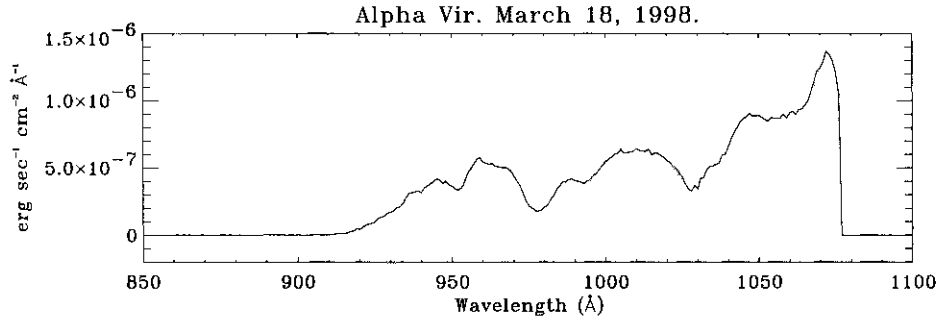


Figure 2. Flux-calibrated spectrum of Spica.

and model atmosphere fitting. In Fig. 2 we can see the image and the corresponding flux calibrated spectrum of the bright star Spica (α Vir). The diffuse emission of the upper atmosphere is seen as long vertical lines in the image, and the spectrum of the star only detectable up to the Lyman limit at 912 Å. We have found a very good agreement between our data and both Voyager data of α Vir and the corresponding Kurucz model atmosphere (Morales et al. in preparation), using the inflight calibration obtained with the full Moon spectrum. Many OB bright stars have been observed by EURD and are in the process of calibration.

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