Apollo 17 Far-Ultraviolet Spectrometer Experiment

Introduction

The primary purpose of the Far-Ultraviolet Spectrometer (FUVS) experiment on the Apollo 17 Command and Service Module was to make measurements from orbit of the ultraviolet emissions from the tenuous lunar atmosphere. It had as secondary objectives non-lunar observations during lunar orbit and trans-Earth coast including zodiacal light, solar atmosphere emissions, Earth emissions (including those from the geomagnetic tail), stellar emissions, and galactic emissions. The FUVS, also known as the Ultraviolet Spectrometer, was mounted on a triangular stand attached to a bulkhead in the Scientific Instrument Monitor (SIM) bay in the Service Module that was perpendicular to the longitudinal axis of the spacecraft.

Instrument Description

The sensor was an Ebert spectrometer, with a half-meter focal length that measured the radiation intensity as a function of wavelength from 1180 to 1680 Angstroms. Its optical components included an external baffle assembly, entrance slit, Ebert mirror, scanning diffraction grating, exit slit, exit slit mirrors, and a photomultiplier. Spectral resolution was 11.5 Angstroms. Field of view was 12 x 12 degrees and the instrument looked forward 23 degrees relative to normal and 18 degrees to the right of the SIM center. Total volume of the instrument, including the baffle, was roughly 0.03 cubic meters and the mass was about 17 kg. Total power requirement was 7 W.

A grating mechanism included a rotating cam, with a cam follower that tilted the grating back and forth within the spectral region, over a range of approximately 5 degrees. Light coming through the 2-mm wide, 57-mm long entrance slit reflects off the spherical Ebert mirror to the diffraction grating. (Both the mirror and grating are coated in vacuum with aluminum and over-coated with MgF2.) The diffraction grating has an area of 104 square cm with a grating spacing of 3600 grooves per mm. The diffracted light from the grating goes back to the mirror and is reflected and focused through the exit slit. The exit slit tripling mirrors "fold" the light to increase the monochromatic photon density passing through the slit. After passing through the slit, the light strikes the detector photocathode, a 25-mm diameter photomultiplier tube that produces an electrical signal related to the intensity of the incident light. An electronics module (pulse amplifier discriminator, 16-bits-per-second accumulator, data multiplexer, and digital output register) included all the signal-processing circuitry for telemetry.

Instrument Operation

The complete scan from 1180 to 1680 Angstroms was achieved once every 12 seconds. The scan occurred at about 75 Angstroms per second except for two 50-Angstrom regions centered on 1216 Angstroms (atomic Hydrogen) and 1470

Angstroms (Xenon) which were scanned at 16.6 Angstroms per second. Optical pulses are converted to electron pulses and measured cumulatively for 0.1 seconds and stored in a 16-bit counter, giving a telemetry rate of 160 bits per second. An optical fiducial mark indicated the end of the scan and its output synchronized the data word format.

The spectrometer operated properly during the mission and provided observations of the lunar surface, lunar atmosphere, zodiacal light, solar atmosphere emissions, Earth emissions, and galactic and stellar emissions. The spectrometer had three modes of operation. The primary one, Mode A, involved looking through the illuminated lunar atmosphere at an angle across the terminator, so that the background lunar surface was dark. This was done typically once per orbit, occasionally it was done twice in an orbit if the spacecraft axis was reversed between terminator crossings. A total of 1200 terminator spectra were obtained. In Mode B, the spectrometer was maintained at a fixed line-of-sight on the dayside, and a tangential swath of illuminated atmosphere, with an illuminated surface background, was measured. Mode C was used immediately after trans-Earth injection to measure across the terminator similarly to Mode A but from a greater distance. FUVS data were collected for approximately 80 hours out of the 148 hours Apollo 17 took to complete 75 lunar orbits, and 60 hours from trans-Earth coast.

References

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