THE FAR ULTRAVIOLET IMAGING SPECTROGRAPH ON SPARTAN-281

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1. INTRODUCTION

The study of diffuse celestial sources in the ground-inaccessible ultraviolet spectral range is less advanced than UV studies of point and compact sources. The main reason is that the characteristics of instrumentation optimized for the two types of objects are quite different. Studies of diffuse objects are best made with fast focal ratio optics with wide fields of view, whereas studies of point and compact objects are best made with large telescope aperture and high angular resolution. As a result, most space ultraviolet instruments to date (such as the International Ultraviolet Explorer and the forthcoming Hubble Space Telescope) are not well suited to the study of faint, extended diffuse objects in the ultraviolet.

The Naval Research Laboratory has developed a Far Ultraviolet Imaging Spectrograph (FUVIS), optimized for the study of diffuse objects in the 970-2000 Å wavelength range. This instrument was first flown as a sounding rocket payload in 1979; an improved version is now nearly flight-ready as the primary science instrument in the U.S. Air Force Space Test Program's Spartan-281 space shuttle payload. Following sections summarize the scientific objectives of the Spartan mission and the instrument characteristics. A more detailed discussion, including references, is given by Carruthers et al. (1988a).

2. OBJECTIVES

The scientific objectives of the Spartan-281 FUVIS investigation require a capability to observe sources of diffuse UV intensity as low as the current faintest estimate of the high galactic latitude diffuse background (~300 photons/cm^2 s Å sr) and emission lines as faint as 1500 photons/cm^2 s sr. However, measurements of the spatial distributions of spectral intensity require an imaging capability, with moderate spatial resolution and a wide field of view in the

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direction along the slit of the spectrograph.

Specific objectives include studies of both the diffuse UV galactic background and of individual diffuse nebulae. They include investigations of the physical properties, composition, and spatial distribution of interstellar dust by observations of its reflection of far-UV starlight and by measurements of molecular hydrogen fluorescence to fainter limits, over larger regions of the sky, and in more spatial detail than accomplished to date.

Observations of far-UV line emission will yield temperature and abundance information on galactic H II regions and planetary nebulae, stellar wind bubbles, supernova remnants, and the "hot" interstellar medium.

3. INSTRUMENTATION

The instrument is designed to provide the highest practicable diffuse-source sensitivity in the far-UV. This is achieved by the use of a microchannel-intensified electrographic Schmidt camera, having an opaque CsI photocathode and f/1 focal ratio optics. Two entrance slits, both with 2.7° angular lengths, are used. The narrow slit has a width of 1.5′ and provides 5 Å spectral resolution; the wide slit has a width of 15′ and provides a spectral resolution of 30 Å (but with 10 times higher sensitivity). Our current estimate of instrument sensitivity (in the 1250-1800 Å range) yields, typically, for an emission line intensity of 1 rayleigh (about 80,000 photons/cm^2 s sr) one count per $(1.5')^2$ pixel in 100 sec. With the signal integrated over the slit length, the high galactic latitude background can be measured with the wide slit with S/N = 10 (100 counts per spectral resolution element) or S/N = 3.16 with the narrow slit in an exposure time of 2667 s.

FUVIS is planned for flight on the space shuttle as part of the Spartan-281 mission, sponsored by the USAF Space Test Program. A Spartan is a short-duration, free-flying satellite (deployed is time about 40 hours); we anticipate making observations during the night portions of 26 orbits (about 12 hours' net observing time). FUVIS can be readily modified for use in later, long-duration unmanned missions by substitution of an electron-bombarded CCD camera for the electrographic camera (Carruthers et al., 1988b). This provides a remote electronic readout capability which retains photon-counting capability. Other readily implemented modifications for follow-on missions include improved spatial and/or spectral resolution and addition of a version covering the middle-UV (1700-3100 Å) spectral range.

REFERENCES

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J.B. Holberg: *How many targets do you get during a Spartan flight?*

G. Carruthers: During a 40 hour mission (about 26 orbits), we would have about 12 hours observing time since we operate only during the night portions of the orbits. Thus, in principle we could observe as many as 24 different targets, but we will probably observe far fewer targets since we have four modes of operation and many targets will need to be observed more than once to accumulate the necessary exposure time.