

PLANNED OBSERVATIONS OF THE DIFFUSE SKY RADIATION DURING SHUTTLE MISSION STS-4

J.L. Weinberg, R.C. Hahn, F. Giovane, and D.W. Schuerman
Space Astronomy Laboratory
State University of N. Y. at Albany
Albany, N. Y. 12203

ABSTRACT

The Skylab flight spare 10-color photopolarimeter (Weinberg, *et al.*, 1975; Sparrow, *et al.*, 1977) is being refurbished for use in Space Shuttle mission STS-4, a test flight currently scheduled for October 1980. Observations will be made of zodiacal light, background starlight, and the Shuttle-induced atmosphere (spacecraft corona), with emphasis on regions of sky closer than 90° to the sun.

A ten color (near UV to near IR) photopolarimeter was used during Skylab missions SL-2 and SL-3 to measure diffuse sky brightness and polarization associated with zodiacal light, background starlight, and spacecraft corona (Weinberg, *et al.*, 1975; Sparrow, *et al.*, 1977). The photopolarimeter and boresighted 16 mm camera (Fig. 1) were attached to an alt-azimuth mounting which was part of an astronaut-operated facility which could deploy an instrument out to a distance of 5.5 m beyond the

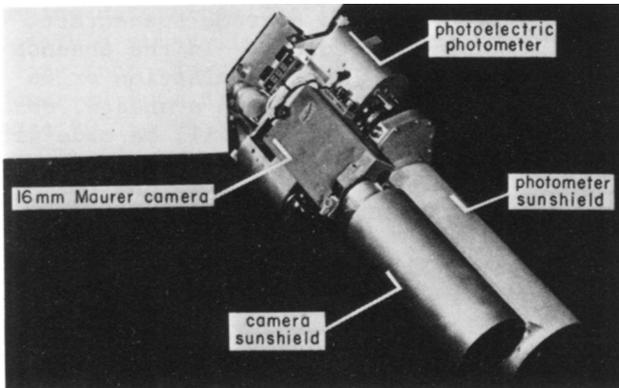


Fig. 1. The Skylab photopolarimeter and camera and their sunshields.

Skylab orbital workshop using scientific airlocks (SAL's) in either the solar or antisolar direction (Henize and Weinberg, 1973). The instrument was designed to make fixed-position or sky-scanning measurements during spacecraft day or night, including mapping the entire sky to within 15° of the sun. Unfortunately, the solar SAL could not be used because a heat shield (parasol) was permanently deployed out the solar SAL following

loss of the meteoroid/heat shield during launch. Thus, observations were restricted to the antisolar hemisphere; deployment of the instrument for only limited times near full moon restricted observations still further.

One of the early Space Shuttle Orbital Flight Test (OFT) missions will provide an opportunity to use the Skylab flight spare instrument to obtain at least some of those astronomical measurements unable to be made from Skylab; it will also be possible to determine the characteristics of the Shuttle-induced atmosphere (spacecraft corona): brightness, polarization, color, angular dependence, time variations. The Shuttle test flight in question is denoted as OFT mission 4 or STS (Space Transportation System) mission 4. This 164-hour mission, which is devoted primarily to thermal tests of the orbiter and to a limited number of scientific and engineering measurements, is scheduled for launch on 28 October 1980; mid 1981 now appears more likely. The mission consists of several distinct phases:

	total hours
• tail-to-sun (TTS), belly-to-earth	18
• nose-to-sun (NTS), solar inertial	79
• bay-to-sun (BTS)	26
• passive thermal control (PTC)	37

Starting one hour after launch, the sequence and phase durations (in hours) are: PTC9, TTS6, PTC3, TTS6, PTC3, TTS6, PTC10, NTS79, BTS26, PTC12. Three additional hours are taken up with the landing sequence.

As with its predecessor, the Skylab flight spare photopolarimeter uses three six-position wheels: a field of view (FOV) wheel and two wheels each containing five interference filters and an open position (Table 1). Variable gain, together with a number of aperture/neutral density filter combinations, gives the photopolarimeter the large sensitivity dynamic range needed to record light levels that could range

anywhere from faint starlight and zodiacal light to extreme spacecraft corona. In the absence of contamination or in the Earth's shadow, observations will be made with the 6° FOV.

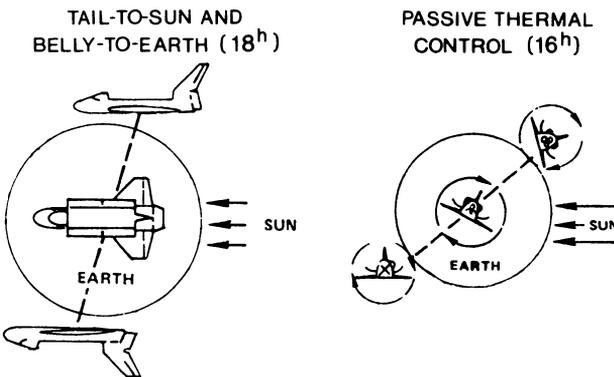


Fig. 2. Schematic diagram of orbiter attitudes during the intertwined tail-to-sun and passive thermal control phases.

Most observations with the photopolarimeter are scheduled during the TTS phase (Fig. 2), but limited observations will also be made during the PTC and NTS phases.

During those parts of the latter two phases where the instrument will see

Table 1. Interference Filter Characteristicsⁱ and Aperture/ND Filter Combinations

Field of view	Filter central wavelength	Filter bandwidth at 1/2 peak transmission
6° diam	A1 4011 Å	121.3 Å
3° diam	A2 4764 Å	44.5 Å
1° diam	A3 5090 Å	49.5 Å
3° with ND 2 filter	A4 5310 Å	63.5 Å
3° with ND 3 filter	A5 5577 Å (4200) ⁱⁱ	20.0 Å
1° with ND 4 filter	B1 6091 Å	81.0 Å
	B2 6297 Å	21.0 Å
	B3 6447 Å (4400) ⁱⁱ	98.0 Å
	B4 7120 Å	163.5 Å
	B5 8229 Å	234.5 Å

ⁱAt center of filter, 20°C

ⁱⁱChanges being considered in a search for color effects in the inner zodiacal light

the sun or the illuminated Earth, respectively, the photopolarimeter will automatically activate and, when "safe", deactivate a protective shutter. The instrument will be powered off during the BTS phase when it is in full sunlight.

The Skylab flight spare photopolarimeter and camera (Fig. 1) will be enclosed in a thermal canister with only the sunshield apertures uncovered. This, in turn, will be mounted in the orbiter bay on the outboard side of a pallet in an alt-azimuth configuration. Figure 3 shows the instrument location in the bay, the directions of scan, and the planned scan limits for the elevation-only scanning mode that will be used. Even with the 6° FOV, the tail assembly is not seen; visual obstruction by the shuttle engine determines the 14° limit. The 120° limit is chosen to avoid possible stray light from sunlit radiators on the forward payload bay doors (not shown in Fig. 3), to provide some overlap with regions of sky observed from Skylab, and to give increased sky coverage for regions closer than 90° to the sun.

During the TTS phase, the instrument will scan back and forth in elevation at 4 deg/sec while the orbiter moves across the sky at its 4 deg/min orbital rate - in a direction perpendicular to the instrument scanning direction. The combined orbiter/instrument motion will result in a saw-tooth pattern of observations projected on the sky (between the 14° and 120° elevation limits). The instrument will be pre-set to change filters after each scan; *i.e.*, the filter sequence (Table 1) will be A1, A2, ..., A5, B1, B2, ..., B5, A1, A2, ..., etc., continuing in this manner for the full six hours of each of the three TTS segments. The camera is used to provide backup information on instrument pointing and on possible anomalous results obtained with the photopolarimeter (*e.g.*, from orbiter-associated clouds of particles). The camera system has a 15° FOV and

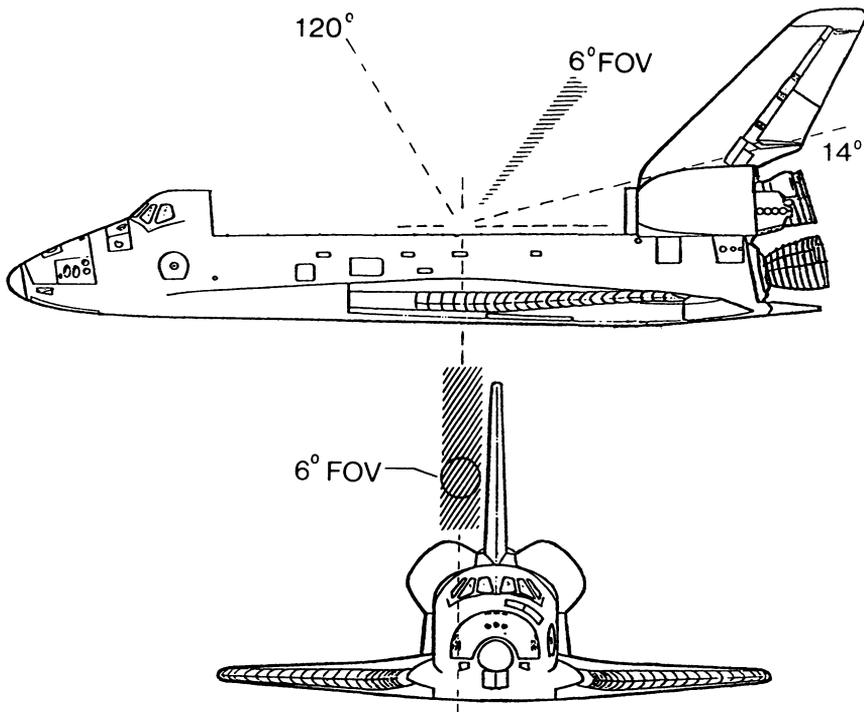


Fig. 3. Instrument location and elevation scan directions in the orbiter reference system. The orbiter is shown without payload bay doors.

automatically takes one frame every 45° in elevation. The same pre-set sequence will be used for observations in the PTC and NTS phases. In the TTS phase the entire payload bay is shadowed from both the sun and the Earth. Thus, it will be possible to observe the zodiacal light to within approximately 20° of the sun - in and out of the ecliptic - without the usual difficulties associated with stray light. The combined orbiter/instrument motion will also result in extensive measurements of the brightness, polarization, and color of the background starlight. Since STS 4 is a day/night mission, some astronomical data can be obtained even if there is significant spacecraft corona.

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