

N73-25880

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Final Report

X-RAY ASTRONOMY FROM SOUNDING
ROCKETS AT MIT

NASA Contract NSR 22-009-654

Period: September 1, 1971
through August 31, 1972

CENTER FOR SPACE RESEARCH
MASSACHUSETTS INSTITUTE OF TECHNOLOGY



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X-RAY ASTRONOMY FROM SOUNDING ROCKETS AT MIT

The research program under this contract consisted of defining scientific objectives, designing and fabricating a new scientific payload, refurbishing a previously flown payload, supporting the launch of these two payloads from White Sands Missile Range, analyzing the data, and publishing the results in the scientific literature.

The new payload which was developed consists of a one dimensional concentrator for soft x-rays ($10\text{\AA} - 80\text{\AA}$), several multianode proportional counters and two star cameras to provide aspect. The response of the instrument resembles a fan beam with a FWHM of $\sim 20'$. This payload can be used to search the sky for new soft x-ray sources and to map the surface brightness of supernova remnants known to emit soft x-rays.

The refurbished payload consists of a modulation collimator to measure celestial positions of x-ray sources with a precision of 1 arc min and an open bank of counters ($\sim 600\text{ cm}^2$) with 1 msec timing to study the rapid time variability which exists in numerous sources. These two payloads provide us with versatile tools to explore a wide range of astrophysical phenomena.

The research under this contract has yielded several important astrophysical results: (1) the identification of Her X-1 as the optical variable HZ Her was confirmed by a direct measure-

ment of its celestial position with a precision of $\sim 30''$;

(2) an average x-ray light curve for the 1.24s periodicity of Her X-1 was obtained with ~ 10 ms resolution. Significant intensity changes on time scales down to 30 msec were detected;

(3) significant structure in the soft x-ray surface brightness of the Cygnus Loop was co-discovered; (4) upper limits were set on the soft x-ray flux from numerous supernova remnants along the galactic plane which resemble the Cygnus Loop in evolutionary state and distance from the Sun.

The "soft" x-ray payload developed under this contract has also been recently re-flown to map the x-ray surface brightness of the Cygnus Loop. The results, soon to be published, will include the finest quality x-ray map of a SNR thus far. This same payload will also be re-flown in Australia next fall to study the Large Magellanic Cloud.

A summary of the three flights and the published papers related thereto are given below:

VII. Aerobee 13.037 UG (Launched May 19, 1972)

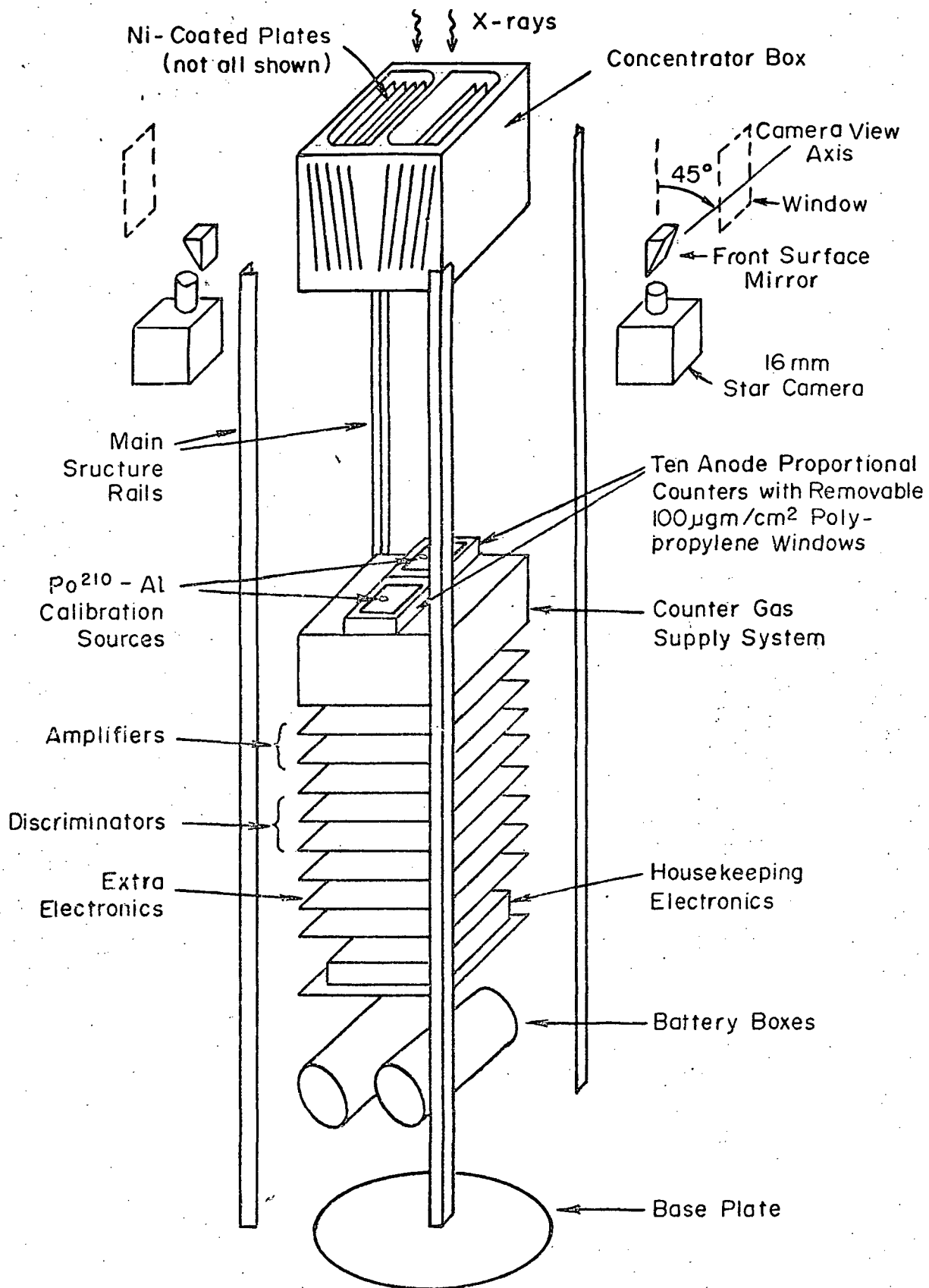
1. "A Soft X-ray Survey of the Galactic Plane from Cygnus to Norma", Borken, R., Doxsey, R., and Rappaport, S., 1972, Ap. J. (Letters), 178, L115.

VIII. Aerobee 13.038 UG (Launched August 9, 1972)

The scientific objectives of 13.038 were the same as those ultimately achieved by 13.039. A timing error in the ACS system caused the target (Her X-1) to be outside the field of view of the x-ray detectors.

IX. Aerobee 13.039 UG (Launched September 16, 1972)

1. "X-ray Pulse Profile and Celestial Position of Her X-1", Doxsey, R., Bradt, H. V., Levine, A., Murthy, G. T., Rappaport, S., and Spada, G., 1973, Ap. J. (Letters), to be published.

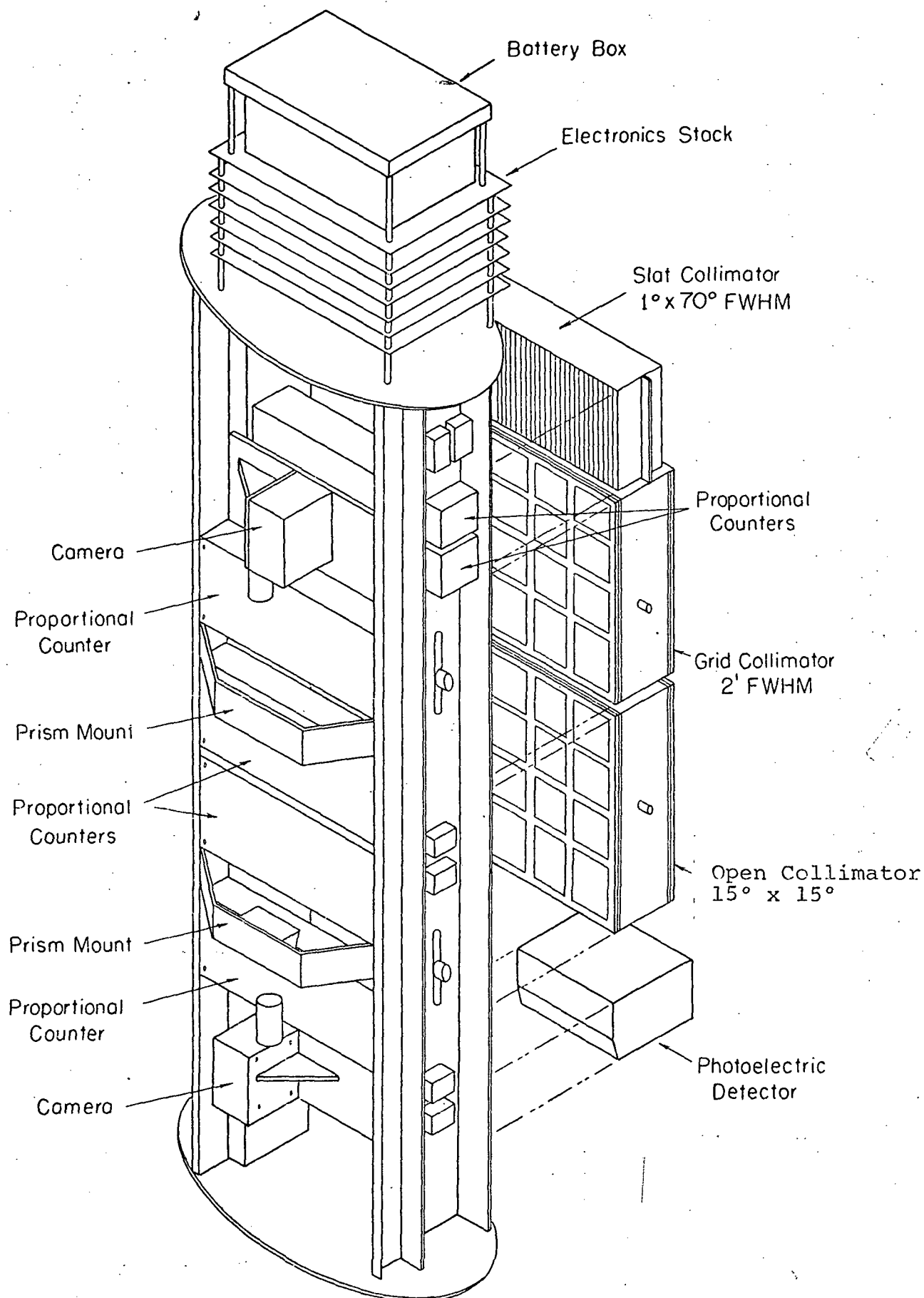


SOFT X-RAY PAYLOAD - EXPLODED VIEW

13.037 and 13.040

2/7/72

Figure 1



13.039 AEROBEE SOUNDING ROCKET PAYLOAD
X-RAY ASTRONOMY EXPERIMENT

APPENDIX

The paper titles together with abstracts and/or the most representative figures are presented below.

A SOFT X-RAY SURVEY OF THE GALACTIC PLANE FROM CYGNUS TO NORMA*

R. BORKEN, R. DOXSEY, S. RAPPAPORT

Physics Department and Center for Space Research, Massachusetts Institute of Technology

Received 1972 September 18; revised 1972 October 16

ABSTRACT

A low-energy X-ray survey ($E \geq 150$ eV) of the Cygnus region and the galactic plane from Cygnus to Norma is described. The soft X-ray emission from the Cygnus Loop was resolved into two distinct regions which contain several of the major optical filaments. Upper limits for soft X-ray emission from the supernova remnants HB 21, CTB 72, CTB 63, and W63 are given.

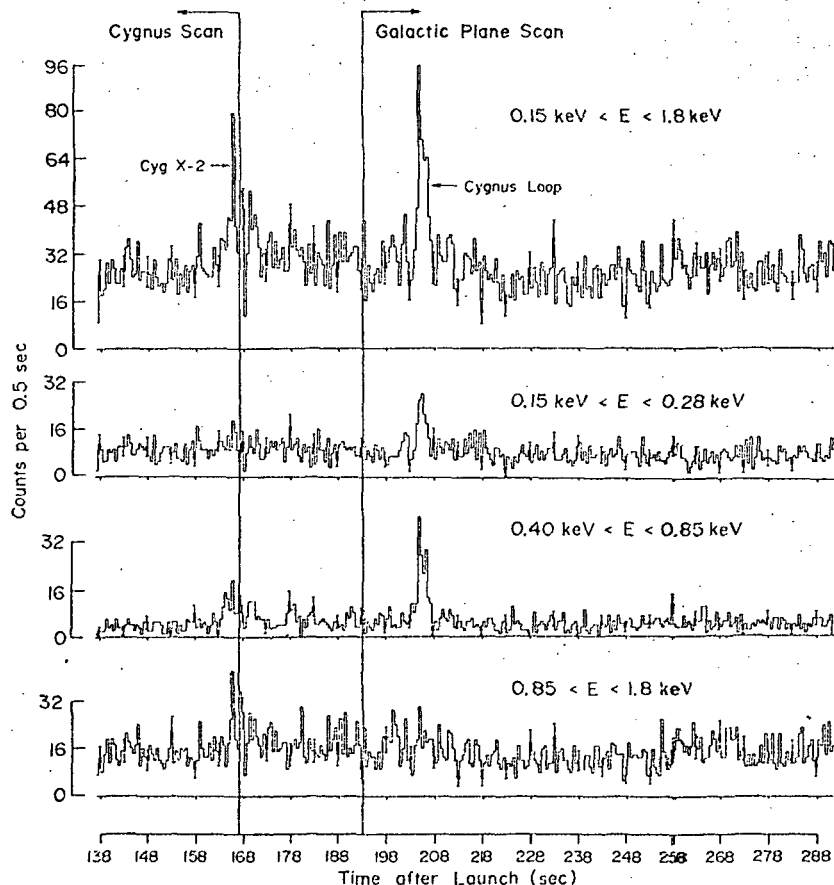


FIG. 3.—Counting-rate data for the entire flight, plotted in 0.5-s intervals for each of the three energy bands and the sum.

X-RAY PULSE PROFILE AND CELESTIAL POSITION OF HER X-1^{*}

R. Doxsey, H. V. Bradt, A. Levine, G. T. Murthy[†]

S. Rappaport and G. Spada[‡]

ABSTRACT

The celestial position of the binary x-ray source Her X-1 has been measured with a precision of 30" and, within the uncertainties, agrees with the position of the optical variable HZ Herculis. An average light curve for the 1.24s periodicity has been obtained with ~ 10 ms resolution. The average pulse is a double peaked structure which shows significant intensity changes on time scales down to 30 msec.

