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CONTRACT NAS5-22386

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Task 11 (Deliverable Item 10) Data Analysis to Separate Particles of Different Speed Regimes and Charges.

Introduction

When comparing the results of the LEAM experiment with the results obtained from an essentially similar instrument flown on Pioneers 8 and 9 many differences are apparent. Some of the important differences are:

1. The LEAM impact rate is substantially higher and cannot be explained by cosmic dust.

2. There is a major peak impact rate at lunar sunrise, a minor peak at sunset.

3. There is a "quiet" period after sunset.

4. There is a preponderance of impacts on LEAM with high pulse heights (the maximum pulse height of 7 is most frequently encountered) whereas on Pioneers 8 and 9 the frequency markedly decreases with increasing pulse heights.

5. Events which excite several films and collectors are much more frequent on LEAM than on Pioneer.

6. Events causing an increase in the accumulator of two or more are relatively frequent.

It has been surmised that most of the events being sensed by the LEAM instruments are not caused by the impact of cosmic dust particles, but rather by the incidence of lunar dust particles transported across the lunar terminator. It was further surmised that the transport was due to the large electric potential difference of the lunar surface across the terminator.

In order to confirm this theory two studies were conducted, a theoretical one by the Bendix Corporation which at least confirmed the probability that effects such as described in Items 1 through 6 above may be caused by the incidence slowly moving highly charged particles.

This theory was confirmed by an experimental study carried out by Concordia College, using the spare LEAM unit, and may now be considered established.

Work Performed

The program FREQ was modified to separate high and low PHA distributions for the various periods relative to sunrise.

Period 1:	Before sunrise	(SR - 45 hrs to SR)
Period 2:	After sunrise	(SR to SR + 45 hrs)
*Period 3:	Daytime*	(SR + 45 hrs to SS - 45 hrs)
Period 4:	Before sunset	(SS - 45 hrs to SS)
Period 5:	After sunset	(SS to SS + 45 hrs)
Period 6:	Night time	(SS + 45 hrs to SR - 45 hrs)
Period 7:	Near sunrise	(SR - 45 hrs to SR + 45 hrs)
Period 8:	Near sunset	(SS - 45 hrs to SS + 45 hrs)
Period 9:	Other times	(Periods 3 and 4)

*Note: For temperature reasons the LEAM is off during most of that time.

For these periods the program produces a breakdown of events according to PHA numbers, both individually and according to low (0 to 3) and high (4 to 7) pulse heights, according to film and collector numbers (rim or center) according to single and multiple sensor excitations and according to single and multiple accumulator increments.

The production of these distributions is automatic and requires no additional input. Archive tapes containing all available LEAM-data have been prepared and are available in the tape library of the 360/91 computer. All tapes are 9-track, standard label. These tapes are listed below:

Archive Tapes A: Dec 72 - March 74 (Day 90)

Tape #	Label	Acc.#
10-322	M2.ZØAMA.ALSPX	50122
TD5318	M2.ZØAMA.ALSPX1	29518
YO422	M2.ZØPFF.AL1	Backup

Archive tapes B: March 74 - Nov 74 (Day 302)

TD6447	M2.ZØAMA.ARCH2	28247
T5891	M2.ZØFEV.ARCH1	29709
YO423	M2.ZØPFF.AL2	Backup

Archive Tapes C: Nov 74 - Feb 76 (Day 60)

TD7129	M2.ZØ2HW.ARCH3	24329
TD5782	M2.ZØ2HW.BAKUP1	29022
TD5782	M2.ZØ2HW.LAYOF	(Backup)

The modified program is in load module form on

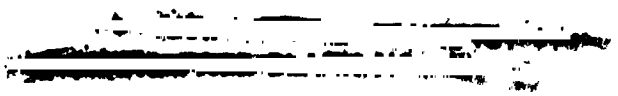
SYS2.LOADLIB(ZØ2HWFRQ)

and is most efficiently run this way.

If further modifications are necessary or desired the program may be recompiled from its source form, residing in the CRBE library as

Recompiling, of course, incurs penalties in both CPU and IO time. It is therefore desirable to construct a new load module with the modified program, if several cases are to be run.

Voluminous computer generated reports containing the described distributions were delivered to the Technical Officer.



Task 12 (Deliverable Item 11) LEAM-Daytime Operation

Introduction

When the LEAM experiment was first turned on, it was found that the combination of solar radiation and the heat generated by its operation would result in temperatures exceeding the design temperature of the electronics and present a real danger of the instrument malfunctioning. It was therefore decided to turn the instrument off from approximately mid-morning to approximately mid-afternoon, and thus protect it from reaching unacceptably high temperatures.

When the data for about 40 lunations had been obtained, it was found that all of the information obtainable from sunrise, sunset and night time operation was essentially repeated and the chance of the instrument being disabled by high temperatures might well be taken for the sake of obtaining data near lunar noon. The instrument was therefore left on during July and August 1976.

Work Accomplished

The data taken during lunar noon turned out to be exceptionally noisy and a large amount of work was needed to construct the archive tape containing these daytime data. The noise was due to several reasons:

(1) Tapes received from the University of Texas frequently proved to be unreadable by the 360/91. After some delay, better physical tapes were delivered to us.

(2) The receiving antenna was changed and a smaller dish substituted. This resulted in extremely noisy range tapes.

(3) The LEAM instrument was not designed to last nearly as long as it actually did. In fact, it performed very well for a much longer

time than expected, or even hoped, but had probably deteriorated by the summer of 1976.

Not much can be done about reasons (2) and (3), but the data were repeatedly and carefully examined and sifted.

The result of this work were two identical archive tapes, available in the GSFC 360/91 tape library containing the daytime data. They are both 9-track, standard label. They are:

Tape #	Label
11-175	M2.ZØ2HW.NOONS1
11-801	M2.ZØ2HW.NOONS2

A filter was further introduced into the program FRQ to remove out of sequence and wrong frame number "cards". This option is operated by including ISEQ=1 into the input.

Computer generated reports were delivered to the Technical Officer.

Task 13 (Deliverable Item 12)

Introduction

This task was based on a paper delivered by Prof. F. L. Whipple (Ref. 1). In this paper Whipple suggests that the average of a quantity he calls "log H" (H here is the pulse height called PHA elsewhere in these reports) should be nearly independent of the (unknown) particle mass, under certain assumptions, and should be nearly symmetrical about the apex.

Work Accomplished

The Pioneer processing program "FFPRO" was modified to produce the distribution of log H of the FFG events with respect to spacecraft azimuth, and plot this distribution. The program FFPRO will produce this particular distribution when a trigger called "IWHIP" is set to 1.

The computer generated report was delivered to the technical officer. The program is in the 360/91 CRBE library called AI2JB. FFPRO.

Reference 1

Fred L. Whipple, "Sources of Interplanetary Dust", Presented at IAU Colloquium # 31, Heidelberg, June 1975.

Task 14 (Deliverable Item 13)

Numerous computer generated reports for Pioneer 8 and 9 cosmic dust data were supplied to the Technical Officer and were compared with the results of the LEAM experiment. Although the instruments on LEAM and Pioneer were essentially similar, their responses were quite different. The main differences were:

(1) LEAM event rates were orders of magnitude higher.

(2) There was no discernible seasonal effect on LEAM but there was an asymmetry in Pioneer data.

(3) Impacts with high pulse heights (PHA) were rare on Pioneer and predominant on LEAM.

(4) Multiple film and collector excitations are more frequent on LEAM.

(5) Multiple accumulator increments are more frequent on LEAM.

The conclusion is forced that different sets of particles cause these responses. On Pioneer the events are caused by the impact of cosmic dust, the so called "β-particles" expelled from the vicinity of the sun by solar radiation pressure, augmented by few extremely high energy , but definitely identifiable (from the so called "Time of Flight" (TOF) events) interstellar grains.

On the moon, the events are due to the impact of slowly moving, highly charged lunar dust being propelled electrostatically across the terminator.

Both a theoretical analysis and experimental testing by other contractors (Bendix and Concordia College) confirm these conclusions.

Task 15 (Deliverable Item 14)

The Pioneer data were archived on 9-track standard label tapes, available at the 360/91 tape library.

Tape #	Label
TD6679	M2.ZØ2HW.PDT
TD5821	M2.ZØ2HW.PDT

For use, it is recommended that the datasets on this tape be transferred to DISK. A program to do this is contained in the CRBE library, called

ZØ2HW.LOADPDT

This particular program loads the datasets on tape onto the disk M2SCR2, but any other diskpack may of course be chosen by modifying LOADPDT. The data sets appear on the diskpack as:

M2.ZØ2HW.PDT(ØPDATA)
M2.ZØ2HW.PDT(NPDATA)
M2.ZØ2HW.PDT(PION72)

The TOF events are contained in

M2.ZØ2HW.PDT(ALBRG)