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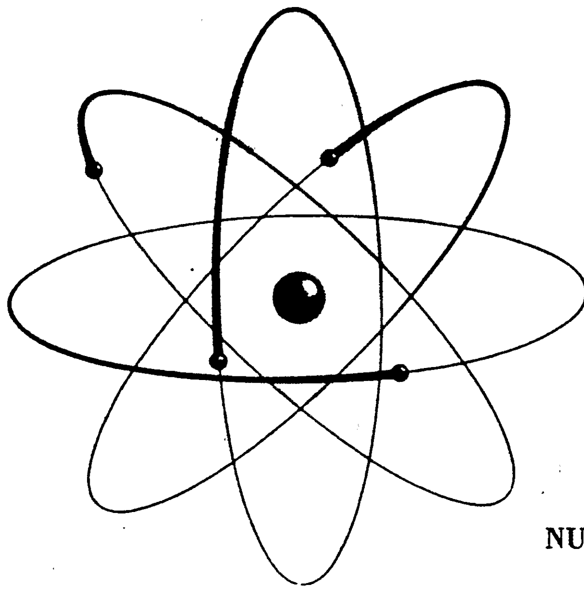
DEFENSE TECHNICAL INTELLIGENCE REPORT
26 JUNE 1980

THE SOUTH ATLANTIC MYSTERY FLASH



NUCLEAR OR NOT? (U)

PREPARED BY

[redacted]
and
[redacted]

SPECIAL CONTRIBUTIONS FROM

Air Force Technical Applications Center
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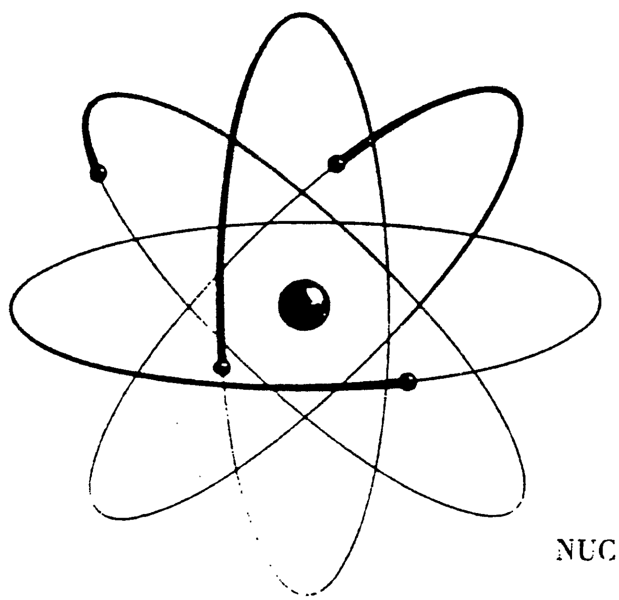

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Dr. John E. Mansfield
and
Houston T. Hawkins, Lt. Col., USAF

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FOREWORD

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FOR THE DIRECTOR:

Jack Vorona

JACK VORONA
Assistant Vice Director for
Scientific and Technical
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I. CONCLUSIONS

[redacted]

II. BACKGROUND

[1]F. Thomas, *Evasive Foriegn Nuclear Testing*, Rand Corporation, R-730-ARPA, July 1971.

[2] Guy E. Barasch, Light Flash Produced by an Atmospheric Nuclear Explosion, LASL-79-84, November 1979 (U).

[3] Sixteenth Status Report on the Adequacy of Fulfilling the Limited Test Ban Treaty Safeguards (U), Annex to JCSM-292-79

III. THE CASE FOR NO DEBRIS

[redacted]

4Glasstone, S. and Dolan, P. J., The Effects of Nuclear Weapons, USDOE, 1977, P 416-9.

[redacted]

G. (U) In addition, as the Bikini BAKER test showed, for explosions near or slightly under the ocean surface,[5] an artificial rainout situation is created. That is, a large volume of sea water is vaporized or physically lofted into the radioactive cloud. This entrained water immediately begins to fall back as droplets of salt slurry. Through this scrubbing mechanism a large portion of debris from the BAKER test fell into the ocean a few thousand of yards from shot point.

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5Glasstone, S. and Dolan op cit, p 48

IV. THE CASE FOR THE BHANGMETER SIGNALS

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[6] G. H. Mauth, Alert 747, Sandia National Laboratories, RS 1243/80/12; May 1, 1980

[7] Henry G. Horak, Vela Event Alert 747, Los Alamos Scientific Laboratory, LA-8364; May 80

FIGURE 7 EARLY TAIL-UP OBSERVED ON YCA DURING LASER CALIBRATION (U)

V. THE CASE FOR CORROBORATION

A. (U) From the onset of Alert 747, efforts were made to find corroborative evidence for a nuclear event in other technical data records. The primary corroboration sought was nuclear debris; this search was unsuccessful for reasons detailed in Section III. Data possibly related to A-747 were also found in records of a number of instruments. However, in each one, the signal was very weak, embedded in noise, or of a phenomenon not well understood. Therefore, from quite early in the history of A-747, both the intelligence analysts and the various reviewing panels tended to discount these signals as possible corroborative evidence of a nuclear burst.

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D. THE HYDROACOUSTIC DATA

E. THE INFRASONIC DATA

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[8]Natal Bank and East Bank are located approximately 10 and 100 kilometers east of Prince Edward/Marion Island.

[redacted]

F. THE TRAVELLING IONOSPHERIC DISTURBANCE

1. (U) The travelling ionospheric disturbance detected at Arecibo, Puerto Rico, was examined as possible corroborative evidence that A-747 was an energetic event in the atmosphere. The purpose of this section is to establish the probability of a random TID transiting the VELA circle at VELA time.

2. *TRAVELLING IONOSPHERIC DISTURBANCE VELOCITY*

a. (U) Because the geometry of this situation is somewhat complicated and apparently unfamiliar, it will be reviewed here. The Arecibo instrument, when operated in this mode, swings a beam in a 15 degree cone from south through west to north and back, measuring the altitude of specific electron densities. A TID is a traveling displacement of electron density; hence the Arecibo instrument can detect both the shape and direction of the TID. The shape is determined by measuring the altitude of a particular electron density as it changes with time. The direction of travel is determined by observing the rate of change of the disturbance as the beam is swung from south to north and back; the change is smallest going in the direction of wave motion and largest going against it. This direct measurement gives an arrival direction for this TID of 25 ± 10 degrees south of east. There is no question that this is the proper solution for direction. This angular window, 15-35 degrees, goes essentially from the Cape of Good Hope to the southern tip of Madagascar. This wave has a south to north component of velocity of $V \sin \theta$, less than V. However, the time of arrival of the wavefront at points on a line oblique to the wavefront generates an artificial "velocity" larger than the velocity V. A wave arriving at an angle θ from south of east will pass the northern detector in a north-south line of length d at a time $d \sin \theta / V$ after passing the southern detector, giving an apparent phase velocity $V_{app} = V/\sin \theta$, greater than V.

b. (U) The calculation of velocity from arrival time of the wave is complicated by the possibility of tilt in the ionosphere. By measuring the difference in arrival times of specific wave features, such as minimum or maximum, at different altitudes in the south position, and then again in the north position, the apparent phase velocity can be determined by referring to Figure 8. The wave, tilted

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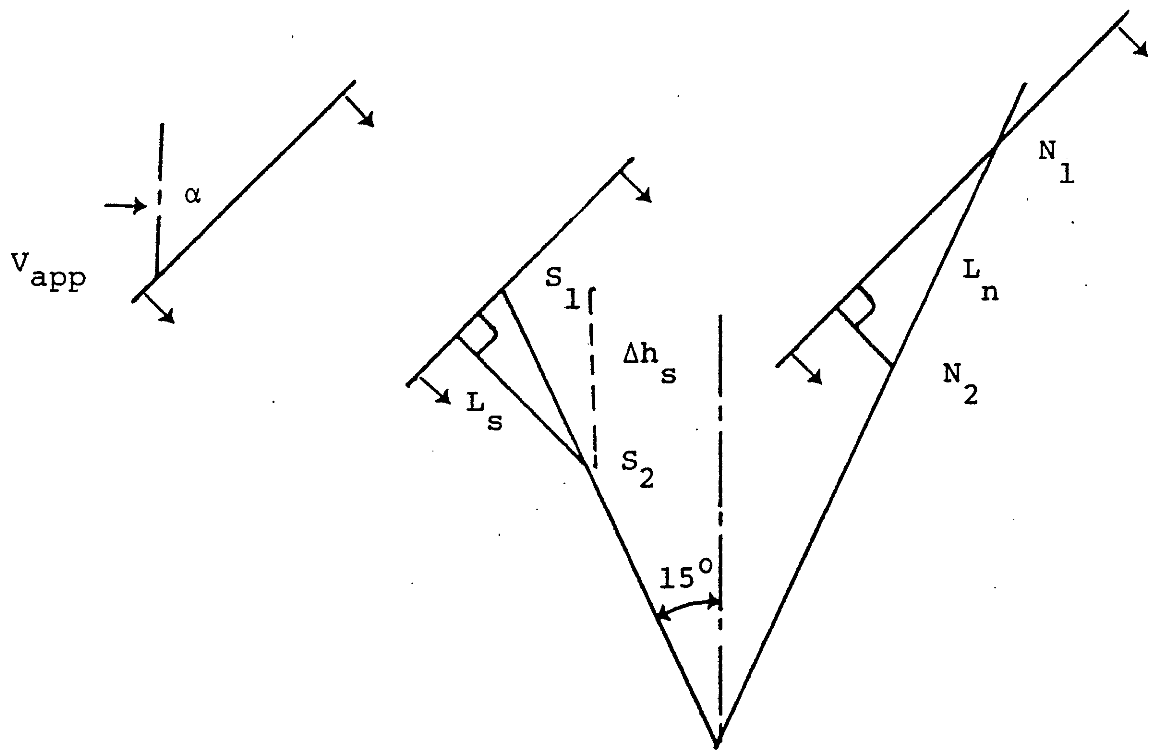

S_1 = UPPER MEASUREMENT POINT IN SOUTH

S_2 = LOWER MEASUREMENT POINT IN SOUTH

Δt_s = TIME DIFFERENCE OF ARRIVAL BETWEEN S_1 AND S_2

L_s = WAVEFRONT DIFFERENCE OF TRAVEL IN TIME Δt

Δh_s = ALTITUDE DIFFERENCE

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FIGURE 8 GEOMETRY OF TILTED IONOSPHERIC WAVE AT ARECIBO (U)

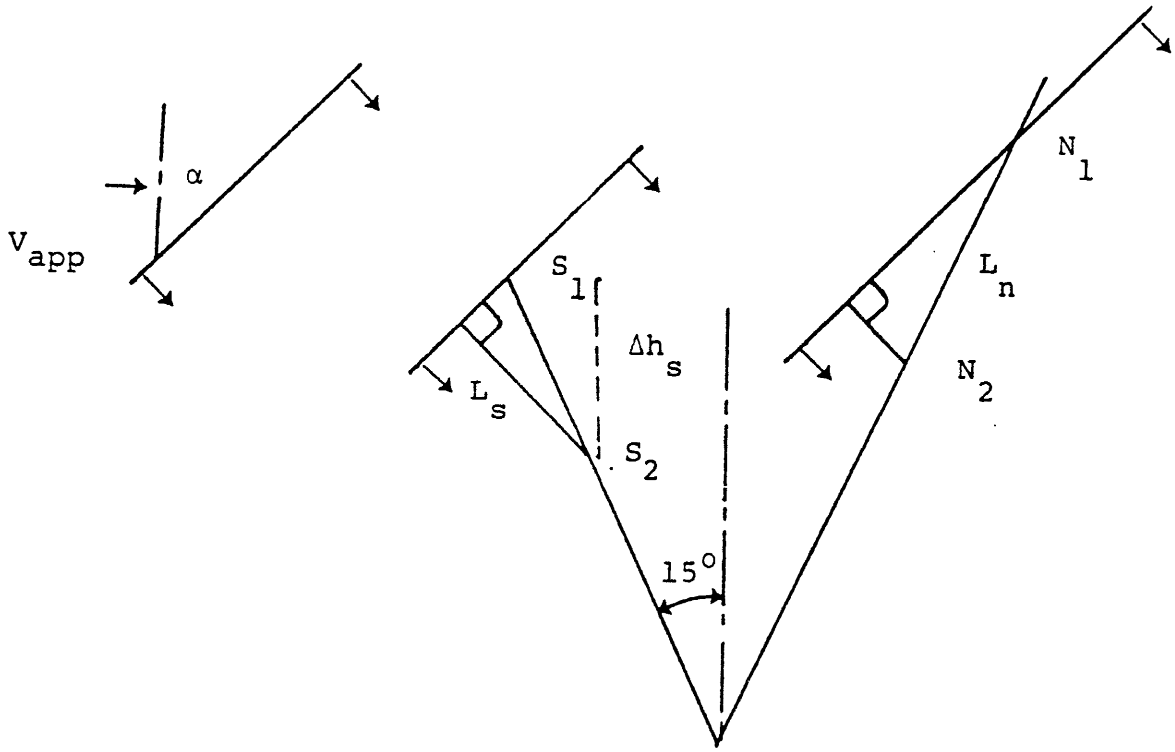

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FIGURE 8 GEOMETRY OF TILTED IONOSPHERIC WAVE AT ARECIBO (U) at an angle from the vertical, reaches the upper measured position S_1 or N_1 first, both in the south and the north. In the south it reaches S_2 after a time Δts. The basic relation for the velocity is thus

$$L_s = V_{app} \cos\alpha \quad \Delta t_s$$

Analysis of the south and north triangles gives

$$V_{app} = \Delta h_s(\tan\alpha + \tan 15^\circ)/\Delta ts$$

$$= \Delta h_s(\tan\alpha - \tan 15^\circ)/\Delta t_n$$

where h is the altitude difference between the measurement points. Eliminating tan gives

$$V_{app} = 2 \tan 15^\circ / (\Delta t_s/\Delta h_s - \Delta t_n/\Delta h_n)$$

Evaluation with the experimental results in Table 2 gives TID velocities of 500-750 m/sec, which are in excellent agreement with acoustic theory and past observations.

3. *TRAVELING IONOSPHERIC DISTURBANCE PROBABILITY*

(U) The normal direction of travel for TID's of natural origin at Puerto Rico latitudes is north to south; most are due to geomagnetic storms. The TID on 22 September was the only north going TID seen in 41 hours of observation at very high sensitivity. If this TID was due to some random natural source in the southern hemisphere, we can estimate the probability that a random signal would be found traversing the VELA circle at VELA time. First the rate of north going signals is one every 41 hours, or r = 0.024/hr. Since the VELA circle subtends about a ninety degree angle at Arecibo, the rate from the direction of the VELA circle is half this, or r = 0.012. The position of random TID's originating inside the VELA circle is given by the ratio of the area of the VELA ircle to that of the circumcribing spherical triangle with apex at Puerto Rico. This triangle has an apex angle of about 90° and a side of 130°. The ratio of the area of the VELA circle, radius = 40 degrees , to the triangle is 0.57. Combining these, the expected number of TID's transiting the VELA circle at VELA time becomes

$$n = 0.57\ rT$$
$$= 0.02 \pm 0.004$$

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B. *FLUX*

(U) Micrometeoroid flux data contained in an article by Dohnanyi (1972) indicated that micrometeoroids of the size necessary to give rise to signals of A-747 intensity and duration were quite rare. With the unique exception of Pioneer 10 data which is discussed later, all measurements made since 1972 have been in agreement with the Dohnanyi model, Figure 9. For particles in the mass region of interest (micrograms to grams) the particle flux is only 10^{-7} to 10^{-14} m^{-2} sec^{-1} $(2\Pi$ sterad$)^{-1}$. Using this flux and the field of view subtended by VELA, Oetzel and Johnston calculated that the the probable frequency of single meteor observation with the requisite A-747 peak intensity and duration with no additional constraints such as rise time and double pulse, is on the order of one per 10^{11} years.

C. *VELOCITY*

1. (U) Velocity distribution data for meteors are generaly somewhat unreliable at low velocities because of selectivity effects which negatively bias the number of low velocity measurements. For example, measurements using optical or radar tracking tend to concentrate on meteors moving faster relative to the viewer. In any case, basic physics dictates that it is impossible for a particle which enters the earth's gravitational field at essentially

VI. THE CASE AGAINST MICROMETEOROIDS

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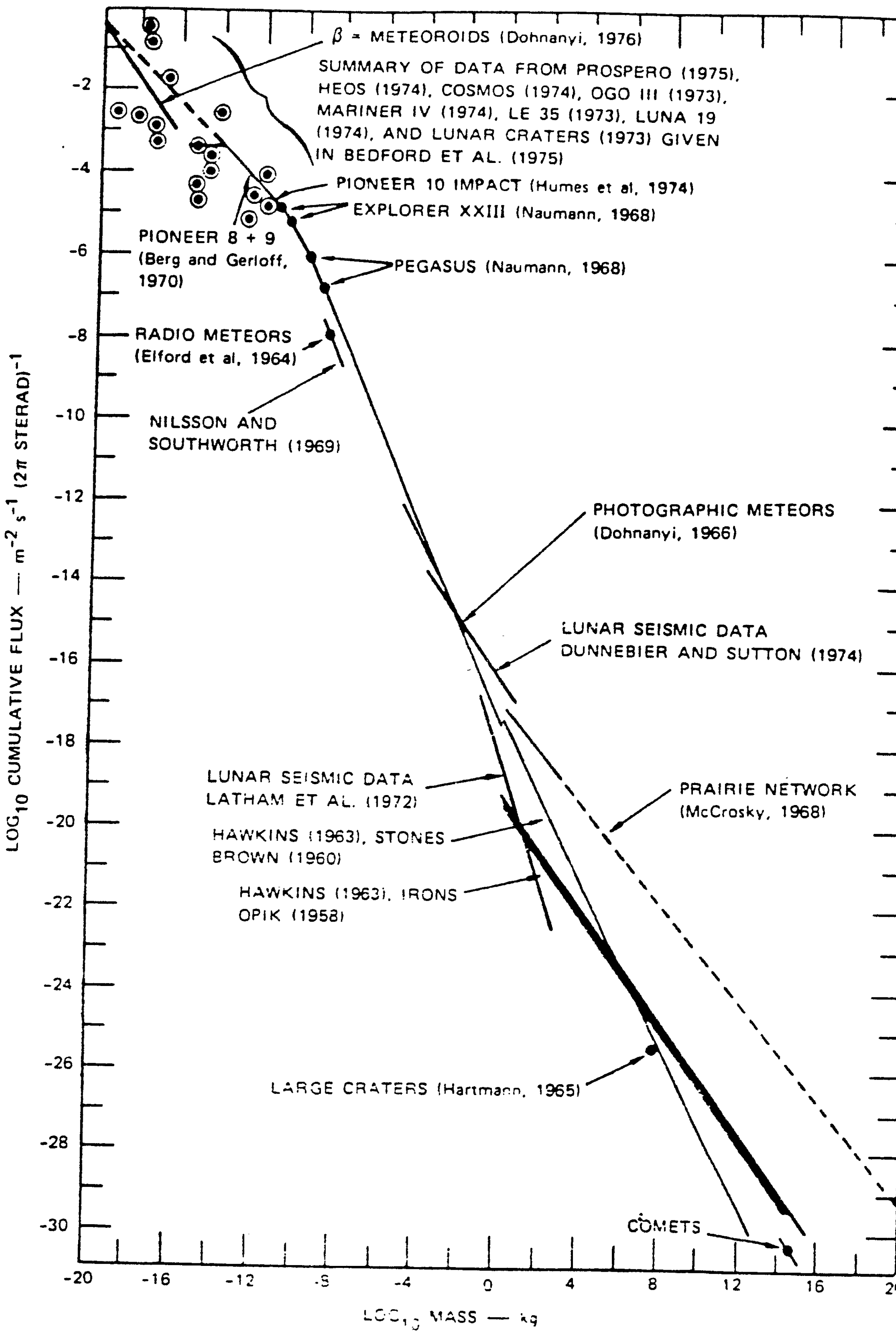

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FIGURE 7 METEOROID FLUX DISTRIBUTION (U)

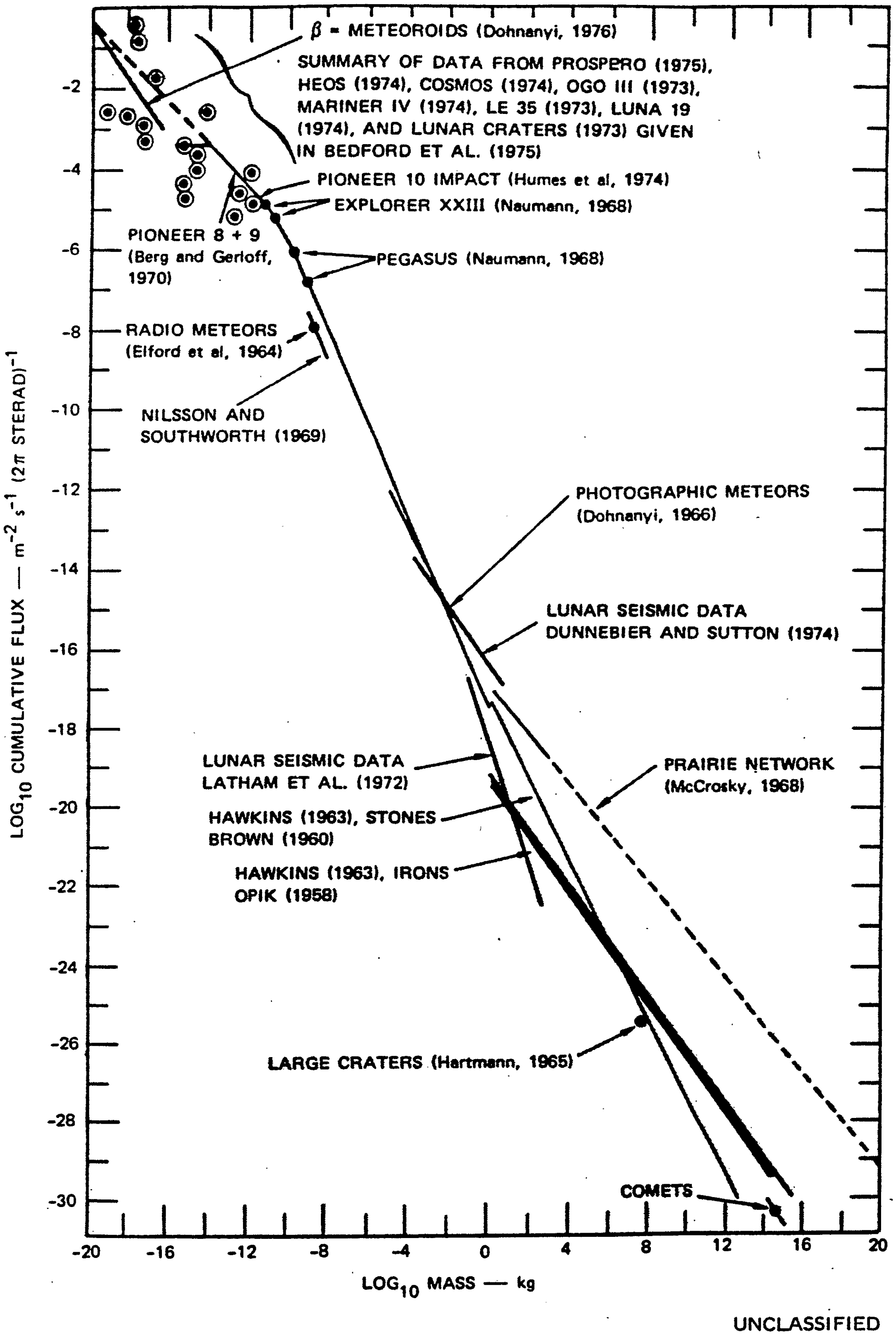

FIGURE 9 METEOROID FLUX DISTRIBUTION (U)

infinity to have a velocity less than 2.8 km/sec at 100,000 km. Since the tangential velocity of VELA is 2 km/sec, the lowest permitted velocity difference between VELA and an incoming micrometeroid is 800 m/sec. This permitted difference would seem to negate the possibility that a diffuse reflecting micrometeoroid could pass within view of VELA and give an optical signature lasting much longer than a few tens of milliseconds.

(U) By way of comparison, the MRC cracked ball-bearing model required a non-permitted low particle velocity relative to VELA ($v \leq 300$ m/sec). This model could only be satisfied by a few pathological cases such as a particle which brushed against the earth's atmosphere and subsequently encountered VELA in its orbit at 100,000 km. Such a happening would be rare in the extreme but not entirely impossible. Most micrometeoroids which encounter the atmosphere are either captured or slung into circular near-earth orbits.

(U) Another mechanism for creating low velocities with respect to VELA would be a "rear-end" collosion of VELA by a relatively high speed micrometeroid. Ejecta from the collision having masses larger than the incoming particle and velocities now less than VELA would fall into a lower orbit and eventual pass in view of the VELA sensors. The improbable combination of factors necessary to create such a situation, even with questions of requisite shape and intensity aside, would make this scenario improbable in the extreme.

D. *ROTATION*

1. (U) Since all known astronomical bodies rotate, it is reasonable to assume that micrometeoroids rotate also. Various mechanisms have been postulated to explain this universal behavior. These mechanisms include random walk collisions with other bodies during the last 10^{10} years or radiation pressure combined with an asymmetrical shape or albedo. Since in space, few mechanisms exist to dissipate this rotational energy, a micrometeoroid's spin rate will continue to increase until the centrifugal force exceeds the particle's radial tensile strength.

2. (U) For small particles the rotational rate at which bursting is likely to occur is much higher than that of large meteors. Rotational spin rates approaching 10^7

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rotations per second are possible. In fact, over 99 percent of particles on the order of a few tenths of a millimeter in diameter should be spinning faster than 10^6 rps, If the A-747 signal were the result of specular reflections, it is difficult to reconcile these rapid spin rates with the observed duration. That is, expected spin rates are so high that glints from specular surfaces should be on the order of microseconds, not hundreds of milliseconds.

3. (U) It is interesting to note also that by creating models with asymmetries in albedo to explain the two-humped A-747 signals, one automatically diminishes the possibility of ever encountering such a particle. The fact is that a major asymmetry in particle geometry or albedo would increase the probability that such a particle would undergo catastrophic disintegration.

E. REFLECTIVITY

1.. (U) Theory predicts that micrometeoroid surfaces would be dulled by radiation damage. Reflectivities much greater than 0.2 would not be expected. However, almost no data exist on the measured reflectivity of micrometeoroids. The one experiment which directly measured reflectivity was the Pioneer 10 AMD (Asteroid/Meteoroid Detector). Unfortunately, the Pioneer 10 AMD data are not directly relatable to either the VELA or Dohnanyi data bases and even disagree with the companion Pioneer 10 particle impact data by several orders of magnitude. In fact, the Pioneer 10 AMD data were considered so unreliable and obscure that Pioneer 11 data were never processed or reduced to a useable format and follow-on AMDs for subsequent flights were not funded.

2. (U) The basic difficulty with the Pioneer data is that far too many bright events were detected. Various extreme models, including particles which disintegrate upon interacting with the electric field from charged spacecraft have been proposed in an attempt to rectify obvious disparities in the data.

3. (U) Another possible explanation of the Pioneer data is that many of the observations involved specular glints from particles in the field of view. That is, one particle with several bright specular surfaces could have been recorded more than once. However, as indicated before, rotational speeds of small micrometeoroids should

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not give glints lasting more than a few microseconds. Thus specular glints do not appear to offer a completely satisfactory explanation for all the Pioneer results.

4. (U) Moreover, no Pioneer 10 event exceeded 40 ms in the observing period of about four months. However, by extrapolating extant data on the power-law, t^{-1}, a bright event lasting 380 ms might be expected at a interval of 3 to 10 years (Figure 10). The power-law extrapolation, however, does not satisfy short duration events. In fact, a more parabolic function is indicated. That is, the data indicate that longer-duration events become increasingly infrequent as some physical parameter, such as lowest permitted velocity, is approached. Further, it should be noted that the faster velocity of Pioneer 10 relative to VELA and the slower velocities of micrometeoroids further removed from planetary gravitational influences permit slower velocities for micrometeroids relative to Pioneer 10. Slower velocities relate directly to longer duration events.

F. *MENISCUS*

(U) The 130° sun angle in the case of A-747 presents the micrometeoroid theory with another hurdle. That is, for spheroidal particles, only a small meniscus of such particles passing in view of VELA would be illuminated. Approximately 85 percent of the particle would be in shadow. For comparision, the Pioneer 10 AMD was designed to observe meteoroids in full solar illumination. This effect would necessitate that to duplicate the right A-747 intensity, a particle in view would have to be larger and therefore rarer. In addition, any surface feature on the particle which would enter the illuminated area and alter reflectivity would have to be moving in the approximate plane of the earth's rotation. However, the distribution of rotational planes for small particles is expected to be isotropic. Thus assuming that a slow and thus improbable rotational speed is achieved, the probability that the requisite rotational plane would be in existence for any particle is low. The actual probability would depend on the size and orientation of the surface feature.

G. *CONCLUSION*

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(U) The 130° sun angle in the case of A-747 presents the micrometeoroid theory with another hurdle. That is, for spheroidal particles, only a small meniscus of such particles passing in view of VELA would be illuminated. Approximately 85 percent of the particle would be in shadow. For comparision, the Pioneer 10 AMD was designed to observe meteoroids in full solar illumination. This effect would necessitate that to duplicate the right A-747 intensity, a particle in view would have to be larger and therefore rarer. In addition, any surface feature on the particle which would enter the illuminated area and alter reflectivity would have to be moving in the approximate plane of the earth's rotation. However, the distribution of rotational planes for small particles is expected to be isotropic. Thus assuming that a slow and thus improbable rotational speed is achieved, the probability that the requisite rotational plane would be in existence for any particle is low. The actual probability would depend on the size and orientation of the surface feature.

G. *CONCLUSION*

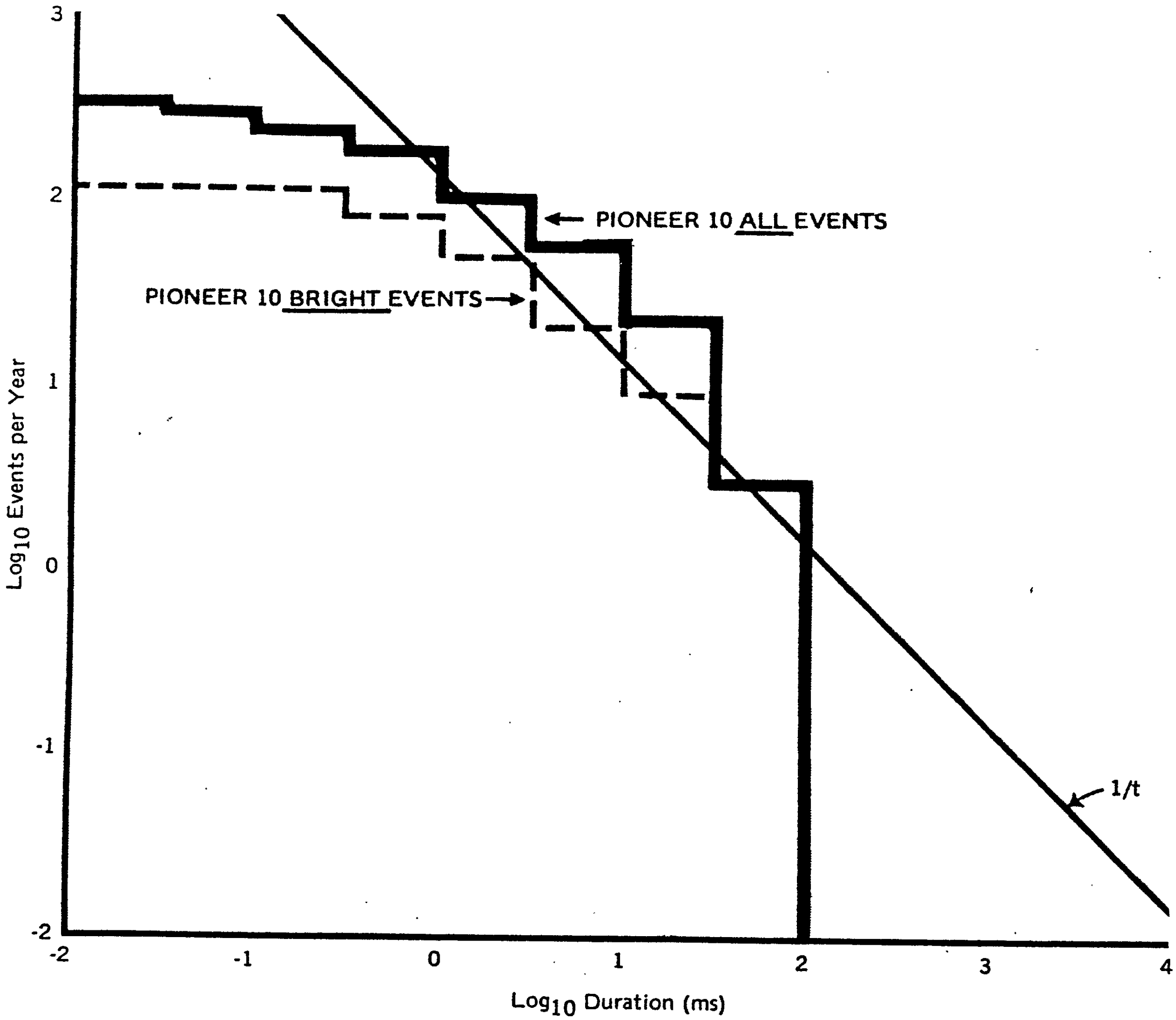

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FIGURE 10 CUMULATIVE DURATION DISTRIBUTIONS FOR PIONEER 10 (U)

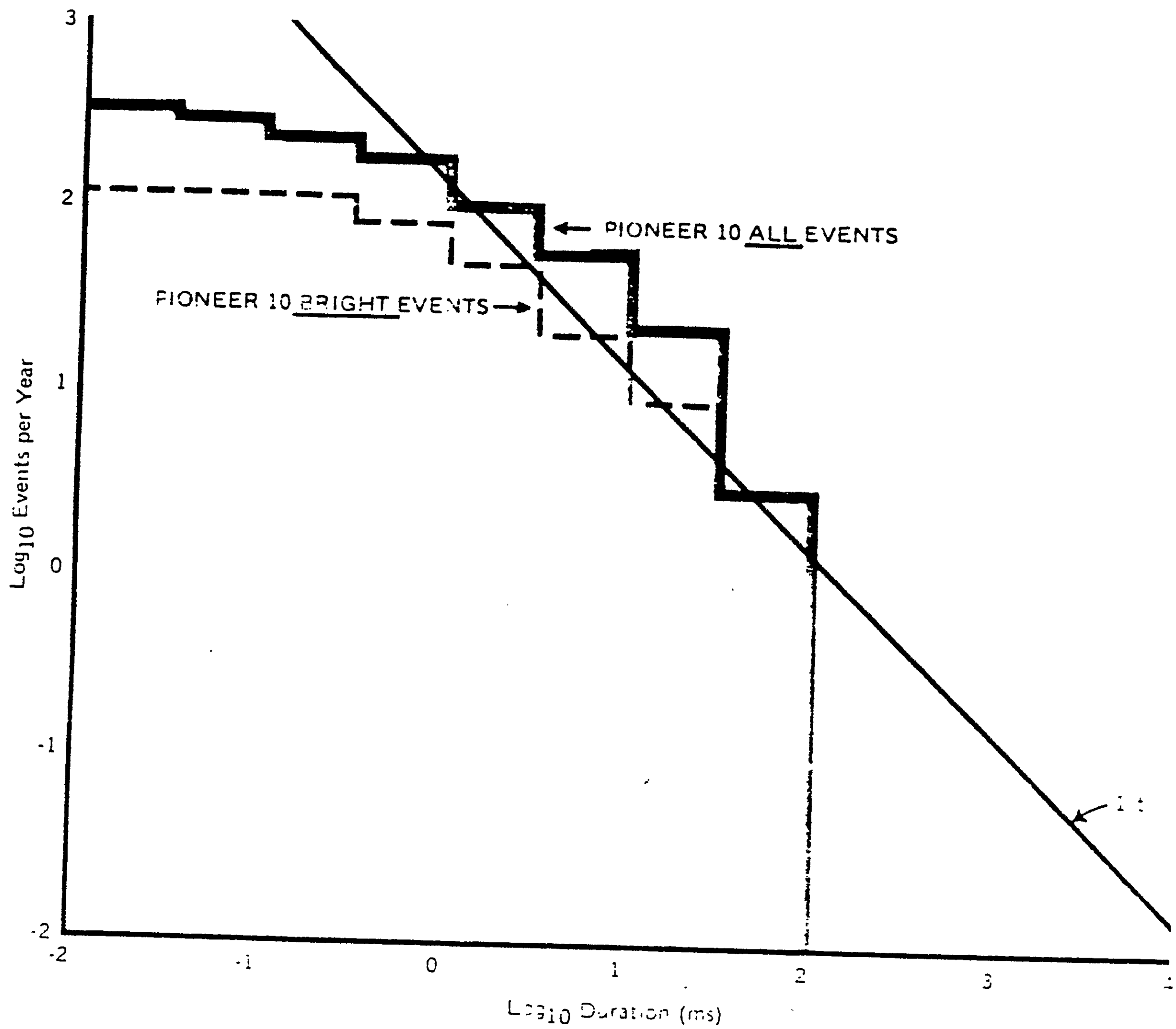

FIGURE 10 CUMULATIVE DURATION DISTRIBUTIONS FOR PIONEER 10 (U)

VI. THE CASE AGAINST THE ZOO