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INTERPLANETARY DUST AND COMET ORBITS

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In the early days of space flight a large number of experiments were launched that consisted of sounding boards and piezoelectric crystal detectors, or microphones. Clicks heard by the microphones were interpreted as being caused by micrometeoritic particles hitting the sounding boards. This interpretation suffered from two difficulties. First, it led to a cumulative spatial distribution almost a factor of a million higher than that derived from measurements by other techniques. Second, a number of the microphone experiments experienced "dust storms" – periods in which their count rates increased by as much as a factor of 1000 over their average background rate.

Last year at this meeting Otto Berg described the results from his extremely sensitive micrometeoroid detectors flown on Pioneers 8 and 9. He described a low-flux model for the interplanetary dust distribution that is in good agreement with other recent measurements and hence casts serious doubt on the validity of the microphone results.

The only comprehensive explanation of the dust storms was attempted by Eric Silverberg in his Ph. D. thesis at the University of Maryland. He suggested that the orbital planes of short-period, low-inclination comets are filled with micrometeroroids because of the effect of solar radiation pressure on their orbits. He further pointed out that "in general there appears to be no dust event seen by the satellites carrying microphone detectors which was not near the plane of a periodic comet. Furthermore no orbiting satellite passed through the plane of a low-inclination comet without registering a flux increase."

Several years of observational results are now available from the Pioneer 8 and 9 interplanetary dust detectors. This makes it possible to test the validity of Silverberg's hypothesis.

Table I summarizes the characteristics of the five largest dust showers discussed by Silverberg. The last column of the table lists the number of counts that would be expected to be observed by the Pioneer 8 and 9 detectors in the same showers. As you can see we would expect with the Pioneer detectors to see as many as 600 counts in a day. For some of the other showers we would expect to see tens of counts per day.

TABLE I–Characteristics of Five Largest Dust Showers

Satellite	Date of storm	Associated comet	Count rate, $m^{-2} s^{-1}$	Duration of storm, hr	Predicted counts per day for a Pioneer-type detector
Vanguard 3	Nov. 16 to 18, 1959	Honda-Mrkos-Pajdusákovà	0.2	70	250
Explorer 1	Feb. 3, 1958	Ororsen-Metcalf	.2	15	55
Electron 2	Jan. 30 to 31, 1964	Brorsen-Metcalf	.11	15	30
Sputnik 3	May 15, 1958	Halley	7	5	630
Electron 2	Feb. 23 to 25, 1964	Encke	.0058	44.4	5

Figure 1 shows all counts registered on the front films of the Pioneer 8 and 9 detectors during the periods when complete telemetry was available. Since solar interference was believed to be present, the count rates were shown separately depending on whether the Sun was within the 120° field of view of the detectors. Each vertical line represents one event. Tick marks are added if more than one event occurred during the same day. The date scale should be interpreted as satellite longitude. The times at which cometary enhancements are predicted are shown at the bottom of the figure. It is apparent that no dust showers are seen then, indeed no detectable showers appear anywhere in the data.

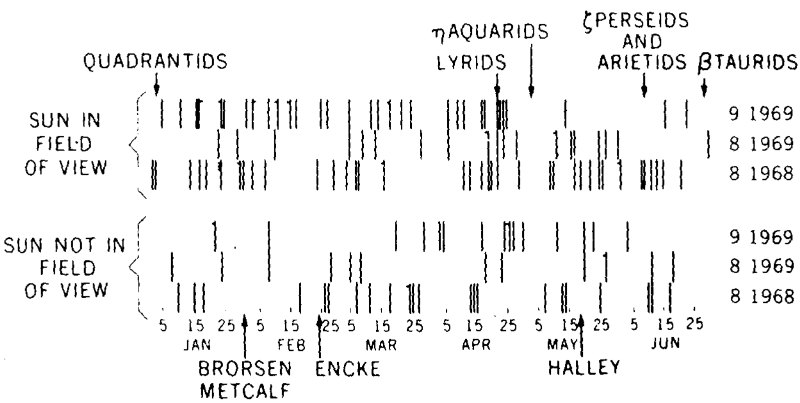

Figure 1–Pioneer 8 and 9 interplanetary dust detector counts.

This makes the Pioneer observations completely at odds with early microphone observations. In particular we can make the following points:

First, no comet-associated dust storms were detected to a limit of at least the factor of 100 more sensitive than previously reported highest rates.

Second, the reported microphone events were for particles in the mass range of 10^{-8} to 10^{-9} g, whereas the events shown in this figure are due to particles smaller than 10^{-11} g. Indeed the largest particle observed by the Pioneer detectors in more than 3 yr of operation is 10^{-10} g. Hence the particles presumed to cause these dust storms are much too rare to even have been observed.

Third, it is no good to suppose that these storms occur only occasionally since Silverberg's claim that they are invariably observed whenever a satellite-borne detector passed through the orbital plane of any short-period, low-inclination comet with perihelion distance less than 1 AU.

The arrows at the top of the figure show the dates of some of the most active meteor showers. The lack of any observed concentration of small particles on these dates is not surprising since it is well known that meteor streams are deficient in small particles.

In conclusion, the dust storms observed by the microphone detectors remain unconfirmed and unexplained. This, combined with their unreasonably high measured particle flux casts serious doubt on any results from this type of detector.