

⁴ Naumann, R. J., "The Near-Earth Meteoroid Environment," TN D-3717, Nov. 1966, NASA.

⁵ Shapiro, I. I., Lantman, D. A., and Colombo, G., "The Earth's Dust Belt: Fact or Fiction," *Journal of Geophysical Research*, Vol. 71, No. 23, 1966, pp. 5689-5741.

⁶ Nilsson, C., "Some Doubts about the Earth's Dust Cloud," *Science*, Vol. 153, Sept. 9, 1966, pp. 1242-1246.

⁷ Mark, H., Sommers, R. D., and Mirtich, M. J., "Effect on Surface Thermal Properties of Calibrated Exposure to Micrometeoroid Environment," Paper 65-138, Jan. 1965, AIAA; also *AIAA Journal*, Vol. 4, No. 10, Oct. 1966, pp. 1811-1817.

Reply by Authors to R. A. Breuch

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IN his comment¹ on our paper,² Breuch credited us with a conclusion that nowhere appeared in that paper. In the authors' enumerated conclusions it was explicitly stated that the "rate of reduction . . . (of cell performance) . . . depends heavily on the micrometeoroid flux distribution chosen as representative of the micrometeoroid environment." We also stated "this rate is not yet definitive." Even if this had not been explicitly stated, it should have been clear that there remained great doubt as to the exact micrometeoroid flux in space since two flux models giving extremely differing results were included in the paper. This was done in an attempt to cover the possible extremes indicated by actual micrometeoroid flux data available at present.

Breuch also says that the micrometeoroid flux models used in Ref. 2 are "inconsistent with recently published data."³⁻⁵ Contrary to his statement, two of these references^{3,4} (all of which are well-known to the authors) contain no micrometeoroid data whatsoever. The third⁵ contains no data relevant to the micrometeoroid particle size used in Ref. 2. Although his comment suggests that these references present a new and better flux model that negates the data and hence the models presented in Refs. 6 and 7, this is really not the case at all. And it is interesting to note that in his own paper,⁸ published in the *AIAA Journal*, September 1967, Breuch cannot refer to this "recently published data" when discussing the micrometeoroid environment, but uses instead Ref. 9, published in 1962, even predating the references used by the authors.

In Ref. 3, Shapiro et al. attempted to find an explanation for the earth's dust belt as recorded by the many American and Russian satellite micrometeoroid sensors. In spite of a very complete computer study of orbiting particle trajectories, they were unable to clarify the situation, and very cleverly indicate the remaining doubt on the subject with the title of their paper: "The Earth's Dust Belt: Fact or Fiction?" Again, there is no new micrometeoroid flux model presented in this reference. In Ref. 4, Nilsson only points out the possibility of thermal noise as an explanation for the data obtained by the microphone sensors on the various American satellites if these should prove, eventually, to be high. He also notes that scientists have known about this noise problem previous to his work and that those making these satellite measurements had already made sensor noise studies. He also notes that no noise was observed on Explorer I while temperatures were changing and that this appears to contradict his explanation. Again, Nilsson does not present a new flux model in his paper. Naumann, in Ref. 5, essentially using

the penetration measurements of Explorer XVI, Explorer XXIII, and Pegasus satellites along with the interpretation of photometric measurements of F-corona and zodiacal light by Van de Hulst, presents a model for "penetrating particles in heliocentric orbits." From the type of data he uses, the model derived applies to meteoroid masses much larger than those considered by the authors of Ref. 2. Consequently, it must be realized that Naumann's model cannot be simply extrapolated into the mass range considered by the authors of Ref. 2 without conclusive proof that such an extrapolation is valid, and without showing conclusively that all of the microphone, photomultiplier, and collection measurement data are invalid. Naumann specifically states that he has not done this and that "it is clear that there are still many unanswered questions that must be resolved before all of the above measurements can be properly interpreted." The authors, as well as others in this field, are fully aware of the controversy existing over the near-earth dust belt, and again it must be repeated that it was for this very reason that two different flux models^{6,7} (in the mass range of interest) giving drastically differing results were presented in Ref. 2.

Breuch also feels that "the previously published problems on the effects of simulated micrometeoroid exposure on thermal control surfaces will be significantly affected" and refers to Ref. 10. This statement is irrelevant when referring to Ref. 10. That paper describes a totally consistent ground study of laboratory degradation of the surface thermal properties of polished metal surfaces, and nowhere in the paper is a flux model assumed to relate damage with real space time. On the contrary, it is explicitly stated in this paper that "meteoroid flux uncertainties are still a major factor preventing good quantitative estimates of surface life in space to be made." The purpose of this work was, in fact, to provide information regarding a possible new sensor for studying micrometeoroid effects in the lower mass size range, and eventually clarifying the controversy that exists. This point, which was specifically made in the introduction as well as elsewhere in that paper, was apparently overlooked by Breuch.

References

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