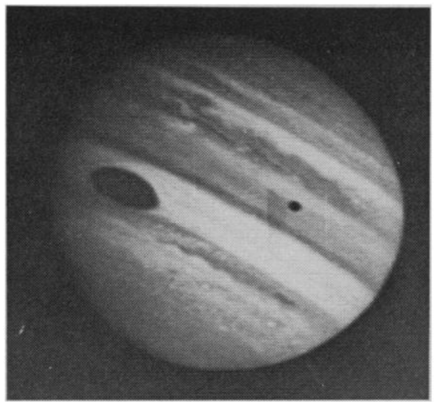

Fig. 4. Blue image taken at 36 R_J at phase angle $\sim 28°$. Note especially the bright spots ringed by dark regions and the many wave structures. The shadow of Io is seen.

a factor of 2. For each of the 75 sectors on the planet we have accurate measurements of the linear polarization and the direction of vibration. At this wavelength and phase angle the polarization varies from several percent at the center of the disk (viewed normally) to ~ 40 percent at the poles (viewed at grazing angles). These high polarizations result from Rayleigh scattering and will permit a solution for the amount of gas above the cloud tops.

One scan line of red imaging data is shown in Fig. 3. The full gray scale in mode 4 is from 0 to 63. The break in the slope of the curve, particularly obvious at the left of Fig. 3, corresponds to the limb and indicates the high spatial resolution of the data. The noise per pixel is about one count when the signal is 50 counts. Averaging over many pixels is expected to yield relative photometric data of high quality in the blue and red passbands.

An example of the mode 4 blue data displayed as an image is given in Fig. 4. An algorithm has been developed for adding green based on the relative amounts of red and blue in order to produce color images consistent with ground-based experience with Jovian color balance. Since the scan lines are not straight lines on the planet, geometric rectification is done prior to display. The image shows the shadow of Io and a wealth of cloud structure on a variety of scales. The equatorial and polar regions seem much more longitudinally uniform than the mid-latitude regions, which are very structured. Four small bright spots, each about 4000 km in diameter and surrounded by rings of darker material, appear in the south temperate latitudes. North tropical latitudes contain several bright swirls of high contrast, at scales down to the limit of resolution. The low-latitude boundaries of the bright North Tropical Zone and South Temperate Zone exhibit a striking wave pattern. The Red Spot appears not quite oval but has the suggestion of sharp tips at its eastern and western ends. Its border is sharp to the limit of resolution and is somewhat darker than the material it encloses. About 80 images were obtained at resolution up to six times greater than that in this image. In addition, several hundred images were taken during the 2 weeks when the planet was more than 40 resolution elements in diameter, as outlined in Table 2.

We plan several types of studies based on the large volume of data obtained during the flyby. The imaging data will first be rectified and displayed as images for a preliminary cloud morphology classification. The intensities, colors, and polarizations of selected regions observed under different scattering geometries will then be compared with the values computed for various multiple-scattering models. Finally, the photometric and polarimetric data on the Jovian satellites will be compared with laboratory data and ground-based measurements.

T. GEHRELS, D. COFFEEN
M. TOMASKO, L. DOOSE
W. SWINDELL, N. CASTILLO
J. KENDALL, A. CLEMENTS
J. HÄMEEN-ANTTILA, C. KEN KNIGHT
C. BLENMAN, R. BAKER
G. BEST, L. BAKER
University of Arizona, Tucson 85721

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4. Various examples of spin-scan imaging are compared by T. Gehrels, V. Suomi, and R. J. Krauss [*Space Research 12*, A. C. Strickland, Ed. (Akademie-Verlag, Berlin, 1972), p. 1765].
5. We are deeply grateful to the large group of people from NASA's Ames Research Center, Jet Propulsion Laboratory, and the Deep Space Net for their combined efforts which resulted in the near-perfect execution of the sequence of some 15,000 instrument commands during November and December 1973. We particularly thank R. Fimmel of Ames Research Center for having personally checked so many of our commands.

21 December 1973

Particle Concentration in the Asteroid Belt from Pioneer 10

Abstract. *The spatial concentration and size distribution for particles measured by the asteroid/meteoroid detector on Pioneer 10 between 2 and 3.5 astronomical units are presented. The size distribution is from about 35 micrometers to 10 centimeters. The exponent of the size dependence varies from approximately −1.7 for the smallest to approximately −3.0 for the largest size measured.*

The asteroid/meteoroid detector being carried on Pioneer 10 and Pioneer 11 measures the contribution to sky brightness in white light from the aggregate of particles in the field of view and the light from bright individual particles which pass through the field of view. The instrument consists of four optical telescopes with 20-cm apertures which look out at an angle of 45° with respect to the spin axis of the spacecraft. The telescopes have 7.5° fields of view and are aligned approximately parallel. The telescopes use RCA 7151 Q photomultipliers with S20 photocathodes. The spectral response is modified by two gold reflections in the Cassegrain-type telescope.

The data obtained from the experiment on Pioneer 10 have been analyzed for the spatial concentration and size distributions of particles observed between 2 and 3.5 A.U. An average result for the 123 particles observed is shown in Fig. 1. This is a cumulative distribution (that is, it is for a given size and larger). The data are generally grouped in the thirds of size decades. However, the entire decade of smallest sizes is grouped together due to the distortion that occurs within 10 m of the telescope. The data points are plotted at the logarithmic mean with a horizontal bar showing the approximate size domain included. Following Dohnanyi (*1*) we have assumed a geometric albedo of 0.2 to derive the particle size. The vertical bars were

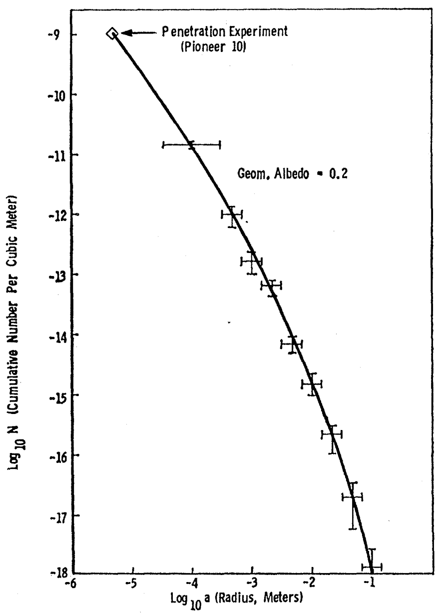

Fig. 1. Particle size distribution in the asteroid belt (2 to 3.5 A.U.).

derived by making the assumption that the uncertainty was proportional to the square root of the number of particles observed multipled by the average transit time through the field of view. The particles were assumed to be traveling in direct circular orbits with no inclination. For a distribution function of the form $N \sim a^{-\beta}$, the value of β varies from about 1.7 for the smallest to about 3 for the largest size measured. We have also plotted in Fig. 1 the point obtained by the meteoroid detector (penetration experiment) on Pioneer 10 (*2*).

To illustrate the change in size distribution we combined the data into decades of size for solar distance increments of 1/4 A.U. This is shown in the histograms of Fig. 2. Since the changes in size distribution that were noted in the data as the region from 2 to 3.5 A.U. was transited are not appreciable on the logarithmic scale used in Fig. 1, they are shown in the histograms of Fig. 2. The particle size domains are shown with each histogram. We have shown the number of events in each bar to give an idea of the statistical uncertainty; this shows why it was necessary to combine data into larger size groupings. Note that the ordinates on these histograms are linear and are expressed in mass per unit volume, which is more meaningful for such a large range of sizes. We assumed a density of 3 g/cm^3 for the conversion. From Fig. 2 it can be seen

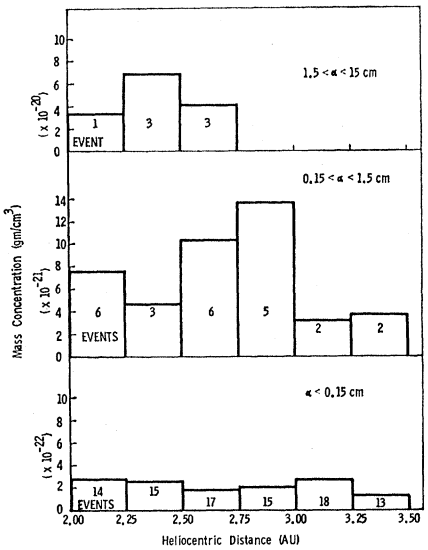

Fig. 2. Mass concentration for three ranges of particle radius.

that the largest sizes were observed in the region from 2 to 3.0 A.U., with an apparent peak at the heliocentric distance where the visible asteroids are most heavily concentrated. The intermediate sizes appear to show the greatest concentration at a somewhat larger solar distance. The change in concentration of the smallest sizes is only a factor of 2 and one can easily conclude a distribution which does not vary with solar distance. The latter is in agreement with the results of the penetration measurement on Pioneer 10 (*2*).

R. K. SOBERMAN
S. L. NESTE
K. LICHTENFELD
General Electric Space Science Laboratory, Philadelphia, Pennsylvania

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3. Supported by NASA contract NAS 2-6559. We would like to express our deep appreciation to the personnel of the Pioneer Project Office, NASA Ames Research Center, for their outstanding work with the Pioneer 10 spacecraft and their unstinting cooperation with the investigators to maximize the scientific yield from this historic mission.

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Interplanetary and Near-Jupiter Meteoroid Environments: Preliminary Results from the Meteoroid Detection Experiment

The first measurements of the population of meteoroids of mass $\sim 10^{-9}$ g have been made in interplanetary space through the region of the asteroid belt, to the orbit of Jupiter, and in the near vicinity of Jupiter by the Langley Research Center's meteoroid detection experiment on Pioneer 10. Specifically, the experiment is detecting meteoroid penetrations in stainless steel targets 25 μm thick along the flight trajectory.

The Langley experiment consists of 234 individually sealed cells pressurized by gas (*1*). The dimensions of each cell are 0.84 by 29.2 cm, the cell volume is 2.5 cm^3, and the cell pressure is 1175 mm-Hg. The sensitive surface area aboard the spacecraft was 0.265 m^2 because of an electronic anomaly in one of the two data systems. This

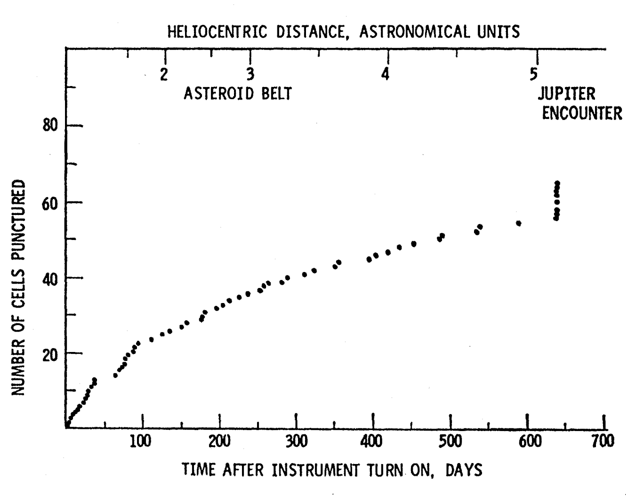

Fig. 1. Data on interplanetary dust obtained by the Pioneer 10 meteoroid detection experiment.