IONIZING RADIATION DETECTED BY PIONEER II

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Pioneer II was launched from Cape Canaveral, Florida on 7 November 1958, and attained a maximum altitude of 1520 kilometers. The payload contained an ionization chamber to measure the total ionizing component of cosmic radiation flux.* Ion chamber data were received during the first half hour of flight. The measured radiation levels are plotted versus altitude. (See Figure 1.) The declination and longitude of the vehicle's position are given for each data point.

The apparatus used was essentially the same as that used in Pioneer I. The ionization chamber** was an aluminum-walled vessel filled with spectroscopically pure argon to a pressure of 13.6 atmospheres at 20 degrees centigrade. Volume of the chamber was 43 cubic centimeters and the areal density of the walls was 400 milligrams per square centimeter.

The electronics was basically a design utilized for the CsI scintillation count-rate meter in Explorer IV.† A d-c electrometer amplifier, with a range of 1000 Roentgens per hour, drove a subcarrier oscillator

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**Fabrication was by Anton Laboratories, Inc., Brooklyn, New York; the design was supplied by J. A. Van Allen, State University of Iowa.

Figure 1. Pioneer II. Ionizing radiation versus altitude including longitudes and north latitudes.
which, in turn, modulated the transmitter. Since the circuit was temperature dependent, in-flight calibration was provided by the substitution of a known voltage for the ionization chamber output. This substitution was made once each 200 seconds for a period of 20 seconds. With this calibration voltage on the input, the subcarrier frequency varied with the temperature of the circuit. Thus, by measuring the subcarrier frequency of the calibration signal, the effective temperature of the circuit could be determined.

Calibration of the ion chamber, itself, was accomplished by utilizing a Co$^{60}$ bomb at the Radiology Department of the UCLA Medical Center.

Several sources of error were considered in determining the range of error to be assigned to each data point. Some of these sources lay in the drift and nonlinearity of the subcarrier oscillator in the vehicle, the demodulating equipment on the ground, and the recording apparatus. The asymmetry of the error flags is due to the fact that the output was, approximately, a logarithmic function of the radiation level. This relationship was used so that the instrument would have a comparatively large dynamic range.

The significance of the information on ionizing radiation which was gathered during the brief life of Pioneer II lies in the fact that it clearly indicates an increase of such radiation with decreasing north latitude. At the apogee of the orbit, in the altitude range of 1470 to 1520 kilometers, the vehicle traversed 7 degrees of latitude. Thus, for an essentially constant altitude, the variation of ionization with latitude was observed. Figure 2 shows the variation of ionization with latitude when the chamber was located at 1500 ± 20 kilometers altitude.

Further, it is possible to obtain a lower bound for the average specific ionization of the observed radiation at this altitude by combining the results of this experiment with those of Explorer IV.$^2$ Data from the

Figure 2. Pioneer II. Ionization versus latitude at an altitude of 1500 ± 25 kilometers.
latter indicated a maximum count rate of well below 10,000 counts per second at an altitude of 1500 kilometers. Calculations, based upon this count rate and the level of the ionization detected by Pioneer II, indicate that the average specific ionization of this radiation is well over three times the minimum average specific ionization. This value of three is likely to be quite low due to the fact that the maximum count rate observed by Explorer IV probably occurred at the geomagnetic equator, whereas the ionization level was observed at higher geomagnetic latitudes and was increasing at a rate of about 0.2 Roentgen per hour per degree decrease in latitude. (See Figure 2.) Thus, if the average specific ionization is calculated, using, in place of the observed maximum ionization level, a value found by extrapolating the curve in Figure 2 to the geomagnetic equator, the ratio of specific ionization to minimum specific ionization would be considerably greater than three.