THE HEAVY NUCLEI EXPERIMENT ON HEAO-3

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The third High Energy Astronomical Observatory, HEAO-3 was launched on the 20th Sept., 1979 into a 496 km, 43.6° orbit, and has since been successfully returning data from all three experiments on board. One of these experiments, that intended to study the heavy and ultra heavy nuclei in the cosmic radiation, is described here.

A schematic view of the instrument is shown in Fig. 1, from which it can be seen that the array is double-ended and consists of three main elements. Two pressure chambers, filled with an argon-methane mixture $\approx$ 850 torr ($1.08 \times 10^5 N/m^2$) each contain two x-y hodoscopes, made of wires spaced 1 cm apart, and three parallel plate ionization chambers. Between the pressure chambers is mounted a Cherenkov counter composed of two layers of Pilot 425 radiator looked at by eight photomultipliers. The array has a total geometry factor of 5.9 m^2sr for events that traverse at least two of the hodoscope pairs and two of the seven charge-measuring detectors. In practice, this means that approximately 5×10^4 iron nuclei are detected per day.

This instrument was designed to achieve a charge resolution of 0.3 charge units over the charge range of $17 \leq Z \leq 120$, which requires a measurement accurate to 0.6% at Z = 100. The spacing of the hodoscope wires, the amount of gas between each plane of the ionization chamber, and the thickness of the Cherenkov radiators were all chosen with this requirement in mind. Response maps of the ionization chambers and the Cherenkov detectors have been prepared using that in-flight data available. The response of the ion chambers has been found to be only weakly spatially dependent, showing a gradient which, for all positions more than 8 cms from the edge, is nowhere greater than 0.05% per cm. The Cherenkov chamber has a much larger spatial variation. Over some 80% of the area the gradients are less than 1% per cm, but near the corners they are larger. The accuracy with which these gradients are measured will steadily improve as further in-flight data are obtained. The Cherenkov response also shows a long term temporal dependence of ± 3%, which is closely, but not uniquely, related to the temperature

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variations. This variation can be measured with great accuracy from the in-flight iron nuclei $\lesssim$ 0.2%.

Examination of selected data shows that the instrument has the intrinsic resolution needed. To date we have resolved individual elements up to iron and even-charged elements up to strontium. It only remains to accumulate sufficient data to determine the corrections with the required accuracy. From one year of data we should have about 100 iron nuclei per cm^2 of detector surface suitable for calibration. That should be sufficient to achieve resolution of individual elements. It will then remain to verify the charge scale by identifying individual element peaks all the way up the charge range, since we cannot rely on theories of energy loss at such high Z values.

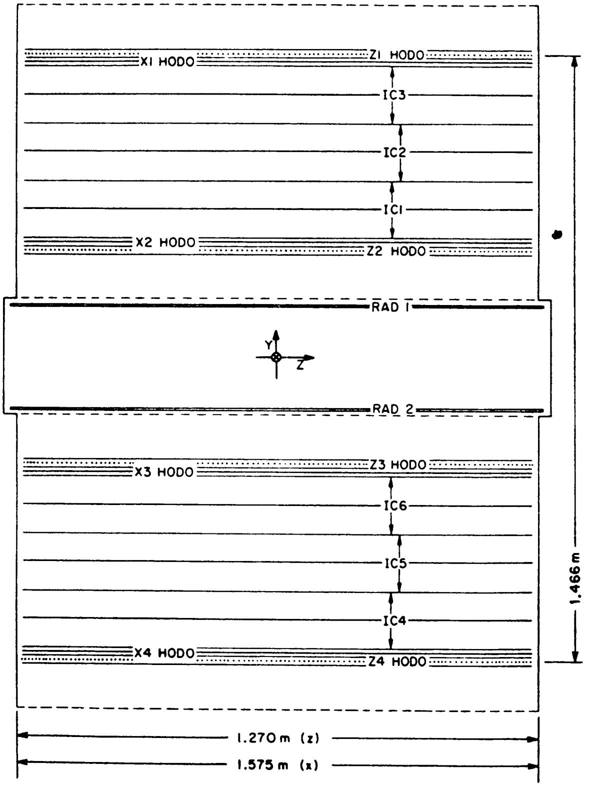

Fig. 1

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