during the ascent or descent of the balloon or at the flight ceiling. Each sandwich was made up of seventy-two layers. After the flight the emulsions were developed by conventional methods and the plastics were etched in sodium hydroxide solution. The plastics were scanned by two methods, first using a low power stereomicroscope and then by the quicker spark scanning technique, and there was good agreement.

The preliminary charge identification was based on photometric analysis of the emulsion track structure and on etching rate measurements on the plastics for particles of very high atomic number ($Z>70$). The final flux values for particles at the top of the atmosphere were found to be

$$J\ (Z\geq 33)\geq 2\cdot 6\ 10^{-5}\ \text{particles/m}^2\ \text{sr s}$$
$$J\ (33\leq Z\leq 40)\geq 1\cdot 9\ 10^{-5}\ \text{particles/m}^2\ \text{sr s}$$
$$J\ (Z>70)\geq 1\ 10^{-6}\ \text{particles/m}^2\ \text{sr s}$$

For comparison, the flux of the iron group ($20\leq Z\leq 26$) is given as about 0·4 particles/m^2 sr s. Attention is drawn to the fact that two particles with Z appreciably greater than 70 were detected, which is in keeping with Fowler's observations. There seems to be some disagreement between the results of this new experiment and that of Fowler for the range $40<Z\leq 70$, however, and it looks as if more measurements will be needed.

The existence of heavy transiron particles in primary cosmic rays was first inferred from stored nuclear tracks found in meteorites. The size of the flux measured was an average over the exposure time of the meteorites, about 10 to 100 million years. In their experiment Fowler *et al.* used nuclear emulsions flown on a balloon at high altitudes, with an emulsion area about two hundred times larger than normal, and nine nuclei with Z greater than 40 were found. The observations of Blandford *et al.* were made with detectors three times larger again, and were carried out in Texas where the geomagnetic cutoff of 5 GeV ensures that the measured particles have relativistic velocities.

MAGNETIC REVERSAL

Short Polarity Events

from our Geomagnetism Correspondent

WHAT is the true rate of reversal of the Earth's magnetic field? Since Cox (*J. Geophys. Res.*, **73**, 3247; 1968) described a field reversal model which predicted the existence of undiscovered short polarity events, the number of reversals known to have occurred during the past 4·5 million years has increased from nineteen to twenty-six. It is thus highly probable that even more short events remain to be discovered. But whether they will all be discovered is another matter. Except in special circumstances, potassium–argon dating of continental rocks is incapable of resolving polarity intervals shorter than several tens of thousands of years; coring processes, burrowing animals and discontinuous sedimentation may obliterate short intervals in ocean sediments; and too little crustal material may be produced during short events to give significant ocean magnetic anomalies. Ultimately it may be impossible to recognize all reversals, even those of the past few million years.

Because of these problems, Harrison (*Earth and Planet. Sci. Lett.*, **6**, 186; 1969) has tried to estimate the true reversal rate from existing data on the assumption that there is some threshold period, T, below which events are too short to be recognized. If this very reasonable assumption is valid, the effect of the threshold will be for an event shorter than T to be assimilated into the interval on each side. Two polarity changes will thus be "lost"; and the apparent reversal rate will go down. The longer T, the lower the apparent rate of reversal will be.

Starting with Cox's model, whereby the number of expected polarity intervals drops off approximately exponentially with increase in their length, Harrison generates a family of theoretical curves of mean polarity interval length against T for reversal rates ranging from 5·2 to 10·3 per million years. He then compares the corresponding experimental curve with these in order to discover how the apparent reversal rate varies with T. The principal point to emerge is that for T greater than about 55,000 years, the apparent reversal rate is somewhat higher than 10·3 per million years and roughly constant. Below 55,000 years the rate decreases to the observed rate at $T=0$ (no threshold). The implication here is that the true rate of reversal is more than 10 per million years.

Yet Harrison seems to have surprisingly little faith in the answer. He suggests, "intuitively", that if the reversal rate were really as high as this, "very little sense would have been made of dating the polarity changes". But this is not necessarily so. Five polarity events (ten reversals), each of, say, 5,000 years, within a given million year period would represent only 2·5 per cent of the total time. For this reason they would be difficult to detect by current methods but would not obscure the boundaries of epochs or long events. Thus although, as Harrison notes, there may be considerable error in the experimental curve of mean polarity interval length against T, it does not follow that a reversal rate of 10 per million years is unreasonable.

INFRARED BACKGROUND

Freak Result Verified

from our Astronomy Correspondent

A PLEA to take seriously last year's surprise measurement of an unexpectedly high value for the far infrared background radiation is published in the latest *Astrophysical Journal Letters* by Houck and Harwit of Cornell (**157**, L45; 1969). Last year's measurement, announced in November by Houck and Harwit in company with Shivanandan (*Phys. Rev. Lett.*, **21**, 1460; 1968), caused disbelief in some, and induced others to rush into print with analyses of the implications. The literature has been short on explanations, however. This ought to be remedied by the latest paper from Cornell which confirms the original rocket result with remarkable ease, although sceptics will still want to see the experiment repeated using independent equipment.

What needed to be verified was the observation that above the absorption of the atmosphere the infrared flux between 0·4 and 1·3 mm fails to correspond to the predicted level by nearly two orders of magnitude. Instead of falling on the spectrum for a black body at 3 K—the temperature of the background radiation which Penzias and Wilson discovered at microwave frequencies—the far infrared measurement corre-