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II-4-36. Multiple Neutron Production in an IGY Neutron Monitor

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The data reported here refer to multiple production of evaporation neutrons in the lead lattice of a neutron monitor by the cosmic radiation at sea level. The average rate of interactions in the monitor is about 2 per sec. and as the mean life of thermalised neutrons is about 170 μ sec. the detected neutrons occur on the average in well separated bursts of about 1 m sec. duration. The number of neutrons in each burst is recorded by suitable electronic circuits in which the first detected neutron opens a 700 μ sec. gate to a fast scaler. The total neutron count stored in the scaler is then read out to mechanical registers.

Curve 'a' of Fig. 1 shows the daily rates of multiplicities of from 1 to 9 detected neutrons; the average multiplicity being 1.23. From results obtained in a separate experiment, in which the monitor was operated in coincidence with a magnetic spectrograph, it can be shown that 77% of the detected neutrons are produced by interacting neutrons, 14.8% by protons and 6.8% by captured muons, with a small contribution of about 1% from muons interacting in flight, nucleons occurring in showers and from pions. Curve 'c' shows the spectrum due to proton interactions, curve 'd' the spectrum due to captured muons and curve 'b', obtained by subtracting the sum of 'a' and 'b' from the total spectrum, gives the spectrum arising from neutron interactions.

From the measured variation of the average neutron multiplicity with proton and neutron energy and from known proton and neutron energy spectra at sea level it is possible to deduce the observed total multiplicity spectrum of the monitor and to calculate the rates of each multiplicity due to nucleons in a given energy interval. For example Fig. 2 shows the fraction of the rate of each multiplicity due to nucleons in five energy ranges.

Finally we suggest that data of the type shown in Fig. 2 may be used to study changes in the energy spectrum of nucleons at sea level and thereby changes in the primary energy spectrum. This may be particularly useful during Forbush decreases as the higher multiplicity events correspond to primary particles of energies considerably in excess of the equatorial geomagnetic cut-off value.

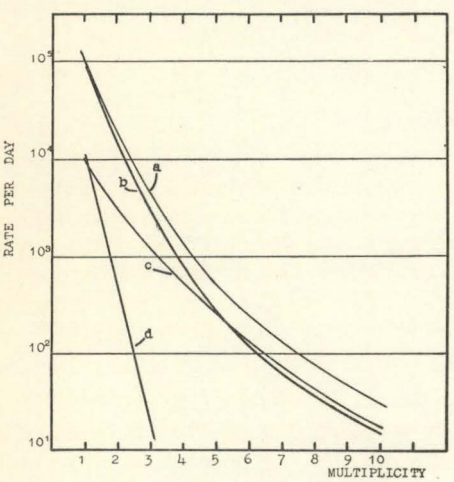

Fig. 1. Daily rate of neutron multiplicity. 'a' total flux, 'b' neutron interactions, 'c' proton interactions, 'd' captured muons.

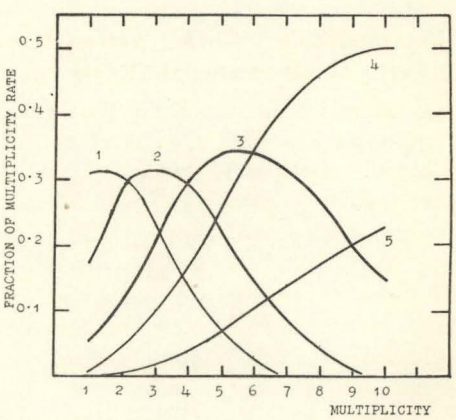

Fig. 2. Fraction of rate of multiplicity due to nucleons in five energy ranges. 1: $0.1<E<0.3$, 2: $0.3<E<1.0$, 3: $1.0<E<3$, 4: $3<E<10$, 5: $10<E<30$. (E in GeV).

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