CR-39 PLASTIC TRACK DETECTOR EXPERIMENT FOR MEASUREMENT OF CHARGE COMPOSITION OF PRIMARY COSMIC RAYS

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A study of the relative abundances and energy spectra of heavy cosmic rays and isotopic composition in the region of Fe peak can yield significant information concerning their origin, acceleration and interstellar propagation. In recent years solid state nuclear track detectors have been employed extensively to study heavy primary cosmic rays. Plastic track detectors necessarily have large geometric factors for heavy primaries, and a continuous sensitivity for the duration of an extended exposure. A balloon-borne experiment consisting of 1 m^2 passive detector array has been designed in order to obtain charge and energy spectra of primary cosmic rays in the region of Fe peak. Included in the array is a new type of nuclear-track-recording plastic, a polymer made from the monomer allyl diglycol carbonate (commercially known as CR-39). The stack was built as a set of nine modules. Three types of stack assembly was adopted for these modules: one consisting of 'pure' CR-39 plastic track detector: the next one, a composite assembly of CR-39 with three layers of 600 micron thick nuclear emulsions: and the last one with CR-39 and Lexan Polycarbonate. The payload was flown successfully in June 1979 from Eielson Air Force Base, Alaska. The flight was aloft for 3 hours 30 min at an average ceiling of 3 gm/cm^2 of residual atmosphere. An attempt to stabilize and orient the payload utilizing a biaxial magnetometer combined with and electrical rotator was unsuccessful. The failure to orient the payload in a stable position would prevent us from determining the true direction of each cosmic ray particle and trace it backwards through the earth's magnetic field using a computer tracing program. Recovery of the payload was routine and all materials were in perfect condition.

CR-39 from one of the modules has been etched in a solution of 6.25N Sodium Hydroxide Solution at 50°C for 120 hours. The etching was carried out in a precisely controlled bath that is stable to ± 0.1°C. Optical scanning of CR-39 was performed using an Olympus SZ-3 stereo microscope. The top fifteen sheets have been scanned for stopping and relativistic cosmic ray nuclei. In this scanning 200 stopping particles and several relativistic primaries were detected. The relativisitic nuclei passed completely through the entire stack of

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thickness 14 gm/cm^2 with no diminution in ionization. Optical measurements on a sample of 50 stopping particles were carried out using Koristka R4 and Leitz/Ortholux Microscopes. We confined our measurements to only those events with high etch rates, and measurements were performed on only three pairs of cones and the ender. No attempt was made to follow the track to the top of the stack in these preliminary measurements. Fig. 1 shows the normalized track etch rate as a function of residual range. Two features stand out very clearly in this figure, i) a smooth variation of track etch rate with range is indicated for individual particles, ii) in the high etch rate region there is no evidence of saturation of etch rate, which is in excellent agreement with the results of Fowler et al [1]. The charge estimates for these particles should become available in the near future after the completion of calibration of CR-39.

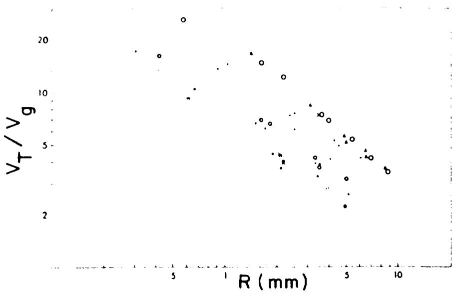

Fig. 1

Fig. 1 Normalized track etch rate as a function of residual range.

Fig. 2 Response of CR-39 to various particles.

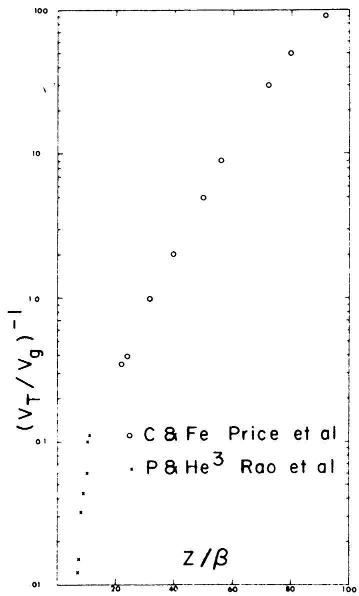

Fig. 2

Fig. 2 shows the response of CR-39 to various particles. Included in the figure are the data of Price et al [2] and our own data [3] from protons and He^3. It is clear from Fig. 2 that the normalized track etch rate approaches unity very slowly as Z/β decreases. We conclude that CR-39 will detect vertically-incident particles with Z/β as low as 8-10.

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