while the second concerns the paucity of the data on heavy meson production by real photons. However, the limited data which are available on the interactions of 1 GeV. photons are encouraging in that heavy mesons[10] and multiple π-mesons[11,12] are produced. This would seem to indicate that the W-W method may be used to interpret the showers induced underground by μ-mesons. If this is the case, then photon interaction processes such as the production of K-mesons and hyperons should occur.

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[1] Fowler, G. N., and Wolfendale, A. W., 'Progress in Elementary Particle and Cosmic Ray Physics', 4, 107 (North Holland Pub. Co., Amsterdam. 1958).
[2] Kaneko, S., Kubozoe, T., Okazaki, M., and Takahata, M., 'Prog. Theor. Phys.', 13, 461 (1955).
[3] Fay, H., Gottstein, K., and Hain, K., Supplement to *Nuovo Cimento*, No. 2, 11, 234 (1954).
[4] Barkas, W. H., Smith, F. M., and Birnbaum, W., *Phys. Rev.*, 98, 605 (1955).
[5] Crowe, K. M., *Nuovo Cimento*, 5, 541 (1957).
[6] Clegg, A. B., Ernstene, M. P., and Tollestrup, A. V., *Phys. Rev.*, 107, 1200 (1957).
[7] Alexander, G., Johnston, R. H. W., and O'Ceallaigh, C., *Nuovo Cimento*, 6, 478 (1957).
[8] Barron, W. C., Short, A. M., and Wolfendale, A. W. (in preparation).
[9] George, E. P., and Evans, J., *Proc. Phys. Soc.*, A, 63, 1248 (1950).
[10] Donoho, P. L., and Walker, R. L., *Phys. Rev.*, 112, 981 (1958).
[11] Bloch, M., and Sands, M., *Phys. Rev.*, 113, 305 (1959).
[12] Sellen, J. M., Cocconi, G., Cocconi, V. T., and Hart, E. L., *Phys. Rev.*, 113, 1323 (1959).

Ratio of Nucleon Mass and Electron Mass

IN classical physics, the value of the fine structure constant $\varepsilon^2/\hbar c$ is 1/137. The value of the pion-nucleon interaction constant $g^2/\hbar c$ is about 14.

The mass of the electron is given by $m_\varepsilon = \varepsilon^2/2r_0c^2$. The fundamental length r_0 appearing in this formula is also equal to the Compton wave-length of the pion.

Let us assume that the mass of the nucleon is given by a formula strictly similar to that for the electronic mass, in particular with the same value of r_0. Then:

$$\frac{m_n}{m_\varepsilon} = \frac{g^2/2r_0c^2}{\varepsilon^2/2r_0c^2} = \frac{g^2}{\varepsilon^2} = \frac{g^2/\hbar c}{\varepsilon^2/\hbar c} = \frac{14}{1/137} = 1920$$

which is not too far from the experimental value 1840.

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Analysis of Permanent Gases by Gas Chromatography Using a Radioactive Ionization Type Detector

BECAUSE of its high sensitivity, simplicity of operation and stability under changing operating conditions, the radioactive ionization-type detector for gas chromatography is one of the most useful so far developed. This detector is, however, relatively insensitive to the permanent gases. From preliminary experiments it has been found possible to increase this sensitivity greatly by introducing a small continuous bleed of organic vapour into the argon carrier stream.

Without the organic vapour bleed into the detector, the mechanism of detection is as described by Lovelock[1]: the argon forms metastable atoms capable of ionizing atoms of any eluted component having a lower ionization potential than argon, and resulting in very high sensitivity to them. The permanent gases, however, have ionization potentials greater than that of metastable argon and hence are not ionized by the argon; thus sensitivity to them is low. Used in this way, the detector current is quite small when the carrier only is passing.

With an organic vapour bleed into the system, the organic vapour is ionized by the metastable argon and produces a relatively high standing ionization current; this is, however, kept below the saturation current of the detector. Permanent gas components entering the detector reduce this higher ionization current to a greater extent than the alteration in current they produce with argon alone. The mechanism of this process may be expected to be complex but can be qualitatively explained from a consideration of energy levels and collision processes.

Using a Pye argon chromatograph with argon carrier gas and a Linde 5*A* molecular sieve column, it has been found possible to detect permanent gases in the range 0–50 p.p.m. by bleeding ethylene into the carrier stream between the column and detector. With a concentration of ethylene in the detector of the order of 1 p.p.m., the minimum detectable concentrations of hydrogen, oxygen and methane were 0·5 p.p.m. and for nitrogen 1·0 p.p.m. (Similar results were obtained using an acetylene bleed into the detector.) Sensitivity is further increased by a factor of about seven when the ethylene concentration is at its optimum value which would appear to be about 100 p.p.m. In cases where the organic vapour has no adverse effect on the column, it was found possible to include it in the carrier gas supply in the required concentration.

A patent application on this work has been made.

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[1] *J. Chromatography*, 1, 1 (1958).

Etching of Calcite

EXPERIMENTS on etching of calcite have been carried out earlier by a number of workers[1] and etch pits on calcite have been reported recently by H. Watts[2] and R. C. Stanley[3]. We have been carrying out experiments on etching of mineral crystals with different etching reagents for some time and have investigated calcite very thoroughly. Some typical results are reported here.

On etching cleavage faces of calcite with a strong solution of sodium hydroxide for one hour, perfectly boat-shaped figures are obtained. A light profile photomicrograph is shown in Fig. 1. The depth of this particular etch pit is 1 μ at the centre and 0·8 μ at the ends.

The etch figures produced by ammonium chloride solution on a freshly cleaved surface of calcite are parallelograms, and these are oriented with their sides parallel to the edges; their depths vary from a few hundred angstroms to 2 microns, according to the etching time. Figs. 2 and 3 show photomicrographs for the two stages of etching for fifteen minutes and one hour respectively. In Fig. 2 the pits are more scattered and cleavage lines are found to be moving as reported earlier by Patel and