placed behind the converter and connected in coincidence as shown in Fig. 1, so that whenever the electron and positron are scattered into separate telescopes the event is recorded. The phosphors were thick, so that only photons above 20 Mev could produce pairs with sufficient energy to cause a coincidence of all four counters. This detector has good discrimination against neutrons and charged particles and was thus suitable for use with the external beam in the presence of a high background.

The detector was placed at an angle of 135° to the direction of the proton beam for all these measurements in order to avoid the large flux of neutrons from the target which is present at small angles. The results obtained at this one angle should be a fairly good measure of relative total yields of π^0s, since the angular distribution of photons in the meson's rest frame is isotropic so that the photon yield at one angle in the lab frame receives contributions from mesons emitted in any direction. That the photon yield in a given direction in the laboratory is not strongly affected by conceivable meson angular distributions can be shown by straightforward calculations.

The results are shown in Table I and Fig. 2. The yields shown are relative to the carbon yield which has arbitrarily been given the value 6.00.

The yield from H^1 appears to be suppressed, in accordance with the selection rule discussed above for a pseudoscalar meson. Further measurements using a liquid hydrogen target in place of the carbon and polyethylene targets will be necessary to establish a positive yield from hydrogen or to lower the present upper limit appreciably. The yields from the series Be^9, B^{10}, B^{11}, C^{12}, which differ by the successive addition of a proton, a neutron, and a proton, suggest that only the neutrons in light nuclei contribute appreciably to π^0-production in proton bombardment. However, differences in the nuclear structure of these nuclei may modify this simple inference.

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Neutral *V*-Particle Decay and the Negative Proton[*]

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Recent experimental evidence on neutral *V*-particles[1] indicates that one variety (denoted here by V^0) decays into a proton and a negative meson (probably pi). The V^0-particles observed thus far are accompanied on the average by several penetrating particles (protons and pi-mesons) and originate in events the total energy of which averages several times 10^{10} ev. Substantially lower energy events seem much less likely to produce V^0-particles, and substantially higher energy events result in penetrating showers of such high density that V^0-particles are hard to identify.

It is reasonable to inquire why it is that a neutral *V*-particle that decays into a negative proton and a positive meson does not also appear with comparable probability (such a particle will be denoted here by $\bar{V}^0$). V^0 and $\bar{V}^0$ would be expected to have the same rest mass, and indeed to be antiparticles of each other. It can then be argued that they should be produced equally readily, whether they are made independently or as members of antiparticle pairs. The disagreement between this argument and the experimental results to date can be resolved either by supposing that $\bar{V}^0$-particles, and presumably then also negative protons, do not exist, or by supposing that V^0- (or $\bar{V}^0$-) particles can actually be produced singly by some kind of coalescence of a proton (or negative proton) and a negative (or positive) meson. The first supposition would require a drastic revision of the quantum theory of particles as it now exists, and should not be adopted until the evidence for it is unambiguous. The second supposition suffers from the well-known difficulty of reconciling the relatively long lifetime for V^0-decay and the relatively high probability for V^0-production. Apart from this objection, to which we return later, it would account for the experiments in that a $\bar{V}^0$-particle could not then appear unless a negative proton were made as an intermediate step; this would necessitate the simultaneous production of an extra proton or V^0-particle, so that the whole process would require approximately 2 Bev more energy in the center-of-mass system than the appearance of a V^0-particle.

The second supposition can be put in explicit form by making the plausible assumption that there is a conservation law for all particles of nucleonic mass: protons, neutrons, V^0-particles, and other possible particles that decay into protons or neutrons, such as perhaps the charged *V*-particles. This is a simple extension of the generally accepted conservation law for protons and neutrons only, and may be stated as follows: the difference between the total number of nucleonic particles (protons, neutrons, V^0) and the total number of antinucleonic particles (negative protons, antineutrons, $\bar{V}^0$) is a constant of the motion. This constant is, for example, equal to two if the primary event is the collision of a high energy proton or neutron with a single nuclear proton or neutron. From the point of view of Fermi's statistical treatment of high energy events,[2] an additional restraint is thereby imposed on the system, and a new parameter analogous to the chemical potential in conventional thermodynamics is introduced.

In a two-body encounter, the total number of protons, neutrons, and V^0-particles that emerge should be two unless the energy is so high that antinucleonic particles can be created. As pointed out by Fermi, this will require a primary proton energy greater than about 10^{12} ev, in which case a penetrating shower of high density is produced and antinucleonic particles are difficult or impossible to identify. On the other hand, it is known that several nucleonic particles (including in one instance three neutral *V*-particles) often emerge from events where the total energy probably does not exceed 10^{11} ev.[3] According to the view adopted here, such events would be regarded as cascade processes that probably take place within a single nucleus.

Sachs[4] has recently suggested that the long V^0-decay lifetime can be understood in terms of the great complexity of the ground and excited states of protons and neutrons (V^0 is supposed to be an excited state of a neutron), which is caused by the presence of many virtual pi-mesons. Such a model can also be used to account qualitatively for the relative ease with which V^0-particles are produced in energetic nuclear encounters, since the high temperature in the small collision volume[2] greatly increases the populations of states which contain large numbers of real and virtual mesons in comparison with the populations of these states for an isolated nucleon or V^0-particle. It seems to us, however, that the essential feature required for an explanation of the apparent lack of reversibility between V^0-formation and decay is independent of the particular model proposed by Sachs, and has to do with the existence of states that connect V^0 and its decay products that are only present with appreciable probability in a region of high temperature.

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