the outer shell of electrons becomes filled (transition from $3d^{10}4s^1$ in copper to $3d^{10}4s^2$ in zinc, and so forth).

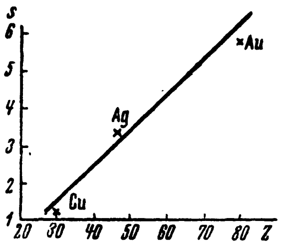

FIG. 1

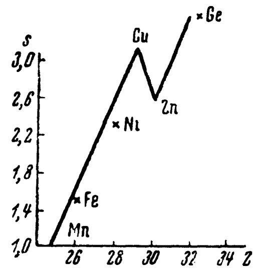

FIG. 2

The experiments performed allow us to draw some conclusions as to the mechanism of the phenomenon. X-ray quanta with an energy of the order of 200 kev knock electrons from the K-shells of the various atoms and give them high energies. The appearance of secondary electrons is due to the fast electrons. Actually it is difficult to picture to oneself how the filling of the external electron shells could play any part in the x-ray photoeffect for quantum energies of about 200 kev, whereas the structure of the external shells plays an essential role in secondary emission[3,4]; when the external shell of the atom is filled, the probability of ionization of the atom is decreased (Fig. 2). This is supoorted by the fact that the blackening of the photographic plate grows almost linearly with increase in atomic number, and is not proportional to Z^5, as might have been expected from the fact that the effective cross section for absorption of x-rays and production of photoelectrons is proportional[5,6] to Z^5.

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The θ-Meson and the Fermi-Yang Hypothesis

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IN the literature one meets with suggestions that the θ-meson can be considered, in the light of the Fermi-Yang hypothesis,[1] as a composite particle consisting of a nucleon and anti-hyperon (or hyperon and anti-nucleon) in the bound state[2,3]. A few considerations in connection with this concept are set forth below.

1. What spin should the θ-meson possess for this representation? Let us consider the θ-meson as consisting of a nucleon and a $[\Lambda^0]$ particle (the brackets here and henceforth indicate the anti-particle).

Experiments made in the course of studying the correlation between the planes of production and of decay of the hyperons[4,5] indicate that the spin of the hyperon, in all probability, is not less than 3/2. Let us assume that the Λ^0-particle has a spin of 3/2. If one now considers a system of two particles with spin 1/2 and 3/2 existing in a bound state, as pictured by Fermi and Yang[1], then one can show that the normal state of this system has the form $^3S_1$ and has a total angular momentum of 1, that is, the θ-meson appears as a vector particle. This is in complete accord with the decay scheme: $\theta \to 2\pi$ (see, for example, Ref. 6).

If we allow the spin of the Λ^0-particle to be greater than 3/2, then the spin of the θ-meson can be greater than 1. To date no angular correlations have been obtained which would confirm a greater spin for the θ-meson; however, the statistics of these experiments are quite inadequate[4].

As for the isotopic spin of the θ-particle, the model under consideration predicts a half-integral value, consistent with an isotopic spin of 0 for the Λ^0-particle[4]. In addition, the anti-particles

$[\theta^0] = ([n] + \Lambda^0)$ and $[\theta^+] = ([p] + \Lambda^0)$ correspond to the doublet $\theta^0 = (n + [\Lambda^0])$ and $\theta^+ = (p + [\Lambda^0])$ [2].

2. At present, in addition to the Λ^0 hyperon, there exist the hyperon $\Sigma^{\pm}$ and, to all appearances, Σ^0 [4,7] with a mass $\sim 2370\, m_e$, all of which decay into a nucleon and a π-meson. It is natural to consider them as forming an isotopic triplet*. Assuming that these hyperons are excited nucleons, it is natural, in the light of the Fermi-Yang hypothesis, to permit the existence of heavy mesons, each consisting of a system of a nucleon and a $[\Sigma]$. We shall label these hypothetical particles as θ_1. The isotopic spin of the θ_1 particle can be 1/2 or 3/2.

If the difference in mass between the θ_1-and θ-particle exceeds the π-meson mass, then the interaction in which the isotopic spin is directly conserved and which is strong, according to the Gell-Mann scheme[2], leads to the decay $\theta_1 \to \theta + \pi$ with an extremely small lifetime ($\sim 10^{-22}$ sec). (We assume that no "unexpected" exclusion rules exist here.)

If the difference in mass between θ_1 and θ is smaller than the π-meson mass, then an electromagnetic interaction which conserves the Z component of the isotopic spin induces, practically instantaneously, a decay of the form $\theta_1 \to \theta + \gamma$ (analogous to the decay $\Sigma^0 \to \Lambda^0 + \gamma$ [4,7]). Only the θ^{++}-particle may be "stable" (in the case that the isotopic spin of θ_1 equals 3/2 and the emission of a π-meson is forbidden by the energetics).

Note added in proof: After the communication of this letter, the author learned that M.A. Markov[8] considered particles analogous to the θ_1-particle.

* We are not considering the "cascade" hyperon $^-\Xi\,(\Xi^- \to \Lambda^0 + \pi^-)$ since at present there are no experimental data which permit one to make definite conclusions concerning the isotopic spin of Ξ.

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Production of a Nuclear Star and π-Meson by a Gamma Photon

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POMERANCHUK has considered[1] the production of a π-meson pair by a collision between a γ-photon and a nucleus where, in the final state, there was a π-meson pair while the nucleus suffered only a slight recoil. In the present work a process is considered in which one of the mesons of the resulting π-meson pair is absorbed within the struck nucleus and produces a nuclear "star". Thus, one has an unusual mechanism for the creation of nuclear "stars" by γ-photons where, in the final state, one also has a fast π-meson which carries off energy of the order of the total energy of the star. All considerations are ultra-relativistic and only the small angles between the γ-photon momentum and the emitted π-meson momentum play an essential role. For these conditions on the indicated process, distances greater than the dimensions of the nucleus play the same role as in the formation of a free π-meson pair[1,2]. This follows from a consideration of the corresponding integrals and is tied in with the small longitudinal transfer of momentum to the nucleus in the process of pair formation (from the uncertainty relation $\Delta r_{\parallel} \simeq h/\Delta p_{\parallel}$).

The intense interaction of the π-mesons with nuclei implies that the nucleus can be considered, in the first approximation, as "absolutely black" as regards π-mesons.

In this process the absorbed meson exists in the same condition as in the process of γ-photon emission where a meson is absorbed by a nucleus. This process was studied by Landau and Pomeranchuk[3] by a suitably constructed Green's function and by an approximate solution of the corresponding wave equation. An analysis of their resulting expressions indicated, however, that the process can be studied with the aid of a radiation