The condition of isotropy can be written in the form $[A_i, H] = 0$. We note that the components of the quantum-mechanical angular momentum coincide with A_i for $Z = \text{const}$. Using Eqs. (2) and (4), one can carry out a classification of the quantum states of a two-dimensional system according to the representations of the group of plane motions, by expanding the Ψ-function in terms of Bessel functions. Since all of the representations we have found are irreducible, the quantum states of the system turn out to be non-degenerate. Thus β appears as a new quantum number, giving the state of a two-dimensional quantum-mechanical system.

In conclusion, we regard it as our pleasant duty to express gratitude to M. L. Tsetlin and F. A. Ermakov for fruitful discussions.

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Radiographic Study of X-Ray Photoelectric Emission

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A RADIOGRAPHIC method has been applied to the study of the dependence of x-ray photoelectric emission on the atomic number of an element. We used a variant of the "reflection" method[1,2] in the arrangement described below. Samples of various substances were carefully ground and polished. Then a few chosen samples were spread out on a glass plate and paraffin was poured over them. When the paraffin had cooled, the glass plate was removed. This procedure gave a block of samples, the upper surfaces of which were located in a single plane. This block was then pressed against the light-sensitive surface of a photographic plate, placed in an aluminum cassette and the entire system was placed in a beam of hard x-rays (~200 kv) in such a way that the x-rays passed through the photographic plate and fell on the surfaces of the samples which were pressed against the photographic emulsion. Due to the great penetrability of hard x-rays, short exposures do not produce appreciable blackening of the emulsion. On the other hand, the photoelectrons and the secondary electrons ("reflected") connected with them produce a significant blackening, which is especially noticeable when electron-sensitive photographic plates are used.

The blackening of the photographic plate was comparatored (on a microphotometer of type MF-2) at various places in the neighborhood of each of the impressed samples, and the previously measured background blackening was subtracted. Graphs indicated that the blackening of the photographic plate approached the straight line region of the blackening curve.

The following combinations of substances were studied:

1) Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, Se;
2) Mo, Pd, Ag, Cd, Sn, Sb;
3) Ta, W, Pt, Au, Hg, Pb, Bi;
4) Cu, Ag, Au;
5) Zn, Cd;
6) Si, Sn, Pb;
7) Cr, Se, Mo, W;
8) Ni, Pd, Pt.

1)-3) are "horizontal" groups, while 4)-8) are "vertical" groups. In other words, in the first case the block of specimens is made up of elements which increase in atomic number as one goes along a period of the Mendeleev chart, while in the second case the block is made up of elements from a single group of the periodic system. Some of the results of the measurements are given in the accompanying figures (the atomic number of the radiator-element is plotted as abscissa and the blackening, in relative units, is plotted as ordinate.

It is clear from Fig. 1 that the blackening, which characterizes the intensity of emission of photoelectrons and secondary electrons, increases almost linearly with increase in atomic number, as has already been pointed out in the literature[1,2]. Figure 2 shows that there is a sharp decrease in the intensity of the electron emission when one passes from the elements of the first group to those of the second. This result occurs for a transition from copper to zinc, from silver to cadmium, etc., that is, for elements such that 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).

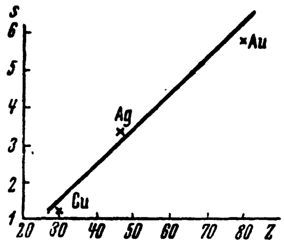

FIG. 1

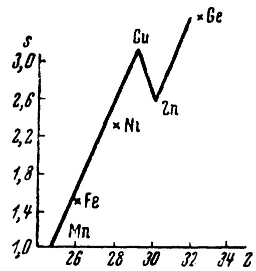

FIG. 2

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: $\theta \rightarrow 2\pi$ (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