ated with a magnetic multipole transition. In this paper the differential coefficient for the particular nuclear transition considered was calculated using Born approximation but without the restriction to nonrelativistic energies. In the overlap region between this paper and the present work, the two results are identical.

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Radiative Capture of Thermal Neutrons without Formation of a Compound Nucleus

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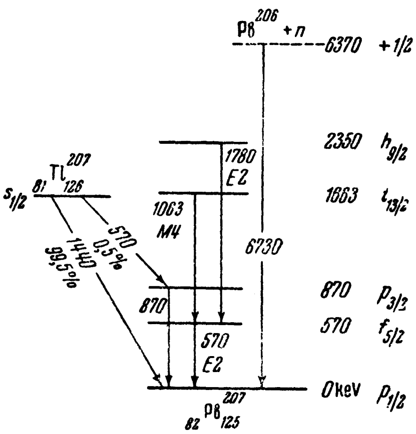
A LARGE amount of experimental data has recently been accumulated in which it is shown that nuclear reactions may take place at low energies of incident particles (1-10 mev) without the formation of a compound nucleus. For example, in reactions of the (d, p), (d, n) and (p, γ) types, the captured particle has little effect on the structure of the nucleus. The state of the resultant nucleus is most frequently affected by the captured particle, which may be located at successive excited levels.[1-8]. This explains the fact that in the reactions (d, p) and (d, n) the probability of exciting successive single-particle levels is considerably greater than for levels of other types.[1-3] In the present note we wish to draw attention to the fact that such a reaction as the radiative capture of thermal neutrons may also apparently take place without the formation of a compound nucleus.

Let us consider the reaction $Pb^{206}(n, \gamma)Pb^{207}$. The lower excited levels of Pb^{207} are well known from various sources [α-decay of Po^{211}, K-capture in Bi^{207}, β^--decay of Tl^{207} and (d, p) and (d, t) nuclear reactions].[9-11] The scheme of these levels and their quantum characteristics are shown in the figure. The ground state of Pb^{207}, in accordance with the experimental value of the spin, must be written as $p_{1/2}$. The 870 kev level is excited in α-decay of Po^{211} and in β^--decay of Tl^{207}. Since Tl^{207} has an $s_{1/2}$ ground level (all odd isotopes of $_{81}Tl$ have spin ½) the 870 kev level must have spin ½ or 3/2. If the spin were 5/2, β-decay to this level would be strongly forbidden ($\Delta I = 2$) and could not be observed. However, this β-transition cannot be an allowed type since the observed intensity of the 870 kev γ-line is small. It is most probably a transition of the first order of forbiddenness. In this case the parity of the 870 kev level is opposed to the parity of the ground state of $_{81}Tl^{207}$ and consequently, agrees with the parity of the ground state of $_{82}Pb^{207}$.



Scheme of the levels of $_{82}Pb^{207}_{125}$. The dashed line represents the state of Pb^{207} resulting from capture of a thermal neutron; the solid lines are established levels of Pb^{207}. $E\,1$ transitions to the $p_{3/2}$ level which are allowed by the selection rules $(+ ½ \rightarrow p_{3/2})$ are not observed.

The absence of a γ-transition from the isomeric level $i_{13/2}$ to the 870 kev level also indicates that the spin of the 970 kev level must be less than 5/2. The shell model[12,13], in agreement with the data mentioned, describes this as a $p_{3/2}$ level. It must be a hole-level since it is completely filled in the ground state of $_{82}Pb^{207}$.

Pb^{207} is obtained from the capture of thermal neutrons by Pb^{206}. Since the ground state of the even-even nucleus Pb^{206} is " + 0 " and the thermal neutron has no orbital momentum, Pb^{207} is formed in a + ½ state. Under these conditions, γ-transitions to the $p_{1/2}$ ground state and the 870 kev $p_{3/2}$ state must be of the electric dipole type (the spin changes by one and the parity changes), and since the energies involved in these transitions, 6.73 mev and 5.86 mev, differ little from each other, they should have almost the same intensity.

In actuality only a γ-transition to the ground state is observed in the capture of a thermal neutron by Pb^{207}.[14,15]. The absence of a γ-transition to the $p_{3/2}$ level can be explained by the fact that the radiative capture of thermal neutrons takes place without the formation of a compound nucleus, as a result of which the excitation of $p_{3/2}$ hole-levels is improbable.

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Possibility of Formation of Penetrating Radiation (μ-Mesons) in the Collision of High Energy Protons with Nuclei

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It is well known that the interaction of slow μ-mesons with nuclei is extremely small[1]. The process of capturing slow μ^--mesons is assumed to be written in the form[2]

$$\mu^- + p \rightarrow \nu + n. \quad (1)$$

Information about the interaction of fast μ-mesons is less certain. In the work in references 3 and 4 it was discovered that for energies exceeding 100 mev, μ-mesons underwent an anomalously greater scattering. The cross section for the anomalous scattering was considerably greater than $10^{-28}cm^2$/nucleon, and is in marked disagreement with the existing theory of scattering of these particles in the Coulomb field of a nucleus with a finite radius. Some authors have assumed that the presence of an anomalous scattering indicates the possibility of a non-coulombic interaction for fast μ-mesons and nuclei.**

The starting point of the present work was the assumption that the anomalously large scattering cross section for μ-mesons was due to a specific nuclear interaction. Such a strong interaction cannot be caused by an extremely small probability process of emission by nucleons of μ and ν particles, i.e., processes which are responsible for reaction (1). Generally speaking, the mechanism of scattering of fast μ-mesons by nucleons cannot appear in processes of absorption of slow μ^--mesons, since the probability of capturing slow μ^--mesons by nuclei is extremely small ($\sim 10^6 sec^{-1}$ for $Z \sim 10$). It is not difficult to see that a strong interaction may be caused by only virtual processes of emission by nuclei of two particles (μ,χ) where the mass of the particle χ may not be less than the μ-meson mass.

It is natural to come to the conclusion that the scattering of μ-mesons depends on the interaction between the nucleon field and the field of a pair of μ-mesons corresponding to the virtual process:

$$(N) \rightarrow (N) + (\mu, \mu) \quad (N\text{—}Nucleon). \quad (2)$$

The possibility of a sufficiently strong pair interaction has already been implied many times[6].

ERRATA
(both of our own and of JETP)

Vol.	Page	Column	Line	Reads	Should read
2	434	2	22	27.3 μ	23.7 μ
2	557	Fig. 10			On the right hand side, abscissa values should read 0, 200 400, 600, 800, 1000.
2	591	2	7	$A = \frac{e^2 H_0^2 \delta_{00}}{mc^2}$	$A = \frac{e^2 H_{00}^2 \delta_{00}^2}{mc^2}$
2	754	1	3 ff.	————	[14] B. B. Kinsey and G. A. Bartholomew, Phys. Rev. **82**, 380 (1951). [15] B. B. Kinsey and G. A. Bartholomew, Phys. Rev. **83**, 234 (1951).
2	771	1	10	Intermediate State	Intermediate State of Tin
	771	1	19	sphere of lead	sphere of tin
3	145	1	1	$R = 10\ ec$	$R = 1/ec$