At that, the core is characterized by a small size $a \approx \hbar/Mc \ll \hbar/\mu_\pi c$.

*Our values for $\rho_\pi(r)$ are substantially different from those of reference 2; however, as was shown in reference 3, the results in reference 2 are in error.

[1] G. Salzman, Phys. Rev. **105**, 1076 (1957).
[2] F. Zachariasen, Phys. Rev. **102**, 295 (1956).
[3] Yennie, Levy, and Ravenhall, Rev. Mod. Phys. **29**, 144 (1957).
[4] Hofstadter, Bummiller, and Yearian, Revs. Modern Phys. **30**, 482 (1958).

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RESONANT SCATTERING OF GAMMA RAYS BY Ni^{60}

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We observed the effect of resonant scattering of gamma rays by Ni^{60} nuclei by a procedure described by us earlier.[1,2] We used a gaseous $CoCl_2$ source. The gamma rays were detected with scintillation counters consisting of organic tolane crystals and FEU-33 photomultipliers. We recorded coincidences between the emitted cascade gamma quanta. The resolution of the coincident circuit was 2×10^{-9} sec.

Nickel and cobalt scatterers were placed alternately in front of one of the detectors. Within the γ-quanta emission-angle interval $180° > \varphi > 126°$ we observed for the nickel specimen an additional absorption of the 133-Mev gamma rays, the absorption being due to resonant scattering. No additional absorption was observed in the cobalt specimen.

We list the experimentally-determined cross sections (in cm^2) of resonant scattering for various angles φ:

φ	180°	150°	90°
$10^{25}\sigma_r =$	3.9 ± 1.2	1.7 ± 1.5	0 ± 1.2

These values agree, within the limits of error, with the σ_r vs. φ curve which we computed theoretically.[3]

The lifetime of the first excited level of Ni^{60} was found to be $\tau = (1.0 \pm 0.3) \times 10^{-13}$ sec (molecular bonds were taken into account in the calculations). This result is in good agreement with that of Metzger,[4] $\tau = (1.1 \pm 0.2) \times 10^{-12}$ sec, and agrees within the limits of error with the result of Alkhazov, Lemberg, et al.[5] obtained by the Coulomb excitation method, $\tau = 5.7 \times 10^{-13}$ sec with a 30% error.

[1] N. A. Burgov and Yu. V. Terekhov, Атомная энергия (Atomic Energy) **2**, 514 (1957).
[2] N. A. Burgov and Yu. V. Terekhov, J. Exptl. Theoret. Phys. (U.S.S.R.) **35**, 932 (1958), Soviet Phys. JETP **8**, 651 (1959).
[3] N. A. Burgov, J. Exptl. Theoret. Phys. (U.S.S.R.) **33**, 655 (1957), Soviet Phys. JETP **6**, 502 (1958).
[4] F. Metzger, Phys. Rev. **101**, 286 (1956).
[5] D. G. Alkhazov and I. Kh. Lemberg, Тезисы IX Всесоюзного совещания по ядерной спектроскопии, (Theses of IX All-Union Conference on Nuclear Spectroscopy) 1959.

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CERTAIN GAMMA TRANSITIONS IN I^{128} *AND IN NEODYMIUM ISOTOPES*

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Using a single-crystal luminescent spectrometer with NaI(Tl) crystal we investigated the gamma radiation produced in radiative capture of thermal neutrons in iodine and in neodymium isotopes. The measurement procedure was described earlier.[1,2]

I^{128}. The emission spectrum of this nucleus contained, in the energy region from 20 to 400 kev, gamma lines with energies 28 ± 2, 135 ± 3, and 158 ± 4 kev. Their respective intensities (percent per captured neutron) were 23 ± 6, 20 ± 4, and 7.5 ± 1.5. The intensities of the 135 and 158-kev gamma quanta were obtained by resolving the summary photopeak, previously[1] ascribed to a single 135-kev gamma line. The 28-kev quanta are the characteristic K radiation of iodine, caused by internal conversion of the gamma rays of the reaction I(n, γ) by the electrons of the K shell of the atom. A comparison of the intensity of this radiation with the theoretical values of the internal-conversion coefficients[3] have made it possible to judge the character of the gamma transitions. The most probable multiplicities of the observed transitions, not in contradiction with the value of the intensity of the characteristic radiations, are E2 for the 135-kev transition and M2 for the 158-kev one. The considerable intensities of the gamma lines indicate that the corresponding transitions take place between low-lying excited levels of I^{128}.

Gamma-line energy (kev)	Gamma-line intensity for natural isotope mixture	Identification of gamma line	Gamma-line intensity (for isotopes)
182 ± 3	2.1 ± 0.4	Neodymium isotopes	
330 ± 10	23 ± 4	Sm^{150}	67
445 ± 10	25 ± 5	Sm^{150} Nd^{146}	40 >40
610 ± 10	20 ± 4	Sm^{150} Nd^{146}	16 ~100
695 ± 10	63 ± 10	Nd^{144}	85 ± 13
840 ± 10	15 ± 3	Nd^{144}	20 ± 4

Nd. The measurements were performed with an Nd_2O_3 target. The energy of the found gamma lines and their intensities, calculated for the natural mixture of isotopes (percent per capture neutron), are listed in the table. The identification of the gamma lines is made difficult by the large number of neodymium isotopes and possible contamination of the target by other rare-earth elements having large neutron capture cross sections. The chemical and mass-spectrometric analysis data indicate that the target contains samarium as an impurity. This makes it possible to attribute the 330-kev gamma line entirely and the 445 and 610-kev lines partially to radiation from the reaction Sm(n, γ).[1,4,5] It follows from the results of Sklyarevskiĭ et al.[6] that the gamma-ray spectra of radiative capture of thermal neutrons in Gd, Dy, and Er contain lines with energies ~180 and 80 — 90 kev, with an intensity ratio ranging from 2 to 5. In the present experiments we found no 80 — 90 kev peak of intensity comparable with that of the 182-kev peak. This means that the gamma quanta causing this peak must be due to the neodymium isotopes. The table contains an identification of the gamma lines, with account of the gamma-quanta intensities, the fractions of the captured neutrons belonging to the individual isotopes, and information on the levels of the neodymium isotopes, obtained by investigating the radioactive nuclei having neighboring values of Z.[7] The intensities of the gamma lines assigned to Sm^{150} were obtained by averaging the data of references 1, 4, and 5.

The 695- and 445-kev gamma rays are due to transitions from the first-excited to ground states of Nd^{144} and Nd^{146} respectively.[7] It is possible that there exist in Nd^{144} and Nd^{146} hitherto-unknown second excited states, with energies 1535 and 1055 kev, and transitions from these to the first excited levels give rise to emission of 840- and 610-kev gamma quanta. In this case the ratios of the energies of these states to the energies of the first levels, $E_2/E_1 = 2.2 - 2.4$, are characteristic of vibrational levels of spherical even-even nuclei.[8]

[1] Ėstulin, Kalinkin, and Melioranskiĭ, J. Exptl. Theoret. Phys. (U.S.S.R.) **32**, 979 (1957), Soviet Phys. JETP **5**, 801 (1957).

[2] Kalinkin, Melioranskiĭ, and Ėstulin, J. Exptl. Theoret. Phys. (U.S.S.R.) **35**, 592 (1958), Soviet Phys. JETP **8**, 410 (1959).

[3] L. A. Sliv and I. M. Band, Таблицы коэффициентов внутренней конверсии гамма-лучей, (Tables of Coefficients of Internal Conversion of Gamma Rays), part 1, M-L, U.S.S.R. Acad. Sci. Press, 1956.

[4] Groshev, Demidov, Lutsenko, and Pelekhov, Атлас спектров гамма-лучей радиационного захвата тепловых нейтронов (Atlas of Spectra of Gamma Rays of Radiative Capture of Thermal Neutrons), M. Atomizdat, 1958.

[5] Fenstermacher, Bennet, Walters, Bockelman, and Schultz, Phys. Rev. **107**, 1650 (1957).

[6] Sklyarevskiĭ, Stepanov, and Obinyakov, Атомная энергия (Atomic Energy) **5**, 454 (1958).

[7] B. S. Dzhelepov and L. K. Peker, Схемы распада радиоактивных ядер (Decay Schemes of Radioactive Nuclei), M-L. U.S.S.R. Acad. Sci. Press, 1958.

[8] G. Sharf-Goldhaber and J. Weneser, Phys. Rev. **83**, 1073 (1955).

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