# TOTAL NEUTRON CROSS SECTIONS FOR LEAD ISOTOPES

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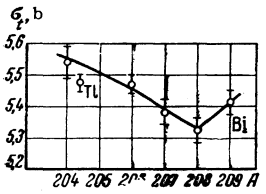
In an earlier investigation[1] we measured the total cross section for the interaction of neutrons with energy 14.2 MeV for the tin isotopes $Sn^{116-120,122,124}$. The nonmonotonicity obtained in the dependence of the cross section on the number of neutrons was connected with the structure of the tin nuclei. A clearer influence of the structure of the nucleus on the total cross sections could be expected if the nuclear shell is filled. Using a procedure described earlier[1,2], we measured the total cross sections on the lead isotopes $Pb^{204,206-208}$, $Bi^{209}$, and Tl.

The measurement results are shown in the figure. The errors indicated are statistical. Control experiments were made to verify the absence of systematic errors connected with the quality of the scatterers, placement of the sample in the beam, etc.




Dependence of total cross section on the mass number of the isotope. The error indicated is equal to the standard deviation.

It is seen from the figure that the influence of the filling of the shell is manifest in the fact that the cross section decreases systematically from $Pb^{204}$ to $Pb^{208}$, and increases on bismuth following the addition of one proton. Such a behavior of the cross section can be attributed to the decrease in the diffuseness of the edge of the nucleus when the shell is filled. The available published data on the differential cross sections for the scattering of protons[3] and $\alpha$ particles[4] by the isotopes of Pb and Bi agree with this assumption. From the curves published by Vanetsian et al.[3] one can see the increase in the differential cross section and the shift of the maxima to the region of larger angles when the scattering angles exceed 90° for $Pb^{208}$ compared with $Pb^{207}$ and $Bi^{209}$. Optical-model calculations show that such a change of the variation of the differential cross section occurs when the parameters describing the diffuseness of the real and imaginary parts of the nuclear optical potential are decreased. An analogous correlation between the total neutron cross section[1] and the changes in the differential scattering cross section of the protons is observed for tin isotopes.

Kerlee et al.[4] measured the dependence of the differential cross section for the scattering of $\alpha$ particles on the energy on isotopes of lead and bismuth. The general behavior of the curves for all the lead isotopes is the same, and the interaction radii obtained from these data coincide. A noticeable difference in the variation of the curves is observed only near the Coulomb barrier, that is, where one can expect a maximum influence of the variation in the diffuseness of the nuclear surface.

If we use the dependence of the total cross section on the width of the diffuse region, calculated on the basis of the optical model[5], we can estimate the decrease in the diffuseness of the edge of the nucleus on going over from $Pb^{204}$ to $Pb^{208}$ to be approximately 0.5 F.

[1] Dukarevich, Dyumin, and Kaminker, JETP 43, 1991 (1962), Soviet Phys. JETP 16, 1403 (1963).

[2] Yu. V. Dukarevich and A. N. Dyumin, PTÉ No. 5, 34 (1961).

[3] Vanetsian, Klyucharev, and Fedchenko, Atomnaya énergiya 6, 661 (1959).

[4] Kerlee, Blair, and Farwell, Phys. Rev. 107, 1343 (1957).

[5] Luk'yanov, Orlov, and Turovtsev, JETP 41, 1634 (1961), Soviet Phys. JETP 14, 1161 (1962).

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