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Warren Fenton Stubbins

October 15, 1958

Printed for the U. S. Atomic Energy Commission

NUCLEON-MOMENTUM DISTRIBUTION IN HELIUM*

Warren Fenton Stubbins

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An analysis of the energy spectrum of neutrons produced by 910-Mev alpha particles in the 184-inch cyclotron striking an internal beryllium target¹ has been made by assuming the nucleons to have a momentum distribution relative to the center of the alpha particle which itself has 0.6 the velocity of light. In the forward direction, at which the neutrons were observed, the elastic collisions between nucleons of helium and beryllium reveal only the momentum distribution in the helium nucleus. A Gaussian momentum distribution for helium nucleons of the form

$$N(p) \propto \exp(-p^2/p_0^2) = \exp(-E/E_0)$$

fits the experimentally determined shape of the neutron spectrum very closely when E_0 is chosen as 5 Mev. This is much less than the expected value.² The quasielastic collisions that occur lower the energy of the observed neutrons by their binding energy so that the computed distribution must be shifted to lower energy by about 10 Mev to coincide with the measured distribution.

Because of the small value above, an independent measurement of the distribution of helium-nucleon momentum was made by the technique of Chamberlain and Segre³ using a liquid helium target. The angular distributions of coincidences between counter telescopes (one was pivoted at the target to vary its angle to the fixed telescope) were obtained for helium and carbon. A comparison shows the angular distribution for helium to be much narrower, about 60 % of that for carbon. This is consistent with the value obtained from the neutron spectrum.

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Work done under the auspices of the U. S. Atomic Energy Commission.

It is suggested by Heckrotte that the neutron distribution may be sharp owing to final-state interactions between the neutrons and the residual nucleons of the alpha particle.⁴ Greider suggests that the carbon angular distribution may be wider than that for helium because in the larger carbon nucleus scattering predicted according to the optical model is greater.⁵ Both these possibilities would increase the estimate of the nucleon internal energies. A tendency for internal nucleon momentum to become small as nuclei become lighter has been observed.⁶

REFERENCES

1. Warren Fenton Stubbins, Bull. Am. Phys. Soc. 3, 335 (1958).
2. John M. Wilcox and Burton Moyer, Phys. Rev. 99, 875 (1955).
3. Owen Chamberlain and Emilio Segrè, Phys. Rev. 87, 81 (1952).
4. Warren Heckrotte (UCRL), private communication.
5. Kenneth Greider (UCRL), private communication.
6. Imhof, Easterday, and Perez-Mendez, Phys. Rev. 105, 1859 (1957).