minute half-life, after subtraction of a long-lived background (~4 percent) and the 40-minute Sn^{123} contribution (~5 percent).

An aluminum absorption curve was run on this activity by making a number of separate identical irradiations of the tin foil and following each decay through a different thickness of aluminum. The absorption curve is shown in Fig. 1. The tin sample used in these irradiations had a thickness of 80 mg/cm². Analysis of the curve as shown in the figure gave a beta-component with a range of approximately 670 mg/cm² of aluminum corresponding to an energy of 1.5±0.2 Mev, plus a gamma-ray background amounting to approximately 3 percent of the beta-counting rate. The beta-ray range and energy were estimated by a Feather analysis, using as reference standard a sample of P^{32} mocked up to resemble the In^{118} source in self-absorption.

There was not sufficient intensity for a lead absorption curve, although measurements taken through 1.0 g/cm² and 4.6 g/cm² of lead gave counting rates equal within experimental error to that of the thick absorber background in Fig. 1.

The In^{119} was identified by 23-Mev irradiation of a sample of tin foil enriched to 95.4 percent in Sn^{120}, followed by dissolution of the foil and precipitation of indium as indium hydroxide from hot 2 M sodium hydroxide solution. The precipitate showed a pure 17.5±1 minute decay. An aluminum absorption curve on a second portion of the irradiated Sn^{120} foil is shown in Fig. 2. A Feather analysis carried out as described above

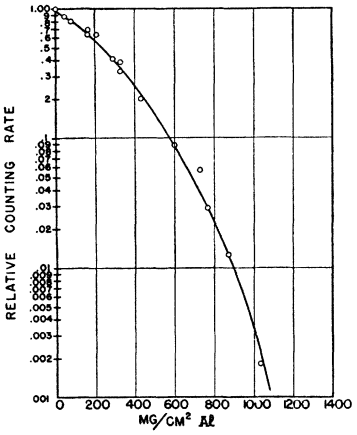

FIG. 2. Aluminum absorption curve of radiation from In^{119}.

gave a beta-range of 1350 mg/cm² of aluminum, corresponding to 2.7±0.2 Mev. Gamma-rays, if present at all, had a counting rate less than 0.001 that of the beta-counting rate.

* Assisted by the joint program of ONR and AEC.

[1] O. Hirzel and W. Waffler, Helv. Phys. Acta **20**, 373 (1947).

[2] The enriched Sn^{119} and Sn^{120} used in this investigation were supplied by Carbide and Carbon Chemicals Corporation, Y-12 Plant, Oak Ridge, Tennessee, and obtained on allocation from the Isotopes Division of the Atomic Energy Commission.

Note on Dirac's Theory of Magnetic Poles

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IN a note bearing the above heading, Professor H. A. Wilson[1] has described a simple method for finding out the value of Dirac's free magnetic poles. I may point out that this method was described by me nearly thirteen years ago[2] in a paper "On the origin of mass in neutrons and protons." I may just quote the result:

"It was Dirac who first showed that quantum mechanics demands the existence of free magnetic poles, having the pole strength (or magnetic charge) $ch/4\pi e=e/2\alpha$, where α=Sommerfeld fine-structure constant. Recently, the present author deduced the existence of free magnetic poles from very simple considerations. If we take a point charge e at A and a magnetic pole μ at B, classical electrodynamics tells us that $A\quad B$ the angular momentum of the system about the line $\overline{AB}$ is just $e\mu/c$. Hence following the quantum logic, if we put this $=\frac{1}{2}\cdot h/2\pi$, the fundamental unit of angular momentum, we have $\mu=ch/4\pi e=e/2\alpha$ which is just the result obtained by Dirac."

[1] H. A. Wilson, Phys. Rev. **75**, 308 (1949).
[2] Ind. J. Phys. **10**, 145 (1936).

Note on Proposed Schemes for Nuclear Shell Models*

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THE two papers by the present writers[1,2] on nuclear shell structure, cover very similar ground, such as assignment of orbital configurations on basis of spins and magnetic moments, statistics of isomerism, and the character of β-transitions. Both papers suggest level schemes to account for the empirically found regularities in nuclear structure. The two schemes are, however, not identical, and even a third proposal has been made by Maria G. Mayer,[3] on basis of the data collected in references 1 and 2. It may thus be of value to explain the relations between these papers.

The basis of all the considerations on shell structure is the observation that the level schemes in a simple potential well give a good account of the regularities of nuclear structure for neutron and proton numbers below 20. Such regularities persist also for heavier nuclei, though they do not correlate with the simple well scheme. These facts suggest, however, that a rearrangement of levels may be successful.

TABLE I. Proposed schemes for nuclear shells.

No. of particles in nucleus	8	20	50	82
No. of particles in shell	2+6	12	30	32
Feenberg and Hammack	$(1s)^2(2p)^6$ $(1s)^2(2p)^6$	$(2s)^2(3d)^{10}$ $(3d)^{10}$	$(4f)^{14}(5g)^{18}$	$(6h)^{22}(4d)^{10}$
Nordheim	$(1s)^2(2p)^6$	$(2s)^2(3d)^{10}$	$(4f)^{14}(3p)^6(4d)^{10}$	$(5g)^{18}(5f)^{14}$
Mayer	$(1s)^2(2p)^6$	$(2s)^2(3d)^{10}$	$(4f)^{14}(3p)^6(5g_{9/2})^{10}$	$(5g_{7/2})^8(4d)^{10}(3s)^2(6h_{11/2})^{12}$
Order of levels in potential well	1s, 2p, 3d, 2s, 4f, 3p, 5g, 4d, 3s, 6h, 5f, 4p, 7i			

In the scheme of Feenberg and Hammack, the rearrangement consists in a pushing up of orbits with radial nodes, such as $2s$, $3p$, $4d$, which progresses more and more for heavier nuclei. Thus, the level scheme is somewhat different for light and heavy nuclei. A qualitative explanation for this tendency is given by the repulsive action of the Coulomb forces on protons, which will cause a decrease in density of nuclear matter at the center of heavy nuclei.

In Nordheim's scheme, the rearrangement is in the opposite sense; that is, radial nodes are not penalized as much as in a potential well. This may also be described as a discrimination against high orbital momentum states. The latter may be caused by the strong interaction between the nuclear particles,