TABLE I. Summary of grain-counting data.

Energy interval, Mev	Average E/μ	Total number of grains	Total length of track (microns)	Grains per 100μ
2–5	7	1613	4778	33.8 ± 0.6
5–10	15	5777	16445	35.1 ± 0.4
10–15	25	7818	22149	35.4 ± 0.3
15–20	35	7933	21997	36.0 ± 0.3
20–25	45	6333	17541	36.1 ± 0.3
25–30	55	4947	13834	35.8 ± 0.4
30–35	65	5764	15732	36.6 ± 0.4
35–45	80	5092	13890	36.6 ± 0.4

in the ionization. The gains have been counted in an effort to detect a corresponding increase in grain density.

It has been found that an experienced observer can count grains consistently, and that the deviations from the mean of the number of grains in intervals as small as 180μ, for all tracks of the same energy and in the same plate, are roughly gaussian.

The grain-counting data for all tracks in the same 5-Mev energy interval have been grouped together and the results are shown in Table I. There is an observable increase in grain density of about 7 percent in the region $E/\mu = 7$ to 40 or 60 after which the density is constant. This is roughly in agreement with the measurements on cosmic-ray particles of Pickup and Voyvodic[7] who report an increase of 10 percent from a minimum at $E/\mu = 3$ to a constant value at $E/\mu = 20$. Our results, like theirs, seem to favor the ionization theory of Wick.[8]

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Energy Response of NaI (Tl) Crystals to Alpha-Particles of Less than 10 Mev*

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RECENT investigation[1] of the response of NaI crystals as scintillation counters of charged particles has shown that, although the light output is essentially linear with energy of incident electrons, protons, and deuterons, there is nonlinearity in the response to alpha-particles of less than 10 Mev. The investigation described here was undertaken to determine in detail the shape of this nonlinearity.

In this experiment, energy control was accomplished by air attenuation and the particles were allowed to strike a freshly cleaved crystal face. To avoid the usual rapid moisture contamination of the crystal surface in the open atmosphere, the entire operation was performed in a dry-box, with signal and high voltage cables brought into the 5819 photomultiplier by means of airtight feed-through connectors. P_2O_5 was used as a drying agent, and no detectable deterioration of crystals cleaved in the box took place in a three-week period.

Two sources of alpha-particles were used, both thin to their own radiations. The first was a "thorium active" deposit yielding alpha-groups at 8.78 Mev and 6.04 Mev from ThC′ and ThC disintegrations, respectively. The second was Pu^{239}, giving 5.16-Mev alphas. Both sources were deposited on the ends of probe rods which passed through a light-tight, sliding seal in the end of the phototube housing. The $1 \times 1 \times 0.1$-cm crystal was held to the tube face by a wire clip, with a drop of mineral oil providing additional optical coupling.

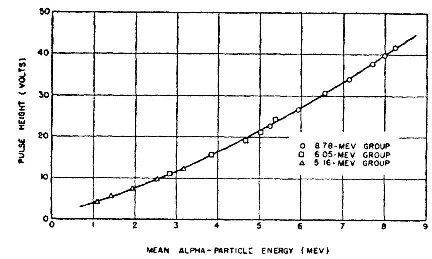

FIG. 1. Mean output pulse height as a function of computed mean energy.

The thorium probe was used in seven positions from 1.00 to 6.00 cm from the crystal, and the Pu source in five positions from 2.00 to 3.62 cm, the near position in each case being the limit at which the source backing reflected a significant amount of light back into the photocathode, producing spurious heightening of output pulses.

Appropriate range corrections for the local atmospheric pressure of 60.2 cm Hg were made, and the mean particle energies were computed from Bethe's range-energy curves.[2]

Output of the 5819 was fed into a low gain preamplifier for polarity inversion, through a Los Alamos model 503 pulse amplifier, and into a continuously variable single-channel pulse-height discriminator. Linearity of the electronic system was checked by applying standard pulses to the phototube anode resistor and observing the corresponding discriminator dial readings. No corrections were found necessary.

In Fig. 1, mean output pulse height for each probe position is plotted against computed mean energy. In every position, the peak of the pulse-height distribution could be determined to within one volt.

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The Hyperfine Structure of $^2P_{1/2}$ State of the Stable Chlorine Isotopes*

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FROM observations of the hyperfine structure (hfs) interaction in an external magnetic field, the nuclear magnetic dipole coupling constants ($a_{1/2}$) for the $^2P_{1/2}$ metastable state of the stable chlorine isotopes have been obtained. As will be shown, the results of these measurements are in excellent agreement with recent work on the ratio of the nuclear magnetic moments of the two isotopes. Use has been made here of the atomic beam magnetic resonance method, as in previous work in the hfs of the $^2P_{3/2}$ state of chlorine.[1,2]

In Fig. 1 the interaction energy of an atom with $I = \frac{3}{2}$ and $J = \frac{1}{2}$ in an external magnetic field is displayed. An estimate of the hfs separation, ΔW, can be had from consideration of the form of the interaction[1,3]

$$\Delta W = h\Delta\nu = 2ha = -\mu_0^2 g_I \mathfrak{F} \frac{4L(L+1)}{J(J+1)} \langle r^{-3} \rangle_{Av},$$

where $\mathfrak{F}$ is a relativistic correction factor of order 1.0 for both the $P_{1/2}$ and $P_{3/2}$ states of chlorine, and the other symbols have their usual meaning. Since the hfs of the $P_{3/2}$ state is known quite accurately, and one may assume $(\langle r^{-3} \rangle_{Av})_{3/2}$ is equal to $(\langle r^{-3} \rangle_{Av})_{1/2}$ to