dominant term in Seitz' expression arises from the second term in his Eq. (25); which can be shown to vanish identically.

On the experimental side, the heat of sublimation can be deduced from the vapor pressure data in the literature,[8] either by using the slope of a vapor pressure plot or by using the third law of thermodynamics together with estimated specific heats for the solid and liquid phases. The two methods do not quite agree, and the second, which gives the lower value, is probably the more accurate. By this method Kelley[9] has obtained a value of 36.1 kcal/mole at 0°K; a more recent but as yet undocumented estimate of 36.5 kcal/mole has been given by the Bureau of Standards.[10]

Table I summarizes the comparison of the theoretical and experimental binding energies. The agreement is closer than the uncertainty in either.

TABLE I. Contributions to the binding energy of lithium.

Theoretical, Silverman and Kohn*	34.5 kcal/mole
Coulomb correction	-0.6
Exchange correction	$-(2.{}_2$ or less)
Correlation correction	$+(4.3$ or less)
Total	$36.{}_0$
Experiment, 0°K	36.5

* See the accompanying erratum by Silverman and Kohn; following a suggestion of Professor Brooks a correction for zero point energy amounting to -0.9 kcal/mole has been added.

I am indebted to Mr. R. A. Silverman for correspondence relating to these calculations and for communication of the corrected results used in Table I.

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[1] R. A. Silverman and W. Kohn, Phys. Rev. **80**, 912 (1950).
[2] T. S. Kuhn and J. H. Van Vleck, Phys. Rev. **79**, 382 (1950).
[3] E. Wigner and F. Seitz, Phys. Rev. **43**, 804 (1933); **46**, 509 (1934).
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[7] C. Herring and A. G. Hill, Phys. Rev. **58**, 132 (1940), Eq. (55).
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[9] K. K. Kelley, U. S. Bureau of Mines Bulletin 383 (1935).
[10] National Bureau of Standards, *Selected Values of Chemical Thermodynamic Properties* (1950).

Erratum: On the Cohesive Energy of Metallic Lithium

[Phys. Rev. **80**, 912 (1950)]

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(Received March 5, 1951)

THE calculations of the letter referred to above were found to contain a numerical error. The corrected Table I of values for the cohesive energy of metallic lithium should now read:

TABLE I.

Method used	Cohesive energy (kcal/mole)
Experimental	36.5
Power series to order k^2	35.2
Variable coefficients using (4)	34.5
Power series to order k^4	35.7
Variable coefficients using (5)	35.4

For the source of the changed experimental value see the letter of Herring in this issue.[1] Furthermore, the theoretical value of Seitz should be changed to 34.5 kcal/mole.

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[1] C. Herring, Phys. Rev. **82**, 282 (1951).

Erratum: Remarks on the Nuclear Resonance Shift in Metallic Lithium

[Phys. Rev. **80**, 913 (1950)]

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(Received March 5, 1951)

CORRECTION of the same numerical error[1] which affected the letter of Silverman and Kohn, Phys. Rev. **80**, 912 (1950), changes the value of P_F to 0.22. The relevant ratio P_F/P_A is thus changed from 1.4 to 1.0.

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[1] R. A. Silverman and W. Kohn, Phys. Rev. **82**, 283 (1951).

Beta-Alpha-Correlation in the Disintegration of Li^8

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BY negative β-decay, Li^8 transforms to Be^8 which is unstable against disintegration into two α-particles. The energy liberated by the entire disintegration $\mathrm{Li}^8\rightarrow 2\mathrm{He}^4+e^-+\nu$ is about 15.8 Mev, and the maximum β-energy (W_0) is about 12.5 Mev.[1] Less than 2 percent of the β-disintegrations go straight to the ground state of Be^8, the rest going to an excited state or states of energy around 3 Mev.[2] There is evidence[3–5] for both the values 0 and 2 for the spin of the Be^{8*}, but the level width is so great (1–2 Mev) that one cannot be entirely certain that there are not two levels present, or, on the other hand, that the properties of a single level of this width need be uniquely defined. Although the two values for the Be^{8*} spin may not be mutually exclusive, however, it would be useful to see what information the $\beta-\alpha$-angular correlation can give on this point, and, incidentally, on the forbiddenness of the β-transition (whether first or second forbidden).

Any evidence of spin 0 would be of a negative character, since it is a general result of angular correlation theory[6] that an intermediate state of spin 0 means a spherically symmetric angular distribution. It remains therefore to examine what predictions can be made about the $\beta-\alpha$ correlation for a Be^{8*} spin of 2 and an assignment of the remaining spins and parities, and of the β-forbiddenness, consistent with the experimental evidence. Bearing in mind that Be^8 must have even parity in both the excited state (spin 2) and the ground state (spin 0), and that the transition to the ground state is clearly more forbidden than the transition to the excited state, we are led to conclude that the only likely β-decay schemes for $\mathrm{Li}^8\rightarrow\mathrm{Be}^{8*}$ are:

(1) $0+\rightarrow 2+$, second forbidden (axial vector interaction);
(2) $3-\rightarrow 2+$, first forbidden (axial vector or tensor interaction).

Each of these schemes would be associated with a third forbidden transition to the ground state of Be^8. Of the two possibilities, one would prefer the first, since it assigns even parity[7] to the Li^8, and a second forbidden transition would seem quite consistent with the "ft" value[3] of 2.8×10^5 for this disintegration, when its exceptionally high energy is taken in account.

The $\beta-\alpha$-angular correlation for schemes (1) and (2) has been investigated by the methods of Falkoff and Uhlenbeck;[8] (1) gives a distribution $I_1(\theta)\sim 1+A_1\cos^2\theta+B_1\cos^4\theta$, and (2) a distribution $I_2(\theta)\sim 1+A_2\cos^2\theta$. By a general result of reference 8, both distributions must become isotropic for the low energy β-particles, and must show greatest anisotropy as the β-energy W approaches W_0. The coefficient A_2 cannot be evaluated explicitly, since it involves the ratio of unknown nuclear matrix elements; A_1 and B_1, however, involve only one nuclear matrix element, which may be dropped as a common factor. These coefficients therefore have been evaluated as explicit functions of W, and tabulated; in the notation of reference 8, $A_1=1/\mu_1(W)$, $B_1=\mu_2(W)/\mu_1(W)$. For $W=W_0$, $I_1(\theta)\sim\cos^2\theta-\cos^4\theta$, and, in fact, even for W down to $\frac{3}{4}W_0$, $I_1(\theta)$ still approximates to a $\cos^2\theta-\cos^4\theta$ distribution in that it has a pronounced maximum near 45° (and 135°). For example, when $W=9.4$ Mev the maximum occurs at 42° and $I_1(0°):I_1(42°):I_1(90°)=2.3:4.9:1.0$. Thus, if only the high energy β-particles are used in the $\beta-\alpha$-correlation experiment, the occurrence of a maximum near 45° in the angular distribution will be a definite criterion for the applicability of scheme (1), since $1+A_2\cos^2\theta$ can never have a maximum between 0° and 90°. If the distribution is anisotropic, but with no maximum between 0° and 90° (at high energies), then we know that scheme (2) applies. An isotropic experimental distribution would, as we have seen, be evidence for an excited Be^8 state of spin 0; it would not be quite conclusive evidence, however, for it could be that we have scheme (2) with the anisotropy of $I_2(\theta)$ too small to be detected. By selecting only the highest energy β-particles for the correlation, experiment, this latter possibility would be reduced to a minimum. Summarizing, then, we conclude that if the $\beta-\alpha$-angular distribution at high β-energies shows any correlation at all, the Be^{8*} has spin 2, and either scheme (1) or scheme (2) applies according as the distribution does, or does not, have a maximum between 0° and 90°. An isotropic distribution probably, but not certainly, means spin 0 for the Be^{8*}.

The work reported above was begun at the Atomic Energy Research Establishment, Harwell, England, in connection with proposed experiments on the $\beta-\alpha$-correlation in the Li^8 disintegration; the writer is indebted to Messrs. J. M. Cassels and T. H. R. Skyrme of Harwell for valuable discussion.

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The Problem of Using Scintillation Crystals as Proportional Counters for High Energy Particles*

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Up to about 10 Mev, close proportionality between the energy of incident particles and light output in scintillation counters is now a well established fact.[1] In the present investigation an attempt has been made to determine whether this proportionality still holds for high energy μ-mesons and whether the energy loss of these particles in the crystal would fit the theoretical formula of Bethe and Bloch.

Lead absorbers were used to select two energy ranges below the energy of minimum ionization including all particles (a) from 29 to 48 Mev, and (b) from 48 to 170 Mev. Particles with energies from 170 Mev upwards constituted a separate group. These energy ranges were selected to give an increase in the energy loss in equal steps (0.7 Mev/g/cm²).

The coincidence pulses of the fourfold Geiger-Müller counter telescope (Fig. 1B) initiated the sweep of an oscilloscope. The pulses from two RCA 5819 photomultipliers, viewing a cylindrical anthracene crystal (both diameter and length 1¼ in.), were delayed and appeared on the sweep together with delayed pulses from Geiger-Müller trays, which determined the range of the mesons through the lead absorbers. Geiger-Müller trays on each side of the telescope prevented shower particles from triggering the sweep.

The aperture of the arrangement was 0.08 steradians, giving an average counting rate of 8 pulses per hour. An additional 16.5-in. lead absorber on top was used to cut off μ-mesons below 580 Mev, thus increasing the counting rate in the ranges for low energies.

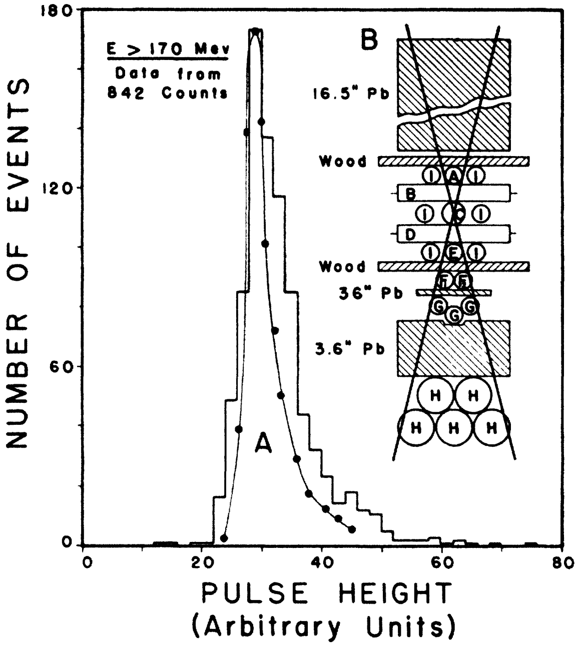

FIG. 1. (A) The histogram shows the distribution of pulse heights found for μ-mesons of energy greater than 170 Mev passing through the phosphor. The smooth curve is the distribution expected on the basis of Landau's theory. (B) Experimental arrangement.

As shown in Fig. 1A, μ-mesons of energy greater than 170 Mev (minimum ionization) passing through the crystal give rise to a pulse height distribution strongly peaked around the mean value of 30.3 Mev. Two conclusions can be drawn:

(1) Because of the rather small spreading out of the pulse height distribution (half-width 20 percent), it is immediately obvious that α-particles and other multiply-charged nuclei should be completely separable from mesons, protons, and electrons.

(2) A possible relativistic increase in energy loss for high energy mesons cannot be deduced directly, because of statistical fluctuations in the ionization process which, according to calculations performed by Landau,[2] are by no means negligible, mainly on account of δ-ray production. This impresses a characteristic skewness on the distribution curve, thus masking the relativistic effect which also tends to produce an appreciable asymmetry. However, some preliminary indication for such an increase might be deduced from the fact that Landau's curve, normalized to pulse height as shown in Fig. 1A, is definitely narrower than the actual distribution obtained by experiment. The difference between the two distributions beyond the maximum (for high energy losses) is quite outside the experimental error of the measurements.

This discrepancy cannot be explained by fluctuations only in the multiplicative effect of the phototubes, which under good conditions for light collection amount to about 5 percent and would certainly affect the distribution equally on either side of the maximum. However, such a difference can be satisfactorily explained on the basis of the Bethe-Bloch formula for ionization loss as corrected by Wick for the density effect, taking into account Wilson's energy spectrum for cosmic rays.

Further experiments are under way to separate, in more direct form, the statistical fluctuations from the expected relativistic rise in ionization. Some indication of an increase up to about 10 percent was reported in photographic plates.[3]

The pulse height distributions in the ranges below minimum ionization energy are broader (Fig. 2), owing to the fact that they result from the superposition of a great many curves similar to