q, the root-mean-square error of the function, are computed by the methods of James and Coolidge. The unit of length is $a_H/9$.

	ϵ minimized	δ^2 minimized
a	0.380	0.3675
c	3.19	3.107
K	1.00162	1.00066
ϵ (ev)	0.049	0.064
δ^2 (ev)^2	$(2.884)^2$	$(2.828)^2$
ρ	1.064	1.055
	$0.017 < q < 0.071$	$0.023 < q < 0.081$

Minimization of δ^2, it will be noted, is rather ineffective in reducing this quantity, and is associated with a relatively much larger increase in ϵ.

From the computed value of ρ and the observed hyperfine splitting of the state one can compute, according to the formulas of Breit and Doermann, the magnetic moment of the Li nucleus. Using the observational results of Granath[3] and the first value of ρ we obtain for Li^7 the magnetic moment 3.28 ± 0.03 nuclear magnetons, while with the second value of ρ we obtain 3.305 ± 0.03. (The estimated uncertainties arise principally from the uncertainties in ρ, as discussed by Breit and Doermann.) These values are to be compared with the value 3.265 ± 0.016 given by the new and completely independent method of Rabi and his co-workers.[4]

These results indicate that an attempt to improve the accuracy of the determination of the nuclear magnetic moment of Li by the h.f.s. method should be based on the determination of a more accurate wave function by the conventional variational method, rather than by minimization of δ^2.

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On Pre-Breakdown Phenomena in Insulators and Electronic Semi-Conductors

It is well known that insulators and electronic semiconductors display in high electric fields E (over 10^5 volts/cm for the former and a few thousand volts/cm for the latter) an increase of electrical conductivity which finally leads to breakdown, and which is approximately representable by $\sigma=\sigma_0 e^{\alpha E}$ (Poole's law). The fact that the illumination of an electronic semi-conductor results in an additional increase of the conductivity *independent of E* shows that the increase of electrical conductivity in intense fields is due to the increase of the number of free electrons, and not of their mobility.

This phenomenon can be explained very simply if the dielectric (or semi-conductor) is described not as a system of free electrons moving in a self-consistent periodic field of force, but simply as a system of neutral atoms. This refers, of course, to the normal state in which there are no free electrons. After the ionization of an atom, the electron can be described as moving freely in the surrounding medium consisting of neutral polarizable atoms and in the field of the remaining positive ion. Since this field is screened by the polarization of the surrounding atoms, the ionization energy must be decreased in the ratio $\epsilon : 1$ where ϵ is the electronic component of the dielectric constant (i.e., the square of the refractive index n for ordinary light).

In an external field E this energy is further decreased by a mechanism similar to that of the Schottky effect in the thermoelectronic emission from metals. In Fig. 1 the

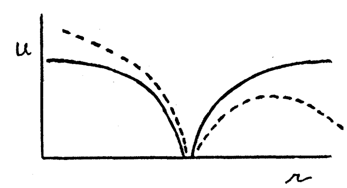

FIG. 1. Potential energy as a function of distance from the positive ion. Full line, without an external field, dotted line in the presence of the field.

full line represents the normal potential energy of the electron as a function of the distance from the positive ion while the dotted line represents the same quantity in the presence of the field. The height of the potential barrier is lowered in the field by the amount

$$\Delta U = eEr_0 + e^2/\epsilon r_0,$$

where r_0, the distance to the maximum from the ion, is given by $e^2/\epsilon r_0^2 = eE$. Thus $r_0 = (e/\epsilon E)^{\frac{1}{2}}$ and

$$\Delta U = 2eEr_0 = 2e(eE/\epsilon)^{\frac{1}{2}}.$$

Now if, in the absence of the electric field, the number of free electrons due to the *thermal* ionization of the atoms, is proportional to $\exp(-U_0/2kT)$, where U_0 is the ionization energy (decreased in the ratio $\epsilon : 1$ compared with an isolated atom), the electrical conductivity in the presence of the field will be proportional to

$$\exp[-(U_0-\Delta U)/2kT].$$

We thus obtain

$$\sigma = \sigma_0 \exp[(e^3E/\epsilon)^{\frac{1}{2}}/kT],$$

differing from Poole's law by the substitution of $E^{\frac{1}{2}}$ for E.

This is in excellent quantitative agreement with the experiments of P. Granovskaja[1] on the electrical conductivity of mica in intense fields (over 10^6 volts/cm) as well as with the (still unpublished) experiments of Joffé on the pre-breakdown phenomena in electronic semi-conductors (up to field strengths of the order of 50,000 volts/cm). It is interesting that on the above theory the effect of the field is *reduced* by the elevation of the temperature, just as is observed experimentally. It should be mentioned that with $E=10^6$ volts/cm, and $n=2$, the distance r_0 is of the order of 30A; i.e., about ten times the interatomic distance. At smaller distances the electron is therefore still attached to the parent ion, just as if there were no neutral atoms between them.

It can be shown that the mechanism of facilitated thermal ionization described above is more effective, both for dielectric and semi-conductors, than the mechanism of electrostatic ionization, which gives an additive (and not a multiplicative) effect proportional to

$$\exp\left[-4\pi(2m)^{\frac{1}{2}}U_0^{\frac{3}{2}}/heE\right]$$

unless the temperature falls below 50–60°K for insulators, or below a few degrees for semi-conductors. Further details of the theory will be published in *Technical Physics* of the U. S. S. R.

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Leningrad, U. S. S. R.
August 10, 1938

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