is itself dependent on the state so that, by a suitable choice of the A- and B-electric fields, it is possible to refocus a single electric state (quantized orientation of the angular momentum vector for a single rotational state). The effective induced moment of the 1, 0 state is positive at high fields (in the A-field) and negative at low fields (in the B-field). The states 0, 0 and 1, ±1 do not have this property. Furthermore, the effective induced moment in a given electric field is inversely proportional to R^2 and the higher rotational states, therefore, have small effective moments relative to that for $R=1$. The function of the wire is to stop all molecules of small effective moment, the overwhelming fraction, which are not susceptible to refocusing operations. The relative population of the low rotational states is small and only 0.01 percent of the total beam is refocused at any one time. Relative electric moments for all orientations of the three lowest rotational states were obtained from a relationship derived by Lamb[6] which is good for all values of λ.

Between the refocusing A- and B-fields the beam passes through a homogeneous C-field wherein a superimposed radiofrequency electric field, normal to the d.c. component, induces transitions between electric levels. After this transition the molecules are in a new electric level with a different, indeed reversed effective electric moment in the B-field, and they are no longer refocused. This is observed by a decrease in the beam when the oscillator frequency equals the energy separation of the levels divided by Planck's constant. (Fig. 1.)

Further details will be discussed in a forthcoming article in *The Physical Review*.

This research was proposed to me by Professor I. I. Rabi and executed under his direction. I am also under obligation to several other members of the physics department. In particular, Professor P. Kusch gave me guidance during the last stage of the work and, with Dr. J. Trischka, assisted in the collection and evaluation of the data.

* Publication assisted by the Ernest Kempton Adams Fund for Physical Research of Columbia University.
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[2] See, for example, R. de L. Kronig, Proc. Nat. Acad. Wash. 12, 608 (1926).
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[6] Professor W. E. Lamb, private communication.

Secondary Emission from Germanium, Boron, and Silicon

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September 9, 1946

MEASUREMENTS of secondary emission were made on the semi-conductors germanium, boron, and silicon. No previous measurements on germanium or boron are given in the literature.

The silicon and germanium were cut from very pure vacuum melts which had been prepared in the laboratory for crystal rectifier studies. The boron was deposited on
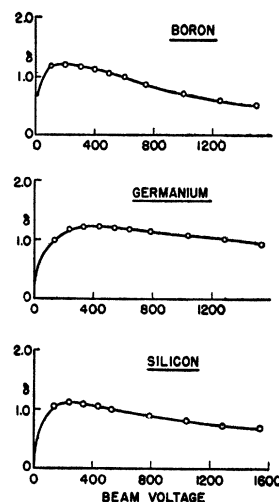

FIG. 1. Secondary emission from boron, germanium, and silicon.

an iron disk by thermal decomposition of boron hydride.

The measurements were made in an electron gun type of tube. The electron beam was focused on the target through a hole in a cylindrical collector surrounding the target. The primary velocity was varied from 100 volts to 1500 volts. The beam current was 10^{-5} amp. and the spot diameter approximately 1 mm. The collector was held at $+40$ volts with respect to the target.

The measurements were made in tubes while on the pump at a pressure of 10^{-6} to 10^{-7} mm. The germanium and silicon were heated by high frequency to dull red before making measurements. The boron only received a 425°C bake out as at higher temperatures there was a possibility of interdiffusion of the iron and boron.

The maximum values of δ (the secondary to primary ratio) and the primary voltage at which they occur are as follows:

	S	V
Boron	1.2	150
Germanium	1.2	400
Silicon	1.1	250

The relation between δ and primary voltage for the three surfaces is given in Fig. 1.

Conductivity of Metal-Amine Solutions

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September 20, 1946

IT has been reported recently by Ogg[1] that when a solution of sodium in liquid ammonia, in the concentration range which yields two liquid phases, is rapidly frozen, a large decrease in resistance occurs. The writer has observed this decrease in resistance by a current-potential method, and has found in agreement with the work of Daunt, Désirant, Mendelssohn, and Birch[2] that the small resistance of the frozen solution resided in the solid itself and not in the solid-electrode contact. It is still possible that this resistance is a property of the contacts between

the pieces of badly cracked solid, and that uncracked pieces are super-conducting.

The potassium methylamine system has been reported[3] to separate into two liquid phases at concentrations higher than $0.01N$. The writer has observed this effect with methylamine to which several percent of ammonia has been added but not with pure methylamine. Rapid freezing of these solutions has yielded changes in resistance similar to those occurring in the sodium-ammonia system. When a $0.05N$ solution of potassium in ten to one methylamine-ammonia was rapidly chilled from 260°K to 90°K and then "healed" at 170°K (ten degrees below the melting point of the mixture), the resistance dropped from a value of 700 ohms at the highest temperature to a steady value of 0.3 ohm in the solid state. The solid possessed a lustrous, metallic, blue-gray appearance. When this solid was melted, two liquid phases, one blue and one bronze, resulted; the resistance of this mixture at a temperature just above the melting point was 2600 ohms.

Ogg has suggested an interpretation of the great decrease in resistance in the sodium-ammonia system in terms of a Bose-Einstein condensation of electron pairs. While the decrease for the above solutions occurs at a temperature well below the B-E condensation temperature for an ideal gas of density corresponding to the concentration of the solution, the discontinuity in resistance of the potassium methylamine-ammonia system occurs at a somewhat higher temperature than the corresponding B-E condensation temperature. For a solution $0.05N$ in potassium ($0.025N$ in electron pairs) the corresponding condensation temperature would be about 90°K, while the decrease in resistance occurs at about 180°K.

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On the Level Scheme of Mg^{24} and the Mass of Na^{24}

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SIEGBAHN has recently reported[1] the γ-ray spectrum associated with the disintegration of Na^{24} to consist of two lines, one at 1.38 Mev and the other at 2.76 Mev. In determining the corresponding level scheme of Mg^{24}, he assumes that these γ-transitions are in cascade. It has already been pointed out[2] that this assumption leads to a mass for Na^{24} which is undesirably high compared to the masses of similar nuclei in the same part of the periodic table. In particular, the mass of 23.99893 given by Siegbahn is about 1.5 Mev greater than that calculated by Barkas[3] for Na^{24}.

Although this is by no means certain evidence that the level assignment is wrong, it should be kept in mind that it is possible to construct a level scheme consistent with the data and giving a mass of Na^{24} which is in close agreement with the Barkas value. In this scheme,[2] it is assumed that the two levels of Mg^{24} are at 1.38 Mev and 2.76 Mev.

Then the 1.38 γ-ray would actually consist of two cascading γ-rays of very nearly equal energy and the 2.76 radiation would be produced by a direct transition from the higher level to the ground state. This assumption is in good agreement with the results of Wilkins[4] and of Dicke and Marshall[5] on the inelastic scattering of protons by Mg. The level at 1.30 Mev obtained by Little, Long, and Mandeville[6] from the inelastic scattering of neutrons on Mg also agrees reasonably well with this scheme. The corresponding mass of Na^{24} would be 23.99745.

In this alternate scheme, the intensities of the radiations of different energies would not be expected to be equal so the application to the determination of the efficiency curve of G-M counters proposed by Siegbahn[1] would not be possible.

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Expanding Universe and the Origin of Elements

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September 13, 1946

IT is generally agreed at present that the relative abundances of various chemical elements were determined by physical conditions existing in the universe during the early stages of its expansion, when the temperature and density were sufficiently high to secure appreciable reaction-rates for the light as well as for the heavy nuclei.

In all the so-far published attempts in this direction the observed abundance-curve is supposed to represent some equilibrium state determined by nuclear binding energies at some very high temperature and density.[1–3] This point of view encounters, however, serious difficulties in the comparison with empirical facts. Indeed, since binding energy is, in a first approximation, a linear function of atomic weight, any such equilibrium theory would necessarily lead to a rapid exponential decrease of abundance through the entire natural sequence of elements. It is known, however, that whereas such a rapid decrease actually takes place for the first half of chemical elements, the abundance of heavier nuclei remains nearly constant.[4] Attempts have been made[2] to explain this discrepancy by the assumption that heavy elements were formed at higher temperatures, and that their abundances were already "frozen" when the adjustment of lighter elements was taking place. Such an explanation, however, can be easily ruled out if one remembers that at the temperatures and densities in question (about 10^{10}°K, and 10^6 g/cm³) nuclear transformations are mostly caused by the processes of absorption and re-evaporation of free neutrons so that their rates are essentially the same for the light and for the heavy elements. Thus it appears that the only way of explaining the observed abundance-curve lies in the assumption of some kind of unequilibrium process taking place during a limited interval of time.