age is to reduce the number of electrons caught and to increase the sharpness of the pattern. On decreasing the bombarding potential without altering the ratio of retarding to bombarding potential the lateral maximum moves away from the primary beam toward the plane of the target, and the ratio of the intensity of this maximum to that of the other becomes greater.

In attempting to interpret these results we have been led to consider the scattering of electrons by a positive nucleus of limited field, one for which the central force on an electron is Ee/r^2 for values of r less than ρ, and zero for all values of r greater than ρ. Such a field would exist for a concentrated positive charge E surrounded by a spherical shell of uniformly distributed charge $-E$ and of radius ρ. The field of a system comprising a central positive nucleus of n electronic charges surrounded by n electrons uniformly distributed over the surface of a sphere of radius ρ will also be roughly of this nature, provided n is not too small. Neglecting the change of mass of the bombarding electrons while traversing the field within the shell it turns out that when such a system is under random bombardment by electrons approaching on parallel lines, the number of these emerging per unit solid angle in a direction making an angle Ψ with the path of the incident beam is given by

$$I_\Psi = K\left(\frac{2\beta-1}{(2\beta-1)^2(1+\cos\Psi)+(1-\cos\Psi)}\right)^2,$$

where

$$\beta = \frac{V\rho}{E},$$

V being the potential drop through which the bombarding electrons have acquired their speed.

An examination of this expression shows that when β is very large the intensity of scattering will be small in all directions except in and near the direction $\Psi = \pi$, that is, in the direction of motion of the incident electrons. As β decreases the emerging electrons are less concentrated in this direction. For $\beta = 1$ the distribution becomes entirely independent of angle. As β decreases from unity to the value one half the scattered electrons become more and more concentrated in and near the direction $\Psi = 0$, the intensity in this direction being infinite for $\beta = 1/2$. For values of β less than 1/2 the distribution curves for the range $1 > \beta > 1/2$ are identically repeated, the distribution approaching uniformity in all directions as β approaches zero.

For a neutral system of two or more concentric shells the distribution will be broken up into various beams or lobes corresponding to groups of electrons whose trajectories pass through one, two or more of the shells. In particular a system comprising two shells will give, in an appropriate range of bombarding potentials, distribution curves similar to that shown in Fig. 1.

All of the main features of the distribution curves so far observed for the scattering from nickel seem reasonably accounted for on the supposition that a small fraction of the bombarding electrons actually do penetrate one or more of the shells of electrons which are supposed to constitute the outer structure of the nickel atom and, after executing simple orbits in a discontinuous field, emerge without appreciable loss of energy.

If the theory of the scattering here proposed proves to be the correct one, there seems no reason why the careful study of such distribution curves as shown in Fig. 1 may not reveal much of interest concerning the disposition of electrons within the atom. It is hoped to report more extensively on this work in the near future.

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THE ATOMIC WEIGHT OF BORON

The application of positive-ray analysis by Aston[1] has yielded the evidence of existence of two isotopes of boron with atomic weights 10 and 11, in accordance with the prediction of Harkins.[2] Although the result of Smith

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[1] *Phil. Mag.*, *40*, 628 (1920).

[2] *Jour. Amer. Chem. Soc.*, *42*, 1988 (1920).

and van Haagen's[3] recent determination of the atomic weight of boron, 10.900, indicates the proportions of these isotopes as nearly 1 to 9, the relative intensities of the positive-ray spectra[4] point to a considerably larger proportion of the lighter isotope. Since we have redetermined the atomic weight of boron by analysis of the chloride and bromide, and have obtained a result more nearly in accord with Aston's experiments than with those of Smith and van Haagen, it seems advisable to state the outcome of our preliminary experiments, without waiting for the completion of the investigation.

Boron was obtained by reduction of boric oxide with an excess of magnesium and extraction with either hydrochloric or hydrobromic acid. To prepare the chloride, dry chlorine was passed over the boron at about 700°. To prepare the bromide, helium saturated with bromine nearly at the boiling point of the latter substance was passed over boron at 700°. After removal of the excess of halogen with mercury both halides were repeatedly distilled with the use of Hempel fractionating columns in sealed all-glass vessels, with complete exclusion of air. Quantitative testing even before the completion of the fractionation showed the absence of silicon halides which constituted the worst impurity. Material was collected for analysis in sealed glass bulbs. Analysis was effected by comparison with silver in the usual way.

The results of the analysis of the chloride agree with those of the bromide in yielding the value 10.83 ± 0.01 for the atomic weight of boron. On the assumption that constant boiling mixtures with the halogen acids were not formed and that no separation of the eight possible combinations of two isotopes of both boron and chlorine took place, this new value for the atomic weight of boron indicates the proportion of the heavier isotope to be about five times that of the lighter.

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(*Continued*)

Isomeric alkyl-pyrimidines and color phenomena: ARTHUR W. DOX AND LESTER YODER. A series of alkyl-diketo-pyrimidines was prepared by condensing alkyl-malonic esters with amidines. In this series four types of isomerism occur, of which the following derivatives are examples: (a) 5-butyl and 5,5-diethyl; (b) 5-phenyl-2-methyl and 5-methyl-2-phenyl; (c) 5-isoamyl-2-phenyl and 5,5-diethyl-2-p-tolyl; (d) 5-allyl and cyclobutane-1,5-spiro. Some of these derivatives are white, others are bright yellow. Color is dependent upon the presence of an aromatic group on the 2-carbon and a labile hydrogen on the 5-carbon. The latter makes possible a rearrangement into a tautomeric enolic form with three double linkages in the ring. The only exception to the color rule is the spiro derivative, which is yellow. Spectroscopic examination of a typical yellow derivative showed an absorption band in the violet between 260 and 330 $\mu\mu$.

An octet formula for benzene: ERNEST C. CROCKER. Proposed formula is ring of six carbon atoms acting as single complex atom. Individual carbons bonded together by sharing single pairs of electrons (single bonds), with hydrogens associated with pairs of electrons, as usual. The six excess electrons of system are "aromatic" electrons, and vibrate between the carbons, in unison. "Aromatic" electrons cause two distinct patterns, o.p., and m., according to the influence of substituents in the ring. The theory accounts well for mono, di and tri substitution products of benzene. It accounts for aromatic structure in general; particularly thiophene, furane, pyrrol, naphthalanene, and anthracene.

Diisopropylhydrazine. J. R. BAILEY, W. A. NOYES AND H. L. LOCHTE. Diisopropylhydrazine can be easily prepared by treating a solution containing acetone, hydrazine chloride, gum arabic and colloidal platinum with hydrogen under pressure. Dimethylketazine $(CH_3)_2C{:}N—N{:}C(CH_3)_2$ is at first formed and this is reduced to diisopropylhydrazine, $(CH_3)_2CHNHNHCH(CH_3)_2$. The latter is a monacid base, which forms stable salts. The free base is very easily oxidized, even by exposure to the air, probably forming an azo compound. The investigation of this and other relations will be continued.

The chlorination products of formanilide: W. LEE LEWIS AND R. S. BLY. When formanilide is chlorinated in the presence of chlorides of sulfur

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[3] Car. Inst. Pub., No. 267 (1918).

[4] Aston, *loc. cit.*