just been published[2], show that the proportion of low-energy electrons in a shower from lead is exceedingly large. Thus Jánossy's estimate of 50 per cent for the number of shower electrons which penetrate the chamber wall appears quite reasonable, even though the thickness of this wall is only 0·6 gm.cm.$^{-2}$. However, the production of electrons in the chamber wall by photons from the lead may appreciably reduce the effective absorption. If we do not take this last effect into account, and if we apply the results given by Bhabha and Chakrabarty in their most recent publication[3], we obtain for E_0 a value of 13·5 BeV. This value is arrived at by considering electrons which travel perpendicular to the chamber axis and which traverse on the average 2·8 cm. of lead thickness. Electrons arriving at an oblique angle traverse a greater thickness of lead, and their shower particles travel a longer path in the chamber. Both effects reduce the value of the electron energy corresponding to a given burst size. The correction to E_0 for the effect of oblique incidence is not easy to compute. At any rate, it appears as if Jánossy's estimate of 20 BeV. for E_0 may be excessive, and a value of 10 BeV. such as given at the Pasadena Symposium may represent a more likely estimate.

(3) Low-energy cut-off of the primary spectrum. Balloon experiments of Millikan, Neher and Pickering[4] by means of cosmic ray telescopes failed to reveal any change of the vertical intensity at latitudes greater than 45°. This places the cut-off energy at a value higher than 4 BeV., rather than at 2 BeV., as quoted by Jánossy. (At 45° the limiting energy corresponding to the Størmer cone is 3·8 BeV., that corresponding to Lemaître and Vallarta's main cone, 6 BeV.)

On the basis of the above considerations, one would obtain from our measurements an upper limit of about 11 per cent for the number of electrons in the primary radiation. However, we are very hesitant about this figure, especially because of the great uncertainty of the shower theory for heavy elements.

In conclusion, it is our present opinion that the question concerning the existence of electrons in the primary cosmic radiation is still open and can only be settled by further experiments. One of these experiments, directed at obtaining information as to relative contributions of electron showers and of nuclear interactions to the ionization bursts observed at high altitude under lead, is at present under way.

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[1] *Rev. Mod. Phys.* (in the press).

[2] Richards and Nordheim, *Phys. Rev.*, **74**, 1106 (1948).

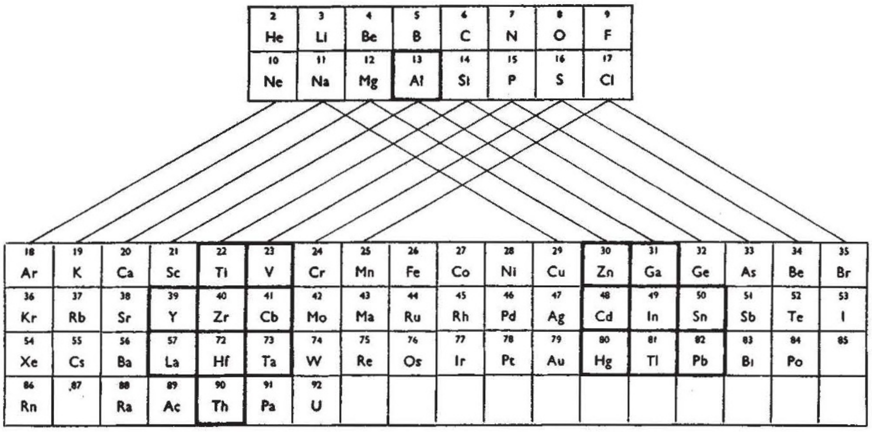
[3] Bhabha and Chakrabarty, *Phys. Rev.*, **74**, 1352 (1948).

[4] Millikan, Neher and Pickering, *Phys. Rev.*, **67**, 234 (1943).

Theory of Superconductivity

IN two previous notes[1], Prof. Max Born and I have shown that one can obtain a theory of superconductivity by taking account of the fact that the interaction of the electrons with the ionic lattice is appreciable only near the boundaries of Brillouin zones, and particularly strong near the corners of these. This leads to the criterion that the metal should be superconductive if a set of corners of a Brillouin zone is lying very near the Fermi surface, considered as a sphere, which limits the region in the momentum space completely filled with electrons.

It will now be shown that this theory affords an explanation of the fact that the superconductive elements lie exclusively in two columns of the periodic table. In the accompanying table they are marked in rectangular blocks, showing that they lie on either side of the so-called 'transition metals'. These metals are characterized by the fact that in going from one to the next along the periodic table, electrons begin to fill the inner zones which previously remained vacant. Thus the bordering columns must have one of the lower Brillouin zones either completely vacant or just filled ; then the necessary condition of superconductivity that the Fermi surface touches the corners of a Brillouin zone will be satisfied.



2 He	3 Li	4 Be	5 B	6 C	7 N	8 O	9 F
10 Ne	11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl

18 Ar	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Be	35 Br
36 Kr	37 Rb	38 Sr	39 Y	40 Zr	41 Cb	42 Mo	43 Ma	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I
54 Xe	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85
86 Rn	87	88 Ra	89 Ac	90 Th	91 Pa	92 U											

Periodic table: two columns of superconducting elements, marked in rectangular blocks

From these considerations we can deduce a rule regarding the superconductive alloys and compounds. An alloy formed of two elements from different sides of the superconductive columns will have a better chance of being superconductive than any other alloy. The reason is that the lower Brillouin zone for one element is nearly filled, while for the other element it is rather more than filled, and the combination of them (obtained by forming the alloy) satisfies the requirement of superconductivity. For example, alloys like $BiAu_2$, CuS, which are formed from two elements from either side of the superconductive columns, will be superconductive themselves, though both elements are not.

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[1] *Nature*, **161**, 968 and 1017 (1948).