LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Structure of Cobalt

POWDER photographs of hexagonal cobalt do not always have consistently sharp lines, and the variation of sharpness is not explainable by internal strains or by small particles of unusual shapes. This may be seen from the following table of visual estimates of the breadths of the various lines on a photograph taken with nickel $K\alpha$ radiation.

$h\ k\ i\ l$	Description	$h\ k\ i\ l$	Description
$1\ 0\ \bar{1}\ 0$	sharp	$1\ 1\ \bar{2}\ 2$	sharp
$0\ 0\ 0\ 2$	sharp	$2\ 0\ \bar{2}\ 1$	broad
$1\ 0\ \bar{1}\ 1$	broad	$0\ 0\ 0\ 4$	sharp
$1\ 0\ \bar{1}\ 2$	broad	$2\ 0\ \bar{2}\ 2$	very broad
$1\ 1\ \bar{2}\ 0$	sharp	$1\ 0\ \bar{1}\ 4$	very broad—almost invisible
$1\ 0\ \bar{1}\ 3$	very broad		
$2\ 0\ 2\ 0$	sharp	$2\ 0\ \bar{2}\ 3$	very broad

We have examined the problem by means of powder and oscillation photographs and have found that the following theory is capable of explaining the observations.

It is well known that the close-packed structures can be derived from three types of close-packed planes of atoms; the co-ordinates with respect to the two hexagonal axes of the atoms in each plane are:

$$(0, 0) \ldots A\,; \quad (1/3, 2/3) \ldots B\,; \quad (2/3, 1/3) \ldots C.$$

In a normal hexagonal structure only two of these types are used, thus: *ABABAB* . . ., but it is easy to see that faults may arise and that the sequence may change to *CBCBCB* . . ., or to *ACACAC* . . . If such faults occur frequently the structure will be irregular, but certain sets of planes, such as the (0001)'s, will obviously remain perfect. In general, all sets of planes with $(h\text{-}k)/3$ integral will be perfect, and this is in accordance with the observations in the accompanying table.

From the broadening of the lines an estimate of the degree of imperfection can be made, and it was found that in the specimen which was examined the probability of a mistake occurring was as high as 1/10.

The same kind of theory is applicable to other problems, notably the broadening of the superlattice lines in $AuCu_3$ due to the presence of small 'anti-phase domains' in single crystals.

A more detailed account of the work on cobalt will be published elsewhere.

O. S. EDWARDS.
H. LIPSON.
A. J. C. WILSON.

Cavendish Laboratory,
Cambridge.
July 14.

Wave Form of Atmospherics

SEVERAL investigators[1,2,3] have shown that an atmospheric often has a characteristic 'slow tail' of a few milliseconds' duration, in addition to the customary wave train of a few cycles of frequency about 10^4 cycles per second. The latter has been associated with the return stroke of the lightning discharge, and precision has recently been given[4] to this suggestion by the calculation of the amplitude and duration of one cycle of this wave from the characteristics of the return stroke, the remainder of the wave being presumably due to reflexions from the ionosphere[5].

As to the 'slow tail', Appleton and Chapman[2] have suggested that this is connected in some way with the slow *c* portion of the lightning discharge. A study of the electrostatic field changes caused by near strokes recorded by these authors[2], however, suggests that the 'slow tail' is the result of the radiation due to the destruction of electric moment during both the *a* and the *c* portions of heavy strokes, an explanation which is supported by the occurrence of the high-frequency radiation due to the *b* portion within the 'slow tail', observed at relatively near distances[1]. The durations involved are obviously of the right order, being in each case a few milliseconds. As to the amplitude, my theory[6] of the increasing corona current as the leader stroke approaches the earth yields, from the relation

$$\varepsilon_r = \frac{1}{c^2 r}\ \frac{d^2 M}{dt^2},$$

a final value of the order of 10 or 20 millivolts/metre for the radiation field due to the *a* portion at 100 km., assuming that the corona current increases as the square of the voltage. During the *c* portion a charge of the order of 10 coulombs often flows from cloud to earth in a time of the order of 3 milliseconds[4]. If this charge is initially at a height of 2·5 km., and if its electric moment is destroyed exponentially, which the aforementioned records[2] show to be approximately the case, then the above relation yields a crest value for ε_r at 100 km. of the order of 70 mv./m. These values compare well with the observed value of 125 mv./m. at 100 km.[1].

It would thus appear that the 'slow tail' represents the radiation resulting from the destruction of the electric moment during the *a* and *c* portions of a lightning stroke.

C. E. R. BRUCE.

British Electrical and Allied Industries
Research Association,
15 Savoy Street, W.C.2.
July 18.

[1] Watt, R. A. W., Herd, J. F., and Lutkin, F. E., *Proc. Roy. Soc.*, A, **162**, 267 (1937).
[2] Appleton, E. V., and Chapman, F. W., *Proc. Roy. Soc.*, A, **158**, 1, (1937).
[3] Laby, T. H., McNeill, J. J., Nicholls, F. G., and Nixon, A. F. B., *Proc. Roy. Soc.*, A, **174**, 145 (1940).
[4] Bruce, C. E. R., and Golde, R. H., *J. Inst. Elect. Eng.* (in the press).
[5] Schonland, B. F. J., Elder, J. S., van Wyk, J. W., and Cruickshank, G. A., NATURE, **143**, 893 (1939).
[6] Bruce, C. E. R., NATURE, **147**, 805 (1941).