Letters to the Editor.

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The Scattering of Electrons by a Single Crystal of Nickel.

IN a series of experiments now in progress, we are directing a narrow beam of electrons normally against a target cut from a single crystal of nickel, and are measuring the intensity of scattering (number of electrons per unit solid angle with speeds near that of the bombarding electrons) in various directions in front of the target. The experimental arrangement is such that the intensity of scattering can be measured

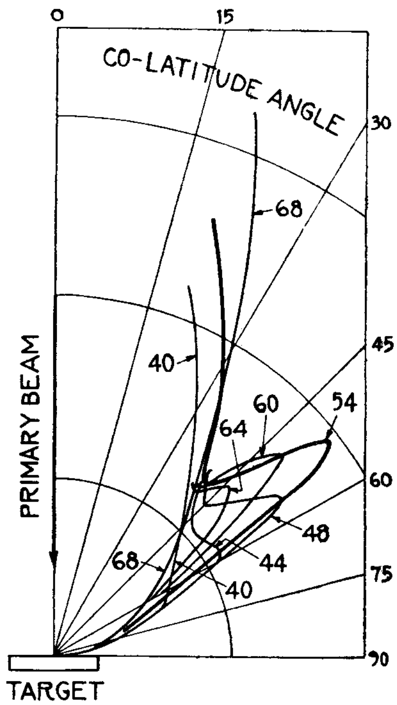

FIG. 1.—Intensity of electron scattering vs. co-latitude angle for various bombarding voltages—azimuth-{111}-330°.

in any latitude from the equator (plane of the target) to within 20° of the pole (incident beam) and in any azimuth.

The face of the target is cut parallel to a set of {111}-planes of the crystal lattice, and etching by vaporisation has been employed to develop its surface into {111}-facets. The bombardment covers an area of about 2 mm.² and is normal to these facets.

As viewed along the incident beam the arrangement of atoms in the crystal exhibits a threefold symmetry. Three {100}-normals equally spaced in azimuth emerge from the crystal in latitude 35°, and, midway in azimuth between these, three {111}-normals emerge in latitude 20°. It will be convenient to refer to the azimuth of any one of the {100}-normals as a {100}-azimuth, and to that of any one of the {111}-normals as a {111}-azimuth. A third set of azimuths must also be specified; this bisects the dihedral angle between adjacent {100}- and {111}-azimuths and includes a {110}-normal lying in the plane of the target. There are six such azimuths, and any one of these will be referred to as a {110}-azimuth. It follows from considerations of symmetry that if the intensity of scattering exhibits a dependence upon azimuth as we pass from a {100}-azimuth to the next adjacent {111}-azimuth (60°), the same dependence must be exhibited in the reverse order as we continue on through 60° to the next following {100}-azimuth. Dependence on azimuth must be an even function of period $2\pi/3$.

In general, if bombarding potential and azimuth are fixed and exploration is made in latitude, nothing very striking is observed. The intensity of scattering increases continuously and regularly from zero in the plane of the target to a highest value in co-latitude 20°, the limit of observations. If bombarding potential and co-latitude are fixed and exploration is made in azimuth, a variation in the intensity of scattering of the type to be expected is always observed, but in general this variation is slight, amounting in some cases to not more than a few per cent. of the average intensity. This is the nature of the scattering for bombarding potentials in the range from 15 volts to near 40 volts.

At 40 volts a slight hump appears near 60° in the co-latitude curve for azimuth-{111}. This hump develops rapidly with increasing voltage into a strong spur, at the same time moving slowly upward toward the incident beam. It attains a maximum intensity in co-latitude 50° for a bombarding potential of 54 volts, then decreases in intensity, and disappears in co-latitude 45° at about 66 volts. The growth and decay of this spur are traced in Fig. 1.

A section in azimuth through this spur at its maximum (Fig. 2—Azimuth-330°) shows that it is sharp in azimuth as well as in latitude, and that it forms one of a set of three such spurs, as was to be expected. The width of these spurs both in latitude and in azimuth is almost completely accounted for by the low resolving power of the measuring device. *The spurs are due to beams of scattered electrons which are nearly if not quite as well defined as the primary beam.* The minor peaks occurring in the {100}-azimuth are sections of a similar set of spurs that attains its maximum development in co-latitude 44° for a bombarding potential of 65 volts.

Thirteen sets of beams similar to the one just described have been discovered in an exploration in the principal azimuths covering a voltage range from 15 volts to 200 volts. The data for these are set down on the left in Table I. (columns 1-4). Small corrections have been applied to the observed co-latitude angles to allow for the variation with angle of the 'background scattering,' and for a small angular displacement of the normal to the facets from the incident beam.

If the incident electron beam were replaced by a beam of monochromatic X-rays of adjustable wave-length, very similar phenomena would, of course, be observed. At particular values of wave-length, sets of three or of six diffraction beams would emerge from the incident side of the target. On the right in Table I. (columns 5, 6 and 7) are set down data for the ten sets of X-ray beams of longest wave-length which would occur within the angular range of our observations. Each of these first ten occurs in one of our three principal azimuths.

Several points of correlation will be noted between the two sets of data. Two points of difference will also be noted; the co-latitude angles of the electron beams are not those of the X-ray beams, and the three electron beams listed at the end of the Table appear to have no X-ray analogues.

The first of these differences is systematic and may be summarised quantitatively in a simple manner. If the crystal were contracted in the direction of the incident beam by a factor 0·7, the X-ray beams would be shifted to the smaller co-latitude angles θ' (column 8), and would then agree in position fairly well with the observed electron beams—the average difference being 1·7°. Associated in this way there is a set of electron beams for each of the first ten sets of X-ray beams occurring in the range of observations, the *electron* beams for 110 volts alone being unaccounted for.

These results are highly suggestive, of course, of the ideas underlying the theory of wave mechanics, and we naturally inquire if the wave-length of the X-ray beam which we thus associate with a beam of electrons is in fact the h/mv of L. de Broglie. The comparison may be made, as it happens, without assuming a particular correspondence between X-ray and electron beams, and without use of the contraction factor. Quite independently of this factor, the wave-lengths of all possible X-ray beams satisfy the optical grating formula $n\lambda = d \sin \theta$, where d is the distance between lines or rows of atoms in the surface of the crystal—these lines being normal to the azimuth plane of the beam considered. For azimuths-{111} and -{100}, $d = 2{\cdot}15 \times 10^{-8}$ cm. and for azimuth-{110}, $d = 1{\cdot}24 \times 10^{-8}$ cm. We apply this formula to the electron beams without regard to the conditions which determine their distribution in co-latitude angle. The correlation obtained by this procedure between wave-length and electron speed v is set down in the last three columns of Table I.

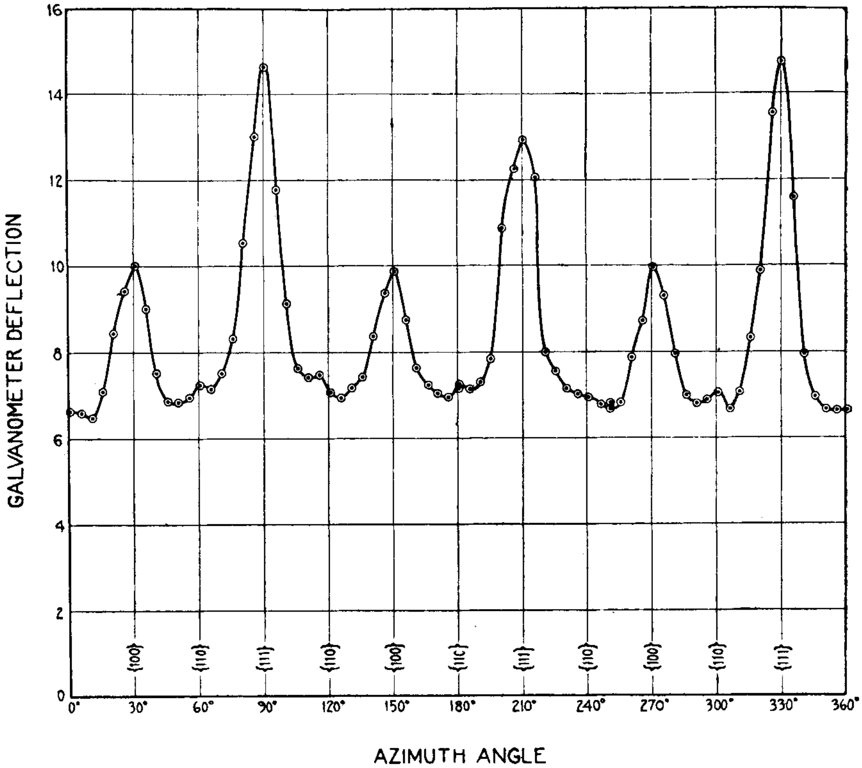

Fig. 2.—Intensity of electron scattering vs. azimuth angle—54 volts, co-latitude 50°.

In considering the computed values of $n(\lambda mv/h)$, listed in the last column, we should perhaps disregard those for the 110-volt beams at the bottom of the Table, as we have had reason already to regard these beams as in some way anomalous. The values for the other beams do, indeed, show a strong bias toward small integers, quite in agreement with the type of phenomenon suggested by the theory of wave mechanics. These integers, one and two, occur just as predicted upon the basis of the correlation between electron beams and X-ray beams obtained by use of

Table I.

Azimuth.	Electron Beams.			X-ray Beams.						
	Bomb. Pot (volts).	Co-lat. θ.	Intensity.	Reflections.	$\lambda \times 10^8$ cm.	Co-lat. θ.	Co-lat. θ'.	$v \times 10^{-8}$ cm./sec.	$n\lambda \times 10^8$ cm.	$n\left\{\frac{\lambda mv}{h}\right\}$.
{111}	54 100 174	50° 31 21	0·5 0·5 0·9	{220} {331} {442}	2·03 1·49 1·13	70·5 44·0 31·6	52·7 31·6 22·4	4·36 5·94 7·84	1·65 1·11 0·77	0·99 0·91 0·83
	174	55	0·15	{440}	1·01	70·5	52·7	7·84	1·76	2(0·95)
{100}	65 126 190	44 29 20	0·5 1·0 1·0	{311} {422} {533}	1·84 1·35 1·04	59·0 38·9 28·8	43·2 27·8 20·4	4·79 6·67 8·19	1·49 1·04 0·74	0·98 0·95 0·83
	159	61	0·4	{511}	1·05	77·9	59·0	7·49	1·88	2(0·97)
{110}	138 170	59 46	0·07 0·07	{420} {531}	1·22 1·04	78·5 57·1	59·5 41·7	6·98 7·75	1·06 0·89	1·02 0·95
{111} {100} {110}	110 110 110	58 58 58	0·15 0·15 0·25	. . . . . .	. . . . . .	. . . . . .	. . . . . .	6·23 6·23 6·23	1·82 1·82 1·05	1·56 1·56 0·90

the contraction factor. The systematic character of the departures from integers may be significant. We believe, however, that this results from imperfect alignment of the incident beam, or from other structural deficiencies in the apparatus. The greatest departures are for beams lying near the limit of our co-latitude range. The data for these are the least trustworthy.

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Mar. 3.

The Brain of Laplace.

THE bicentenary of the death of Newton (March 20, 1727) is within a fortnight of the centenary of the death of Laplace (March 5, 1827), and no one acquainted with the work of both can think of one or other except in association. It may, therefore, not be an unfitting occasion to refer to an historical point with regard to the great Frenchman, when we are celebrating the great Englishman.

The physiologist and anatomist Magendie propounded the theory that the intelligence of a human being was in the inverse ratio of the amount of cerebro-spinal fluid contained in the brain case. Writing in 1827, the year of Laplace's death, his "Mémoire physiologique sur le cerveau,"[1] he inserted the following words :

"Je me suis trouvé dans la douloureuse nécessité d'examiner le cerveau d'un homme de génie mort dans un âge avancé, mais jouissant encore de la plénitude de ses facultés intellectuelles ; la somme totale du liquide céphalo-spinal ne s'élevait pas à deux onces, et les cavités du cerveau en contenaient à peine un gros" [$=\frac{1}{8}$ once].

I have been unable so far to find any further reference in the writings of Magendie "to the brain of this man of genius who died at an advanced age" and in the fullness of his intellectual powers. Magendie appears to have given no further account of this brain; at least I have found none. Laplace died at the age of seventy-eight in the year Magendie wrote. I have also failed to discover any minute record of Laplace's death which would suggest that an autopsy was made or was a "douloureuse nécessité." I would venture, therefore, to ask those who may be better acquainted than I am with the circumstances of Laplace's death to let me know why his brain came into Magendie's possession and whether a full report on it was ever written. Magendie, indeed, mentions no name, and this might lead one to consider his investigation of the matter was confidential. However, I think the ascription is certain, for quite recently Miss Helen Hunter Baillie—a lady who combines the blood of other famous anatomists with that of a famous author,[2] placed in the hands of Miss Miriam Tildesley a letter of Joanna Baillie to her great niece Miss Sophy Milligan. This letter, dated Hampstead, Monday, 1834, contains the following important paragraph :

"MY DEAR SOPHY. . . . Dr. Somerville told us not long ago a whimsical circumstance regarding the head of La Place, the famous French astronomer. Some Ladies and Gentlemen went one day to the house of Majendie (sic !), the great anatomist, to see the brains of this Philosopher which they conjectured must be of a very ample size, and seeing a preparation on the table answering their expectation they were quite delighted. 'Ah ! see what a superb brain, what organs, what developments ! This accounts completely for all the astonishing power of his intellect, etc.' Majendie, who was behind them and overheard all this, stepped quietly forward and said : 'Yes, that is indeed a large brain, but it belonged to a poor Idiot, who when alive scarcely knew his right hand from his left. This, Ladies and Gentlemen' (handing to them a preparation of a remarkably small brain), 'this is the brain of La Place.' Dr. Somerville was told this anecdote by Majendie himself. . . .

Your affectionate Aunt, J. BAILLIE."

This Dr. Somerville can scarcely be other than the physician, fellow of the Royal Society, and husband of Mary Somerville, the learned lady who studied Newton's "Principia" in the original, was the correspondent of Laplace, and paraphrased his "Mécanique Celeste." There can thus be no doubt that Magendie was in possession of the brain of Laplace, and very little doubt that the passage in the "Mémoire physiologique sur le cerveau," written 1827, refers to that brain. The questions I would put to the French readers of NATURE are these : What became of Magendie's preparations ? Have they, and with them Laplace's brain, survived until to-day ? If so ; has any one reported on it, or does any account by Magendie other than that I have cited, written or printed, exist ? So few brains of great thinkers have been available for examination, that it would be a real disaster if Laplace's should have had only four lines devoted to it.

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Mar. 31.

[1] Published by Magendie in his own *Journal de Physiologie expérimentale et pathologique*, Tome 8, p. 228; 1828.

[2] The mother of Joanna Baillie was sister of William and John Hunter.

The Microscopical Examination of Flint Surfaces.

DURING the course of my work in the experimental fracture of flint by (*a*) human blows delivered by a hammer-stone, (*b*) unguided percussion, (*c*) unguided pressure, and (*d*) the application of heat, it became, in my opinion, possible, by a close examination of an extensive series of each of the differing types of flaking produced by these various methods of fracture, to differentiate between the work of man, and that of Nature ("Pre-Palæolithic Man," W. E. Harrison, publisher, Ipswich). While engaged upon this research I was much interested to notice that not only the type of flaking of the different series served to distinguish them from each other, but also that this difference appeared to find support, though in a less obtrusive manner, *in the appearance of the surface of the flints* broken by the methods above enumerated.

Most of those who are familiar with fractured flints of prehistoric date will have probably noticed the marked differences, often observable to the naked eye, between, for example, specimens broken by thermal effects and others fractured by human blows. The surfaces of the flake-scars of the former exhibit, generally, a much duller, less bright, surface than those of the latter. It occurred to me that this difference was caused possibly by the fact that these surfaces differed in texture, and had thus offered a differing resistance to the natural force, or forces, responsible for the imposition of 'polish,' or 'gloss," upon the flake-scars of fractured flints. Further, it seemed highly probable that this difference in texture, if it existed, would have been most likely to have been produced by the two differing forms of fracture, and I compared, provisionally, the surfaces of a flint broken by thermal effects, to those of an apple which has been pulled in half with the hands and exhibits a rough surface, while I likened the surfaces of the