contractions and relaxations alternate, or in other words the quick phase of the nystagmus does not disappear before the entire muscle is paralysed.

After the total disappearance of the nystagmus the kymograph is stopped (at 28 sec. past 12), and now after one or more minutes we ascertain whether recovery of the function is already discernible. As shown by the curve at 37 sec. past 12 new small minimal contractions recur. Every one of them is again followed directly by a quick relaxation.

As stated above, five other quite successful experiments yielded the same result.

CONCLUSIONS.

BARTELS assumes in his theory that the rapid phase of the vestibular nystagmus is brought about by a reflex originating near the proprioceptive nerve-fibers and that the terminal branches of the trigeminus in the orbita play a part in this process.

As the facts brought out in the present investigations have proved this not to be the case, his theory cannot be accepted.

The place where the reflex for the quick phase of the nystagmus arises is therefore to be looked for more towards the centra in the brainstem.

Physics. — *"Research by means of Röntgen Rays on the Structure of the Crystals of Lithium and Some of its Compounds with Light Elements"*. I. By J. M. BIJVOET and A. KARSSEN. (Communicated by Prof. P. ZEEMAN).

(Communicated at the meeting of March 26, 1921).

[For some ten years the researches at the Laboratory for general and inorganic chemistry of this University have for the greater part been directed to the solid substance. With a view to extend the methods of research also to those that make use of Röntgen rays, hoping in this way finally to get more knowledge about the finer internal states of equilibrium, steps were taken to get the required Röntgen apparatus.

Through the great kindness of the municipality and of the Amsterdam University Association we have now this institution at our disposal, and we feel obliged to express our hearty thanks to both bodies.

The task we have set to leads us to the typical allotropic substances, but first we wanted to examine some simple, but nevertheless very interesting cases, in which results could be expected which are of importance for the knowledge of the nature of the link. For these cases were chosen Li and LiH, with the result described below. A. SMITS].

I. LITHIUM.

1. *Introduction.* The investigation of Li and some of its compounds with light elements is perhaps more suitable than many of the compounds examined hitherto for drawing conclusions concerning structure and binding of the particles on account of the small number of electrons outside the nucleus of the component atoms [1]).

The notion e.g. that electrons and ions must be considered as equivalent elements of the space lattice, which view offers inter alia great advantages for the explanation of the structure of the

[1]) Thus DEBYE and SCHERRER could show for LiF, that there are no atoms, but ions in the lattice-points. Physik. Zeitschr. **19**, 474 (1918).

crystal, and for the relation between infra-red and ultra-violet frequencies, may be tested in a simple way in the case of lithium. In the case of an equally simple lattice set with atoms of a higher atomic number the problem will be more difficult to solve. Thus we hope to make out presently for lithium hydride, whether possibly negative hydrogen ions occur here [1]).

The simplicity of these substances in contrast with more intricate compounds gives scope for hope that the result will be unequivocal. Moreover the said lithium compounds have the advantage that in using the method of DEBYE and SCHERRER place and intensity of the lines are much less influenced by the absorption in the rod than they are with heavier compounds. The latter, when results of rays of different wave-lengths [K_{Cu}- and K_{Cr}-rays] are recorded, may give rise to small changes in intensity relations even as far as reversing them if intensity is slightly differing. So it lately appeared to us with sodium bromate.

2. *Apparatus.* A Rausch von Traubenberg-Debye tube with exchangeable anti-cathode was used, as described by BIJL and KOLKMEYER [2]). The required high voltage direct current was obtained by rectifying transformed alternate current with a Snook. The radius of the camera used was 5.0 cm., the dimensions of the diaphragms were the same as those described by BIJL and KOLKMEYER. The sample was rotated by means of a clockwork.

3. *Photograms.* After being cleaned under paraffin-oil and washed with dry ether a rod of lithium, 1,5 to 2 mm. thick was covered with a thin protecting layer of paraffin, and fastened by means of a glass foot in the axis of the camera. Even after days the surface remained bright metallic and shiny. A Cr-anticathode was used. The exposure lasted $\pm$ 12 hours with a mean current of $\pm$ 12 mA., parallel spark between plate and point 3 cm. Then a film was made of a glass rod covered with paraffin to be able to eliminate the interference lines caused by these substances.

4. *Observations and calculation.*

In column 1 of Table I are recorded the distances on the film from the middle of the image to the interference lines, expressed in mm., and

[1]) Compare MOERS, Z. f. anorg. u. allg. Chemie **113**, 179 (1920).

[2]) These Proc. Vol. 21, p. 405.

TABLE I.

Distance in mm. and estimated intensity	$10^3 \sin^2 \frac{\vartheta}{2}$	$Cr_{K\alpha}$-radiation			$Cr_{K\beta}$-radiation		
		Σh^2	$10^3 \sin^2 \frac{\vartheta}{2}$ calculated	$h_1h_2h_3$	Σh^2	$10^3 \sin^2 \frac{\vartheta}{2}$ calculated	$h_1h_2h_3$
1	2	3	4	5	6	7	8
43.1 z	179				2	177	110
47 5 zs	214	2	213	110			
70.4 m	428	4	427	200			
81.0 zz	535				6	530	211
91.6 s	640	6	640	211			
116.1 ms	852	8	854	220			
120. zz	879				10	884	310

the estimated intensities; in column 2 the values for $10^3 sin^2 \frac{\vartheta}{2}$ calculated from this (on account of the slight absorption in the lithium correction for the thickness of the rod was here unnecessary). In the well-known way the values referring to β-lines have been separated by the aid of the ratio $\lambda_\beta : \lambda_\alpha = 2{,}079 \cdot 10^{-8} : 2{,}284 \cdot 10^{-8}$. In correspondence with the regular crystalline form a common factor for $10^3 sin^2 \frac{\vartheta}{2}$ of the α-lines was found, great 213,4. In connection with density, atomic weight, value of AVOGADRO and wave-length (resp. 0,534, 6,94, $0{,}6062 \cdot 10^{24}$ and $2{,}284 \cdot 10^{-8}$) it follows that if the number of particles per cell is n, a value for the common factor A is calculated for $n = 2$, which corresponds with the observation and is equal to half the factor mentioned, while for $A = 106{,}7$ follows $n = 1{,}99$; hence per cell (lattice parameter $a = 3.50 \cdot 10^{-8}$ cm.) there are two particles. In connection with the intensities of the diffraction lines, those of planes with odd Σh being absent, it is obvious that lithium crystallizes in centered cubes [1]).

Table II gives the observed and calculated intensities, in which only the factor of the number of planes, the factor of LORENTZ, and the structure factor (which in this case is the same for the planes with

[1]) HULL already studied lithium, but could not decide between cubes with two atoms per lattice-point and centered cubes. Phys. Rev. **10**, 661 (1917).

even Σh, and zero for those with odd Σh) have been taken into consideration. Hence absorption in the rod, temperature factor, and polarisation factor are not taken into account. We hope to ascertain in how far anything can be concluded with regard to the configu-

TABLE II.

Planes	Intensity	
	Observed	Calculated
100	—	—
110	zs	6.0
111	—	—
200	m	1.5
210	—	—
211	s	4.0
220	ms	1.5
221 } 300 }	—	—

ration of the electrons outside the nucleus after photometry of the film. It can, indeed, already be stated that it is not possible to satisfy the crystallographical and intensity conditions by a model, in which by the side of the Li-ion, the valency-electron occupies a definite place in the space-lattice. We tested the arrangement which may be obtained in the following way, and which is the only one that deserves consideration:

Draw the system of non-intersecting trigonal axes in the cell with edge $a' = 2a$ and place the valency-electron on each axis in the middle between the ions. That the intensities calculated for this model are not in agreement with the observed intensities appears from table III (supposition B; the effect of the distance of the remaining electrons from the nucleus can be neglected in this case.)

On the other hand agreement with the observed intensities *is* found, when in this model the valency-electron is placed not on the trigonal axis, but revolving in circles normal to the trigonal axis in the midst of the Li-ions (Table III, supposition C); here r = radius of the path supposed circular. The weakening factor occur-

ring in this case for the electron [1]) makes the calculated intensities, for values of $\frac{r}{a'} > \pm 0{,}1$, i.e. $r > \pm \frac{1}{4}$ of the distance between two nuclei, differ but little from those found for case A (simply centred cubic lattice; the intensities of column A are not essentially affected by taking into account a weakening factor for the Li-atom.) The choice between the two models that are in agreement with the Röntgen investigation, viz. that with atoms in the lattice points and that with ions between which binding circles, will be postponed till after photometry of the film [2]).

TABLE III [3])

Planes	Intensity			
	Observed	Calculated		
		A	B	C $\left(\frac{r}{a'} = 0{,}1\right)$
211	—		16	8
220	zs	216	96	78
321	—		14	0
400	m	54	6	20
332	—		4	1
422	s	144	64	77
431 } 510 }	—			2
521 } 440 }	ms	54	60	22

It is, however, very questionable whether a decision can be made with sufficient probability along this line, i.a. on account of the un-

[1]) Cf. the analogous calculations on binding circles in diamond by COSTER. These Proc. Vol. 22, p. 536 and KOLKMEYER, Vol. 23, p. 120.

[2]) Possibly this choice will be still more difficult here than it is for diamond, as the number of valency-electrons is here only $1/8$ of the total number.

[3]) The planes for which the structure factor becomes zero independent of the value of $\frac{r}{a'}$ have not been included in the table.

certainty of some intensity factors, e.g. those referring to the thermal movement of the valency electrons.

For the value of the diameter of BRAGG's *atomic domain* [1]) follows from the given structure $3.04.10^{-8}$ which is in very good agreement with the value given by BRAGG ($3.00.10^{-8}$).

5. *Summary.* Lithium crystallizes in centered cubes, lattice-parameter $a = 3{,}50.10^{-8}$ cm.; no lattice of stationary valency electrons. Possibly binding circles normal to the trigonal axes.

In conclusion we express our great indebtedness to Prof. SMITS for his assistance and the great interest he has taken in this work.

Laboratory of Physical and Inorganic Chemistry of the University.

Amsterdam, March 14th 1921.

Whilst this paper was being printed our attention was directed by a paper of THIRRING (Z. f. Phys. 4, 1, 1921), to the appendix of a paper by HABER (Sitz. Ber. der Preuss. Ak. d. Wiss. 51, 990, 1919), from which appears that at a meeting of the d. Chem. Ges. DEBYE already communicated the result of still unpublished investigation of Li, which agrees with our conclusion as to the arrangement of the Li-particles, and the rejection of the lattice of stationary electrons.

[1]) Phil. Mag. August. (1920), p. 169.

Experimental Psychology. — "*On the Development of Attention from the 8th until and including the 12th year of life.*" By F. ROELS and J. FELDBRUGGE. (Communicated by Prof. C. WINKLER).

(Communicated at the meeting of February 26, 1921).

I.

The literature records little about the development of attention in children, the writers having confined themselves only to the value which the experimental investigation of attention in adults, possesses for a proper notion of the development of attention in children. Their investigations regarded the range of attention for simultaneous and successive impressions, its intensity, the aptness for distraction or the power of resistance to disturbing influences, the degree of clearness of the several elements observed in one action. True, in the first part of his "Vorlesungen zur Einführung in die experimentelle Pädagogik und ihre psychologischen Grundlagen" [1]) MEUMANN describes, on the basis of his own investigations, the development of attention in young individuals in all these respects, but for want of space he had to forego the publication of his experimental results. Children were also experimented on a.o. by F. N. FREEMAN [2]), A. KOCH [3]), J. HABRICH [4]), D. KATZ [5]) and M. v. KUENBURG [6]); with exception of the first, all about attention and conscious isolating abstraction, i.e. fixating of uniform elements from simple pictures.

[1]) Leipzig 1916, p. 179 volg.

[2]) Untersuchungen über den Aufmerksamkeitsumfang und die Zahlauffassung bei Kindern und Erwachsenen. Pädagogische Arbeiten des Leipziger Lehrervereins I, 1910.

[3]) Experimentelle Untersuchungen über die Abstraktionsfähigkeit von Volksschulkindern. Zeitschrift für angewandte Psychologie 7, p. 332.

[4]) Experimentelle Untersuchungen über die Abstraktionsfähigkeit von Schülerinnen, Ibid. 9, p. 189.

[5]) Studiën zur Kinderpsychologie. Wissenschaftliche Beiträge zur Pädagogik und Psychologie. Heft 4, 1913.

[6]) Ueber Abstraktionsfähigkeit und die Entstehung von Relationen beim vorschulpflichtigen Kinde. Ibid. 17, p. 270; See also K. BÜHLER: Die geistige Entwicklung des Kindes². Jena 1921, p. 162.