Physics. — *Vapour pressures of neon of different isotopic compositions.* By W. H. Keesom and J. Haantjes (Abstract of Communication N⁰. 239c from the Kamerlingh Onnes Laboratory).

A new apparatus for differential measurements of vapour pressures was constructed, securing a very good heat contact between the vapour pressure reservoirs and the bath of constant temperature. This apparatus was built in a cryostat in which it was possible to liquefy neon with the aid of liquid hydrogen. In a neon bath (liquid or solid) we carried out measurements about the differences in vapour pressure of neon of five different isotopic compositions (atomic weights between 20.043 and 21.157).

It appeared that at a fixed temperature the pressure is a linear function of the atomic weight. This was checked to be true within $3\,^0/_{00}$, the limit of our accuracy, at 27° K. From our measurements we derived the value of $log\ p_{20}/p_{22}$ as a function of temperature. For the solid state a deviation from the theoretical formula was found, which may be due to a difference in potential energy for the two isotopes in the solid substance as well as to a deviation of Debije's formula for the zero point energy.

From the dependence of $log\ p_{20}/p_{22}$ on temperature in the liquid state we are able to derive that the specific heat of the liquid of Ne^{20} is higher than that of Ne^{22}.

We also found that the triple point of Ne^{22} is 0.134 degree higher than that of Ne^{20}, and calculated a difference in melting-heat for the two isotopes of 1.18 cal/mol, the highest value belonging to Ne^{22}.

Physics. — *The isotopes of nickel.* By J. de Gier and P. Zeeman.

Among the experiments we made this year with our mass spectrograph, arranged according to Thomson's parabola method, those with nickel gave results differing considerably from Aston's latest data on the isotopes of this element.

The disaccord may be of little importance as to the atomic weight of

nickel, because of the faintness of the isotopes concerned. But possibly our results can get some importance for the systematics of the isotopic table.

ASTON [1]) analysed nickel by means of its carbonyl. Two isotopes with mass numbers 58 and 60 were found and the relative abundance was estimated at 2 : 1.

Later on in his publication [2]) of April of this year ASTON reported on two other faint isotopes.

Several new lines were detected, of which those for the mass numbers 61 and 62 were new isotopes, with reasonable certainty. Lines present at 56 and 64 showed a steady decrease in intensity as the experiments proceeded, indicating that they were largely if not entirely due to adventitious compounds. They never quite disappeared, so the existence of these isotopes could not be excluded by ASTON.

But the abundance of neither could be so high as 1 %.

Photometry gave the abundance of the isotopes 58, 60, 61 and 62, equal to 67,5 %, 27,0 %, 1,7 % and 3,8 %.

Our experiments were also undertaken with the volatile carbonyl of nickel. This is now on the market and is sufficiently pure for our case. So we were not obliged to take special precautions when using it.

When the carbonyl was led through the discharge tube, the inner wall was coated with a black deposit of nickel [3]). Especially when the current density was high, the discharge soon became instable and it was not possible to continue the exposure long enough.

This difficulty was overcome in the same manner as that of the abnormal cathodic sputtering in our previous experiments [4]) with the inert gases. Diluting the carbonyl with oxygen had a favourable influence and the disturbance by the coating was much retarded by it.

On the other hand the current density was chosen so low that the useful working-time of the tube was considerably greater.

Of course the bundle is less intensive now. Accordingly the canals had to be chosen as wide as possible, an upper limit being given by the resolving power of the apparatus.

Wide canals are the more necessary because the intensity of the bundle is distributed here over many sorts of ions. The carbonyl gives rise not only to parabolas of the metal ions but also to groups of strong lines for NiC, $NiCO$, $Ni(CO)_2$, etc., the intensity of these lines being of almost the same order as that of the Ni-lines.

So the intensity of the two faint Ni-isotopes was apt to be too small.

[1]) Phil. Mag. **45**, 936, 1923.

[2]) Proc. Roy. Acad. London **149**, 396, 1935.

[3]) Before the methods of evaporating and cathodic sputtering were established, nickel mirrors for optical experiments were occasionally made by passing nickel-carbonyl through a heated glass tube. See P. ZEEMAN: Mesures relatives au Phénomène de Kerr; Arch. néerlandaises **27**, 47, 1894.

[4]) P. ZEEMAN and J. DE GIER, Proc. Roy. Acad. Amst. **37**, 127, 1934.

The large canals have the disadvantage of giving broad parabola as will be seen from the reproduction. It was however still possible to get altogether trustworthy results in this way. At the start of the experiments with nickel it was our intention to look after isotopes on 56 and 64.

The very first photos were already interesting. Line 56 was absent and 64 was clearly visible. By prolonging the exposures not a trace of 56 could be found. So we may conclude that a nickel isotope of mass-number 56 does not exist to an abundance greater than 0,1 %.

Line 64 was easy to get and appeared to have the same relative intensity during the whole experiment. This indicated clearly that it was not due to an adventitious compound.

In other respects the behaviour of the 64 line was also quite like that of the other nickel lines. On the most intensive plates all the metal lines were prolonged, and the relative intensities were apparently the same as those of the main group.

Another striking proof of the identity of the 64-ion lies in the fact that the plates always gave a repetition of that line together with the other isotopes in the groups of NiC, $NiCO$, $Ni(CO)_2$ etc. In the reproduction the group of NiC will still be distinguished, the $NiCO$ group being too faint to be wholly reproduced.

As a result of our research we get none but even isotopes. The repetition of the lines in several almost aequidistant groups, clearly resolved, excluded every other possibility.

The isotope 61, reported by ASTON, could not be found by us. We have made our lines sharper in order to be sure that the line could not be shadowed by the other lines.

Exposures with still sufficient intensity could be made but not a trace of additional blackening was seen between the lines 60 and 62. So this isotope cannot be present to more than 0,2 %.

It is difficult to ascribe the disaccord of ASTON's results to a special cause. Only a comparison of the plates in connection with the experiments that preceded his nickel exposures can give some answer to this.

Nevertheless, it is remarkable that we also got a line 61 when we experimented with carbon hydrides. The action of halogenes in the tube on the grease also caused this line.

The line is then easily explained by a C_5H ion, the other carbon series being present then to a much larger extent.

If this were the case with ASTON's line 61, we should be inclined to mistrust the abundance figures for 60 and 62 as C_5 and C_5H_2 would also be present up to a slight degree. However, another explanation of line 61 being equally possible, this time not affecting the relative intensities of 60 and 62, we have only enlarged proportionally ASTON's figures. By varying the time of exposure we found for the relative intensity of 64 to 62; ± 1: 4, 5. With packing fraction and change of scale we obtain an atomic weight of 58,68 according with the international value of 58,69.

long exposure   short exposure

The abundance figures as given in the table are now:

		Mass numbers	58	60	61	62	
ASTON	{	Mass numbers	58	60	61	62	
	{	$^0/_0$ abundance	67,5	27,0	1,7	3,8	
ZEEMAN-DE GIER	{	Mass numbers	58	60	—	62	64
	{	$^0/_0$ abundance	68,1	27,2	—	3,8	0,9

Sept. 1935.

Laboratory "Physica" of the University of Amsterdam.

Mathematics. — *Verteilungsfunktionen.* Von J. G. VAN DER CORPUT. (Erste Mitteilung).

(Communicated at the meeting of September 28, 1935).

Einleitung.

Die in dieser Arbeit auftretenden Zahlen werden alle reell vorausgesetzt. Verteilungsfunktionen treten auf bei Folgen; eine Folge ist eine abzählbar unendliche angeordnete Zahlenmenge. Ist U die Folge $u_1, u_2, \ldots,$ so bezeichne ich mit $U_\gamma(x)$ die Anzahl der Zahlen $u_\xi < \gamma$ mit $\xi \leq x$. Desgleichen bezeichne ich, falls V die Folge $v_1, v_2 \ldots$ darstellt, mit $V_\gamma(x)$ die Anzahl der $v_\xi < \gamma$ mit $\xi \leq x$; desgleichen $W_\gamma(x)$, $T_\gamma(x)$, u.s.w.

Ist es möglich, bei der Folge U die natürliche Zahl x unbeschränkt so wachsen zu lassen, dasz $\dfrac{U_\gamma(x)}{x}$ für jedes γ nach einem Grenzwert $\psi(\gamma)$ strebt, so nenne ich diesen Grenzwert $\psi(\gamma)$ eine Verteilungsfunktion der Folge U. In diesen Mitteilungen werde ich beweisen:

Satz 1: *Jede Folge U besitzt wenigstens eine Verteilungsfunktion.* Hieraus folgt

Satz 2: *Ist es bei gegebener Folge U und bei gegebenem η möglich, die natürliche Zahl x unbeschränkt so wachsen zu lassen, dasz $\dfrac{U_\eta(x)}{x}$ nach einem Grenzwert ζ strebt, so besitzt die Folge U wenigstens eine Verteilungsfunktion, die in η den Wert ζ annimmt.*

Denn dann gibt es eine Folge von monoton wachsenden Zahlen $x_1, x_2, \ldots$ mit

$$\lim_{h \to \infty} \frac{U_\eta(x_h)}{x_h} = \zeta. \quad \ldots \ldots \ldots \ldots \quad (1)$$

Die Folge $u_{x_1}, u_{x_2}, \ldots$ besitzt nach Satz 1 wenigstens eine Verteilungsfunktion. Diese ist auch Verteilungsfunktion der Folge U und nimmt wegen (1) in η den Wert ζ an.