Letters to the Editor.

CONTENTS.

Note on Transport Phenomena and Quantum Mechanics.

IN a recent paper we have studied the transport phenomena by modifying Maxwell's method in the light of the new Statistical methods. The dynamics of Collision was studied by a method due to Perisco. In recent years Wave-mechanical collisional methods have been developed by several authors and Massey and Mohr have shown how collisional area obtained by the above methods can be used for studying transport phenomena.

In the present investigation we have incorporated the Wave-mechanical method for studying scattering of electrons by a positive nucleus and thus calculated the value of the constants A_1, A_2 represented by the expressions

$$A_1 = 2\pi\int I(\theta)\sin^2\theta/2.\sin\theta\, d\,\theta$$

$$A_2 = 2\pi\int I(\theta)\sin^3\theta\, d\,\theta$$

where $I(\theta)$ is the intensity of scattering, θ is the angle of scattering.

Taking Wentzel's expression

$$I(\theta) = \left(\frac{Z\epsilon^2}{2mv^2}\right)^2\int\frac{d\theta}{(\sin^2\theta/2+b)^2}$$

where Z is the atomic number, ϵ = electronic charge, m the mass and v the velocity of the electron, $b = \frac{1}{4k^2R^2}$, $k = \frac{2\pi mv}{h}$, R = distance between the two particles.

For completely ionised stellar matter $r = \frac{1}{2}\left(\frac{Am_H}{\rho}\right)^{1/3}$ where A is the average mol. wt., m_H = wt. of the H atom, ρ the density of stellar matter.

We thus have

$$A_1 = 4\pi\left(\frac{Z\epsilon^2}{2mv^2}\right)^2\left[\log\frac{1+b}{b} - \frac{1}{1+b}\right]$$

$$A_2 = 16\pi\left(\frac{Z\epsilon^2}{2mv^2}\right)^2\left[(1+2b)\log\frac{1+b}{b} - 2\right]$$

A_1 and A_2 may be computed for different cases and their values introduced into our previous formula, would lead to the evaluation of viscosity k, conductivity h, self-diffusion D and diffusion between two different gases D_{12}.

In the following tables are given values for some well-known giant and dwarf stars.

The first three stars are assumed to contain completely ionised iron while the last two completely ionised Ca-atom. It has already been pointed out that Kothari's Model-Dwarf should be treated relativistically. Here however non-relativistic values have been

Stars	Density	Temp.	Viscosity k in e.s.u.	Conductivity in gm./cal.	Self-Diffusion D	Diffusion D_{12}
Model-Giant (Chapman) ..	0·1	7×10^6	$9\cdot986\times10^{-3}$	13·3	$1\cdot998\times10^3$	14·93
Capella	0·1234	$9\cdot08\times10^6$	·02	2·70	$6\cdot6\times10^3$	10·3
Model-Dwarf (Kothari) ..	$1\cdot36\times10^6$	$1\cdot37\times10^7$	$6\cdot904\times10^2$	$1\cdot685\times10^5$	6·048	
ϵ_2 Eridani	$9\cdot8\times10^4$	10^8	3·719	$3\cdot242\times10^4$	1·350	
Sirius B	5×10^4	10^9	1·216	$1\cdot658\times10^5$	·688	
,, ,, ...	,,	10^8	1·216	$1\cdot658\times10^4$	·688	
,, ,, ...	,,	$1\cdot37\times10^7$	1·216	$2\cdot271\times10^3$	·688	

calculated for comparison. It is noticed that viscosity and diffusion are effected by density alone increasing with increasing density while conductivity is a function of temperature as well.

For the relativistic case $I(\theta)$ involves a factor $(1-v^2/c^2)$ and hence is greatly diminished while for $v\sim c$, $I(\theta)\sim 0$ and hence, k, $\mathfrak{F}$ and D have zero values.

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[1] Ganguli and Mitra, *Curr. Sci.*; *Ind. Jour. Phys.*, 1934, **9**, 81.

[2] For references see Mott and Massey, *Atomic Collisions* (Cambridge).

[3] Mott and Massey, *Proc. Roy. Soc.*, A, 1933, **140**, 145, 436; also Mazumdar, *Z. Phys.*, 1934, **91**, 706.

[4] Wentzel, *Ibid.*, 1927, **40**, 590.

[5] Mott, *Proc. Roy. Soc.*, A., 1932, **135**, 429.

Note on Surface Tension and Its Variation with Temperature.

IN connection with a recent note[1] of Sibaiya "On the ratio of temperature co-efficients of surface tension and density" it may be pointed out that Cantor[2] who followed the same method as Sibaiya obtained the value of the ratio 2·33 instead of 2.

The nature of the cohesive forces has been studied in detail in recent years and the following relationship between Van der Waals force and the surface tension has been established.[3]

$$\text{Van der Waals Constant } a = 2\pi\int_0^R \psi(z)dz$$

$$\text{Surface Tension } \gamma = \pi\rho^2\int_0^R z\psi(z)dz$$

Lately London[4] has given a quantum-mechanical expression of Van der Waals force. According to him the interaction energy between two similar molecules is given by

$$\epsilon = -\tfrac{3}{4}\cdot\frac{\alpha^2 J}{R^6} = \frac{k}{R^6}$$

where J is the ionisation potential, α the polarisability and R the distance between the molecules. This corresponds to the potential $\psi(z)$ of Laplace. By introducing the above expression for $\psi(z)$ we have

$$\gamma = \frac{\pi k\rho^2}{4d^2} \quad \text{.. .. .. ..} \quad (1)$$

Expression (1) was derived by Gyemant[5] as well by considering the surface energy originating from electric dipole.

By differentiating (1) with respect to T

$$\frac{d\gamma}{dT} = \frac{2\pi k\rho}{4d^2}\frac{d\rho}{dT} - \frac{\pi k\rho^2}{4}\cdot\frac{2}{d^3}\cdot\frac{dd}{dT} + \frac{\pi\rho^2}{4d^2}\cdot\frac{dk}{dT}$$

or,

$$\frac{1}{\gamma}\cdot\frac{d\gamma}{dT} = \frac{2}{\rho}\frac{d\rho}{dT} - \frac{2}{d}\cdot\frac{dd}{dT} + \frac{1}{k}\cdot\frac{dk}{dT} \quad \text{..} \quad (2)$$

If β be the co-efficient of cubical expansion = thrice the co-efficient of linear expansion,

$$\frac{1}{\gamma}\cdot\frac{d\gamma}{dT} = -2\cdot66\,\beta + \frac{1}{k}\frac{dk}{dT} \quad \text{.. ..} \quad (3)$$

Now in order to study the effect of temperature on k we must remember that

$$k = -\tfrac{3}{4}\,h\nu_0\alpha^2, \text{ where } \alpha = \alpha_0 + \frac{\mu^2}{3kT},$$

$$\nu_0 = \frac{e}{\sqrt{m\alpha}} \text{ and } h\nu_0 = J.$$

If there is no permanent dipole moment ($\mu = 0$) α and ν_0 and so k are independent of temperature. On the other hand if $\alpha_0 \ll \frac{\mu^2}{3kT}$, the expression for surface tension reduces to the formula similar to Gyemant's and

$$k = -\tfrac{3}{4}\cdot\frac{hc}{\sqrt{m}}\cdot\frac{\mu^3}{(3k)^{3/2}}\cdot\frac{1}{T^{3/2}}, \text{ and}$$

$$\frac{1}{k}\cdot\frac{dk}{dT} = -\frac{3}{2T}.$$

It should however be noted that London's