UNKNOWN FORCES OF MATTER AND KINETIC ENERGY OF THE PHOTON *

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ABSTRACT

The existence of certain internal forces of matter explains the phenomenon of the density of bodies and, also, that of the optical groups of substances.

Now, the impaction of a photon in a substance will produce a reaction in it, and the energy transfered internally will be measured by the work of the internal forces mentioned above.

As concerns the photon, it will also experience some action in the moment of impact, since it suffers a loss of its energy; and some of the rules which establish this loss will be found and stated in this study.

Finally, among the terms of an equation, which is fundamental in the development of the present theory, appears the formula of the kinetic energy of the photon *when the latter moves in the interior of a body*. This constitutes an important discovery, especially for the mechanics of the QUANTA.

* Translated from the Spanish by Angélia Louvet.

UNKNOWN FORCES OF MATTER

In this work I shall make known the manner in which the phenomenon of the penetration of light in matter has allowed me to observe certain forces which have remained completely ignored until to-day.

Among these forces there are some upon which the phenomenon of the density of the bodies appears to depend, and, jointly, there are others which seem to act in modelling or adjusting the intimate nature of the bodies according to certain groups which I have denominated *optical groups of impaction.*

Effectively, in my work, entitled *The Impaction of the Quanta of Light,* it is demonstrated that all the bodies are distributed in groups, in accordance with a precept which I discovered and which says that *"between the loss of velocity suffered by light as it passes from a vacuum to the interior of a body and its density, there exists a relation which has a constant value for an undetermined number of substances or, otherwise said, for a group of these substances"* *

But as the value of this relation alters each time that there is a change in certain common characteristics of the substances which constitute a group, many different groups will be formed, all the bodies being distributed among them.

In order to express this rule in the form of an equation, we will write

$$\frac{C - V}{d} = \text{constant} \quad \ldots \quad \ldots \quad \ldots \ldots \quad \ldots \quad \ldots \qquad \text{(I)}$$

designating:

C the velocity of light in a vacuum, that is, $2.998 \cdot 10^{10}$ cm/sec.,
V the velocity of light inside the body,
d the density of the body.

But its contents will be seen clearly only after having examined the following figures thoroughly:

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* *Las Masículas y la Impacción de los Quanta de Luz.* Boletín de la Academia de Ciencias Físicas, Matemáticas y Naturales. Año XXI - Tomo XX - Nº 55 - 1961 (Palacio de las Academias, Apartado de Correos 1421, Caracas, Venezuela, S. A.)

Glucides (Carbohydrates)	*Formula*	*Index of refraction* * n ($\lambda = 0.5893\mu$)	*Density* d	*Constant* $\frac{C-V}{d}$
Starch	$(C_6H_{10}O_5)$ x	1.5300	1.5000	$0.69 \,.\, 10^{10}$
(1—α) Arabinose	$C_5H_{10}O_5$	1.5670	1.5850	0.68 . "
Cellulose	$(C_6H_{10}O_5)$ x	1.5300	1.5000	0.69 . "
Gum arabic		1.4760	1.3500	0.71 . "
Lactose	$C_{12}H_{22}O_{11} . H_2O$	1.5420	1.5250	0.69 . "
d-Lyxose	$C_5H_{10}O_5$	1.5410	1.5450	0.68 . "
β-Rhamnose	$C_6H_{12}O_5 . H_2O$	1.5310	1.4710	0.70 . "
Sucrose	$C_{12}H_{22}O_{11}$	1.5651	1.5880	0.68 . "
1-Xylose	$C_5H_{10}O_5$	1.5440	1.5250	0.69 . "
			Average	$0.69 \,.\, 10^{10}$

Corneous and connective tissues	*Index of refraction* * n ($\lambda = 0.5893\mu$)	*Density* d	*Constant* $\frac{C-V}{d}$
Tortoise-shell	1.5910	1.3050	$0.85 \,.\, 10^{10}$
Horn	1.5600	1.3000	0.82 . "
Gelatin	1.5400	1.2700	0.82 . "
Wool	1.5400	1.2800	0.82 . "
Silk	1.5400	1.2500	0.84 . "
		Average	$0.83 \,.\, 10^{10}$

Fermentation alcohols	*Formula*	*Index of refraction** n ($\lambda = 0.5893\mu$)	*Density* d	*Constant* $\frac{C-V}{d}$
2 - Pentanol	$CH_3CH_2CH_2CHOHCH_3$	1.40530	0.8090	$1.06 \,.\, 10^{10}$
Butyl (n)	$CH_3(CH_2)_2CH_2OH$	1.39909	0.8100	1.05 . "
tert - Butyl	$(CH_3)_3COH$	1.38779	0.7887	1.06 . "
Ethyl	CH_3CH_2OH	1.36100	0.7902	1.00 . "
1 - Heptanol	$CH_3(CH_2)_5CH_2OH$	1.42410	0.8219	1.08 . "
1 - Hexanol	$CH_3(CH_2)_4CH_2OH$	1.41330	0.8200	1.06 . "
Isoamyl	$(CH_3)_2CHCH_2CH_2OH$	1.40723	0.8104	1.07 . "
Isobutyl	$(CH_3)_2CHCH_2OH$	1.39560	0.8024	1.05 . "
Isopropyl	$CH_3CHOHCH_3$	1.37757	0.7887	1.04 . "
Propyl (n)	$CH_3CH_2CH_2OH$	1.38543	0.8044	1.03 . "
			Average	$1.05 \,.\, 10^{10}$

* Values of the indices of refraction for the sodium D line.

The values of the indices and of the densities are for an ambient temperature of about 20° C.

In the *anisotropic* bodies we have chosen the following indices: the *ordinary* in the uniaxial and the *intermediate* in the biaxial.

To calculate the value of $(C - V)/d$ we have used the equivalent formula $(C - C/n)/d$. And for the value of the constant, in each group, we have taken the average which appears at the foot of the respective table, thus:

GROUP	*CONSTANT* *Averages of* $\frac{C - V}{d}$
Glucides (Carbohydrates)	$0.69 \cdot 10^{10}$
Corneous and connective tissues	0.83 . "
Fermentation alcohols	1.05 . "

This established, if we substitute in the second member of equation (I) the word *constant* for its abbreviation *const*, the result will be:

$$\frac{C - V}{d} = const$$

whence we deduce

$$V = C - d\ const$$

and, after squaring both members and then transposing, we will obtain successively:

$$V^2 = C^2 + d^2\ const^2 - 2\ C\ d\ const$$

$$C^2 - V^2 = 2\ C\ d\ const - d^2\ const^2 \quad \ldots\ldots\ldots\ldots\ldots \quad (II)$$

Now, from Einstein and Planck's equations, $E = m\ C^2$, $E = \nu h$, we deduce

$$m = \frac{\nu h}{C^2}$$

designating:

ν the frequency of radiation, which does not vary when the photon passes from a vacuum into the interior of a body.* Its value is, in the present case, $5.087 . 10^{14}$, that is to say, the frequency which corresponds to the wave length $\lambda = 0.5893\ \mu$ (sodium *D* line).

h Planck's constant, which is equal to $6.624 . 10^{-27}$ erg.sec

C the velocity of light in a vacuum, that is to say $2.998\ 10^{10}$ cm/sec

m the mass of a quantum of light or photon, the value of which, obtained by the calculation for the mentioned frequency, is, in round numbers, $3.75\ 10^{-33}$ grams (or more exactly $3.749\ 10^{-33}$ g).

If we now multiply by m both members of the equation (II), the result will be:

$$m\,C^2 - m\,V^2 = 2\,m\,C\,d\,const - m\,d^2\,const^2 \quad \ldots\ldots\ldots\ldots \quad \text{(III)}$$

The first member, that is $m\,C^2 - m\,V^2$, of this new equation, represents the loss of energy which the photon experiences when passing from a vacuum to the interior of a body,** and the second member shows that this loss is a function of the density d.

Effectively, in order to see clearly how this loss of energy depends on the density, it will suffice to apply the second member of the equation (III) to two bodies which belong to a same group; for instance: gum arabic and sucrose, both belonging to the group of glucides.

For gum arabic ($d = 1.35$; $const = 0.69\ 10^{10}$), the result is:

$$m\ (2\,C\,d\,const - d^2\,const^2) = 1.77\ 10^{-12}\ ergs.$$

For sucrose ($d = 1.59$; $const = 0.69 . 10^{10}$), we obtain:

$$m\ (2\,C\,d\,const - d^2\,const^2) = 2.01\ 10^{-12}\ ergs.$$

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* Those radiations which suffer alterations in their frequency, as happens in the *Compton effect* and in the *Raman effect,* etc., are excluded from this work.

** This energy which the photon loses is absorbed by the body and may produce in it physical, chemical and other phenomena. The following simile though very ordinary, can be useful to interpret what takes place: On the surface of the Eearth a body A, moving at a great velocity, encounters an immobile body *B,* collides with it, and, moves it out of its position into another at *greater height;* after the collision, body A continues to move, but at a lesser velocity, and the energy which it has lost is transfered in the state of potential energy to body *B;* now then, if body *B* goes back to the spot where it was in the moment of the collision, the potential energy which it has gained will again be transformed into kinetic, and finally, into calorific energy, radiations, etc., giving origin to physical, chemical and other phenomena. The explanation of this is found in the principle of coservation of energy and in the force of attraction (gravitation) which is exercised between bodies.

Now let us designate with the letter E the loss of energy suffered by the photon, so we will have:

$$E = m\,C^2 - m\,V^2$$

And as E must be less than or, at most, equal to $m\,C^2$, we will write:

$$E \leqq m\,C^2$$

Now, in each group there may be a body with a density resulting in $E = m\,C^2$. This density value will then be a limit value and, therefore, the bodies with a greater density will not belong to the said group.

To obtain this maximum density, we will write

$$m\,C^2 - m\,V^2 = 2\,m\,C\,d\,\text{const} - m\,d^2\,\text{const}^2$$

or

$$E = 2\,m\,C\,d\,\text{const} - m\,d^2\,\text{const}^2 \quad \ldots\ldots \ldots \quad \text{(IV)}$$

wherefrom one infers

$$-m\,\text{const}^2\,d^2 + 2\,m\,C\,\text{const}\,d - E = 0$$

that is to say a complete second grade equation in d, from which we deduce

$$d = \frac{C}{const} \mp \frac{\sqrt{m^2C^2 - m\,E}}{m\,const}$$

If we make $E = m\,C^2$, this equation will be transformed into

$$d = \frac{C}{const}$$

that is, *the maximum density.*

In accordance with this formula, the values of the maximum density, in the mentioned groups, will be:

GROUP	*MAXIMUM DENSITY*
Glucides (Carbohydrates)	4.344
Corneous and connective tissues	3.612
Fermentation alcohols	2.855

Now let us take from each group a body having the same density. If the bodies chosen in this way are represented with the letters $\alpha, \beta, \gamma, \ldots$ and we represent the groups to which they belong, respectively, with the letters $A, B, \Gamma, \ldots$ we shall have a *set of bodies with a fixed density,* or, simply, a *set.**

* As an example of a set we will mention the oil of Cinnamomum Cassia (Group of the essential Oils) and human Blood (Group of the vital Substances) which have the same density, that is, 1.055.

Let us consider the losses of energy produced by any two bodies of a set; for instance: by the bodies α and β.

We will apply equation (IV), that is

$$E = 2\ m\ C\ d\ const - m\ d^2\ const^2$$

Now, C is invariable, and m (the frequency having a determined value) does not vary either, and d is also unalterable because both bodies belong to the same set. Then, E will depend on *const*; and the losses of energy produced by the bodies α and β, will be:

$$E_\alpha = 2\ m\ C\ d\ const_A - m\ d^2\ const_A^2$$

$$E_\beta = 2\ m\ C\ d\ const_B - m\ d^2\ const_B^2$$

from which, by subtraction, we deduce:

$$E_\alpha - E_\beta = 2\ m\ C\ d\ (const_A - const_B) - m\ d^2 (const_A^2 - const_B^2)$$

A particular value is obtained when the density of the bodies of a set is equal to the unity; effectively, for $d = 1$ the former equation is transformed into

$$E'_\alpha - E'_\beta = 2\ m\ C\ (const_A - const_B) - m\ (const_A^2 - const_B^2)$$

which, applied to the fermentation alcohols and to the glucides, will give us

$$E'_\alpha - E'_\beta = 0.57\ .\ 10^{-12}\ ergs$$

that is,

$$E'_\alpha = E'_\beta + 0.57\ .\ 10^{-12}\ ergs$$

but if we applied it to the fermentation alcohols and to the corneous and connective tissues, it would give us

$$E'_\alpha = E'_\gamma + 0.34\ .\ 10^{-12}\ ergs$$

From all that has been expounded we conclude that the phenomenon of the loss of energy suffered by the photon radicates in the density of the substance and in the group to which it belongs.

Moreover, since this loss occurs in the same moment in which the light goes through the body, we deduce that it is caused by the resistance which the latter opposes, and, **as this resistance cannot be other than the expression of a quantity of energy equal in abso-**

lute value to this loss, it must be measured by the work of certain internal forces.

Now, the existence of such forces gives us the key to a clear understanding of the phenomenon of the loss of energy suffered by the photon, because the density of the bodies as well as the optical groups must naturally be consequences or results of the actions of the said forces.*

This being settled, we shall see, finally, that **in those bodies in which the dispersion presents approximate values, the relation between the losses of energy suffered by the photon, for two different values of its mass, does not change, even if the nature of the body changes.**

This new rule, which I have found, can be verified applying it to various bodies chosen at random, as may be seen in the following:

Substance	*Formula*	*Temp.* °C	*Indices of refraction* n_G' (λ_G'= 0.4340 μ)	n_C (λ_C= 0.6563 μ)	*Dispersion* $n_G' - n_C$
TABLE 1					
Glycerine	$C_3H_8O_3$	20	1.4828	1.4706	0.0122
Chloroform	$CHCl_3$	20	1.4580	1.4443	0.0137
Propyl alcohol (n)	C_3H_7OH	20	1.3938	1.3834	0.0104
Water	H_2O	20	1.3404	1.3312	0.0092
Ethyl alcohol	C_2H_5OH	20	1.3700	1.3605	0.0095
TABLE 2					
Carbon disulphide	CS_2	20	1.6748	1.6182	0.0566
Bromnaphthalene	$C_{10}H_7Br$	20	1.7041	1.6495	0.0546
Aniline	$C_6H_5NH_2$	20	1.6204	1.5793	0.0411

$C = 2.998 \quad 10^{10}$ cm/sec

$\nu_G' = C/\lambda_G' = 6.907 \,.\, 10^{14}$/sec

$\nu_C = C/\lambda_C = 4.568 \,.\, 10^{14}$/sec

The different subscripts which we have put to λ, ν, n and m correspond to the Fraunhofer lines designated with those same letters, that is, G' and C.

* **It is possible that these forces are the same that hold up the integration in the atom.**

Moreover, we have placed in each table those bodies which possess *dispersions with approximate values,* and we have also put in each one, and at the foot of them, the indispensable data to make the following calculations.

But, first, in order to simplify those calculations, we shall transform $mC^2 - mV^2$ into $\nu h(1 - 1/n^2)$ making use of the equalities $m = \nu h/C^2$, $n = C/V$. In this way, we shall be able to write:

$$E = m\,C^2 - m\,V^2 = \nu\,h\left(1 - \frac{1}{n^2}\right)$$

whence we deduce

$$\frac{E_{G'}}{E_C} = \frac{m_{G'}C^2 - m_{G'}V_{G'}^2}{m_C C^2 - m_C V_C^2} = \frac{\nu_{G'}}{\nu_C}\;\frac{1 - \dfrac{1}{n_{G'}^2}}{1 - \dfrac{1}{n_C^2}}$$

Relation which applied to the bodies represented in Table 1, will give:

Substance	$\dfrac{E_{G'}}{E_C}$
Glycerine	1.53
Chloroform	1.53
Propyl alcohol (n)	1.53
Water	1.53
Ethyl alcohol	1.53

If, in the same way, we apply the said relation to the bodies of Table 2, we shall obtain the following results:

Substance	$\dfrac{E_{G'}}{E_C}$
Carbon disulphide	1.57
Bromnaphthalene	1.56
Aniline	1.56

The relation $E_{G'}/E_C$ is, therefore, *invariable* in the bodies which present dispersions whose values differ little.

Now, if we wish to carry further the verification of this rule, we can substitute the mass $m_{G'}$ by m_H, and choose, in order to apply it, some of the bodies already mentioned.

For instance:

Substance	*Temp.* °C	*Indices of refraction* n_H* ($\lambda_H = 0.3968\mu$)	n_C ($\lambda_C = 0.6363\ \mu$)	*Dipersion* $n_H - n_C$	$\frac{E_H}{E_C}$
Water	20	1.3435	1.3312	0.0123	1.69
Chloroform	20	1.4630	1.4443	0.0187	1.69
Carbon disulphide	20	1.6994	1.6182	0.0812	1.74
Bromnaphthalene	20	1.7289	1.6495	0.0794	1.74

$C = 2.998 \,.\, 10^{10}$ cm/sec

$\nu_H = C/\lambda_H = 7.554 \quad 10^{14}$/sec

$\nu_C = C/\lambda_C = 4.568 \,.\, 10^{14}$/sec

$$\frac{E_H}{E_C} = \frac{\nu_H (1 - 1/n_H^2)}{\nu_C (1 - 1/n_C^2)}$$

KINETIC ENERGY OF THE PHOTON

We have seen, as we made the exposition of this theory, that from one of the fundamental equations of its development, that is, of equation (III), we deduce (and this constitutes a discovery of importance) that the kinetic energy of the photon, *when the latter moves in the interior of a body,* is not represented by the formula of classical mechanics $m\,V^2/2$, nor by the formula of the relativistic mechanics of Einstein: **

$$\frac{m\,C^2}{\sqrt{1 - V^2/C^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (V)$$

but rather by a much more simple one, that is, by $m\,V^2$, or

$$\nu h \frac{V^2}{C^2}$$

* The values of the indices of refraction which figure in this column correspond to the line *H* of the calcium.

** This relativistic formula neither represents the kinetic energy of the photon, *when the latter moves in vacuo;* effectively, for $V = C$, the expression (V) becomes infinite.

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