ELASTIC WAVES DUE TO OPTICAL POTENTIAL

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The phenomenon of optical potential producing elastic waves has been studied. The possibility for absorption is considered and the possibility of the conversion of elastic waves into photoelectric current or other forms of radiation is discussed.

Fornbach et. al.[1] considered the nucleus as continuous optical medium having definite refractive index and absorption coefficient. Byfield, et. al.[2] solved Schödinger equation and expressed meson nucleus interaction. Watson[3] considered meson as sufficiently energetic and moving with a velocity which is of the order of the velocity of light c. When it impacts on nucleus, two phenomena occur—(i) Scattering[2,4-10] and (ii) Shock waves carrying nuclear excitation are formed when internal atomic configuration is undisturbed. The velocity of nucleus responsible for shock waves follows, and meson responsible for optical potential impacts repeatedly till it is finally absorbed or scattered. Considering the scattering phenomenon, Watson[3] neglected the phenomenon of 'field effect' which corresponds to the recreation of meson. When meson is once absorbed, scattering ends but simultaneously the absorbed meson affects atomic configuration and elastic waves form which get converted into heat radiation or photoelectric current according to different circumstances as we can see in television and photoelectric cells.

The photomeson problem is represented by Watson[3] thus :

$$\Phi = 1 + \Omega a^{-1} H' \tag{1}$$

where Φ is the wave matrix, H' the perturbation and Ω the scattering of meson in nucleus.

$$\begin{aligned} \Phi &= 1 + \left[1 + \left(\frac{1}{a}\right) R \right] F\,\Omega_c \left(\frac{1}{a}\right) H' \\ &= 1 + \left[1 + \left(\frac{1}{a}\right) R \right] F \left(\frac{1}{e}\right) H' \end{aligned} \tag{2}$$

where $\Omega_c \left(\frac{1}{a}\right) = \frac{1}{e}$, e being an algebraic entity.

The transition operator T is defined by

$$T = (H' + R + V)\,\Phi \tag{3}$$

$$T = H' + (V + \triangle)\,F\Omega_c \left(\frac{1}{a}\right) H' + RF \left(\frac{1}{e}\right) H' \tag{4}$$

(for absorption)

$$(V + \triangle) F\left(\frac{1}{e}\right) H' = \left\{ (t_c + \triangle) + \left[1 + (t_c + \triangle)\left(\frac{1}{e}\right) \right] \sum_{\alpha_1} I_{\alpha_1} F_{\alpha_1} \right\} \left(\frac{1}{e}\right) H' \quad (5)$$

which splits up in the following parts :

$$T = T_a + T_s + T_\pi$$

$$T_a = RF \left(\frac{1}{e}\right) H'$$

$$T_s = \left[1 + (t_c + \triangle) \left(\frac{1}{e}\right) \right] \sum I_{\alpha_1}, F_{\alpha_1} \left(\frac{1}{e}\right) H'$$

$$T_\pi = \left[1 + (t_c + \triangle) \left(\frac{1}{e}\right) \right] H'$$

where T_a stands for the transition operator for absorption, T_s for scattering and T_π for neither absorption nor scattering. For absorption of photomeson and for producing change in the atomic configuration, the transition state is denoted by I and represented by the equation

$$< I \left| T_a \right| A > = < I \left| 1 + (t_c + \triangle) + \frac{1}{e} \right| I > < I \left| H' \right| A > \quad (6)$$

The transition operator in the case of elastic phenomenon is

$$\left(I_q \left| T_a \right| A_\gamma \right) = \left(\lambda_q \overset{(-)+}{\Omega_c} < I \left| H' \right| A > \right) \quad (7)$$

where $\overset{(-)+}{\Omega} = 1 + (t_c + \triangle) \left(\frac{1}{e}\right)$ and λ_q is a plane wave. The possibility for the absorption of photomeson has been derived by Watson[3] by the equation,

$$P_a = \pi < T_a^+ \delta (E_A - H_0) T_a >$$

$$= \pi < H' \left(\frac{1}{e}\right)^+ \overset{+}{F} R \delta (E_A - H_0) RF \left(\frac{1}{e}\right) H' > \quad (8)$$

Neglecting small contribution from cross-section term, we have

$$P_a = < H' \left(\frac{1}{e}\right)^+ \triangle_0 \left(\frac{1}{e}\right) H' > + < H' \left(\frac{1}{e}\right)^+ (\overset{+}{F} - 1) \triangle_0 (F - 1) \frac{1}{e} H' > \quad (9)$$

Kelly[11] considered the optical potential as

$$V_{op} = V^{(0)}{}_{op} + V'_{op} \quad (10)$$

where $\overset{(0)}{V}_{0p}$ is the contribution of V_{0p} used for interaction with nucleus, i.e.

$$\overset{(0)}{V}_{0p} = -\frac{Ze^2}{r} + V \tag{11}$$

The conservation of energy in case of interaction of photons is represented by Einstin's equation

$$hr = \frac{mv^2}{2} + e\phi \tag{12}$$

where ϕ is the potential function for electron for the material. Since we are concerned with the absorbed photons,

$$\frac{mv^2}{2} + e\phi = -\frac{Ze^2}{r} + V$$

or

$$v^2 = \frac{2}{m}\left[-\frac{Ze^2}{r} + V - e\phi\right]$$

so that

$$v^2 = \frac{2}{m}\left[V_{0p} - e\phi\right] \tag{13}$$

Yette investigated the photoeffect by means of suspended dust particle carrying charge and its weight counter-balanced by electric field. We write

$$qE = mg \tag{14}$$

where m is the mass and q is the charge in the photoeffect process. As the particle loses the charge its sign changes from $(q+e)$ to $(q-e)$, that is,

$$(q \pm e)\frac{E}{\rho} = \frac{mg}{\rho}$$

Since $v = \sqrt{\frac{E}{\rho}}$ for elastic waves,

$$(q \pm e)\, v^2 = \frac{mg}{\rho} \tag{15}$$

From (13) and (15) we have

$$v^2 = \frac{2}{m}\left[V_{0p} - e\phi\right] = \frac{E}{\rho}$$

If the surface of substance constitute condenser plate, photoelectric current flows through the circuit in which the condenser is connected. If appropriate voltage is not supplied, current ceases to flow according to the condition $eU_b = \frac{mv^2}{2}$. When the electrons are dislodged from a great inner depth, their velocity is small. Thus the coating of suitable compound causes the emission of electron from the upper surface and so provides greater intensity to photoelectric current.

Thus we see that absorption of optical potential from elastic waves by suitable arrangement in which electrons are dislodged from outer surface, photoelectric current flows or exposes photographic plates; otherwise it is damped and ceases to show any photoeffect further.

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