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LINEAR FUNCTIONAL TRANSFORMATION OF ELECTROMAGNETIC WAVE THROUGH VOLTERRA FUNCTIONAL

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ABSTRACT

Vitto Volterra defined functional as a law given by which to every function $x(t)$ defined within (a,b) there can be made to correspond one and only one quantity z perfectly determined. The definition of the functional was a particular case of mapping where the domain contains only the set of functions. Later the function of a line was introduced. It was shown that in this case also the functional was linear functional. By using the functional which the function of a line I showed that the electromagnetic wave was linearly transformed into straight line and vice versa.

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INTRODUCTION

In notation form the functional was written as $z = F\left[x(t)\right]$, where $x(t)$ was the function, (a,b) is the interval, F was the law and z was the unique quantity. Later the functional of the line was introduced (Volterra, 1959). A quantity was a function of lines L closed and not intersection in space. There can be made to correspond a definite value of the quantity which can be denoted by $F(L)$. These function of the lines will evidently be particle functional of the three functions $x(s), y(s), z(s)$ which gave the coordinates x, y, z of the points of the line L as s varies between limits 0 and S. Volterra functional and integro differential equation (4) was used in various branches of mathematical physics. Moisal (Volterra, 1959) worked on functional dynamics considering a set of functions as coordinates. The group of all functional transformations was envisaged by Jain *et al*. (1980) in their modification of Einstein's non symmetric theory. Samiuddin *et al*. (1991, 2013) studied the functional non symmetric field theory through film space technique. In this study the dynamical theory energy conversion has yielded new terms of far reaching importance.

Linear functional

Let there be two function $y_1(t)$ and $y_2(t)$ such that

$$F\left[y_1(t)\right] = z_1 \text{ and } F\left[y_2(t)\right] = z_2 \text{ and } F\left[y(t)\right] = z \quad (1)$$

Such that $z = \alpha z_1 + \beta z_2$ (2)

then $F[y(t) = z = \alpha z_1 + \beta z_2 = \alpha F[y_1(t)] + \beta F[y_2(t)]$ (3)

Hence the functional is linear.

Equation of electromagnetic wave

The wave equation is a second order linear partial differential. Light also comes under electromagnetic spectrum. Electromagnetism has dual property. According to Newton the light was made up of tiny particles moving in a straight line but Huygen view was that light is made up of wave vibrating up and down perpendicular to the direction in which light travels.

Electromagnetic wave equations are

$$(c^2\Delta^2 - \frac{\partial^2}{\partial t^2})\vec{E} = 0 \qquad (4)$$

$$(c^2\Delta^2 - \frac{\partial^2}{\partial t^2})\vec{B} = 0 \qquad (5)$$

$$\Rightarrow E = B \qquad (6)$$

Hence the general electromagnetic wave equation can be written as

$$F(x,y,z,t) = 0 \qquad (7)$$

Linear transformation

Sine curve as light wave: Light also comes under electromagnetic spectrum. Electromagnetism has dual properties It is made up of particles and it is also in wave form. According to Newton the light is made up of tiny particles travelling in a straight line. And according to Huygen light is made up of waves vibrating up and down perpendicular to the direction in which light travels. When dealing with the light wave it can be referred to the sine wave.

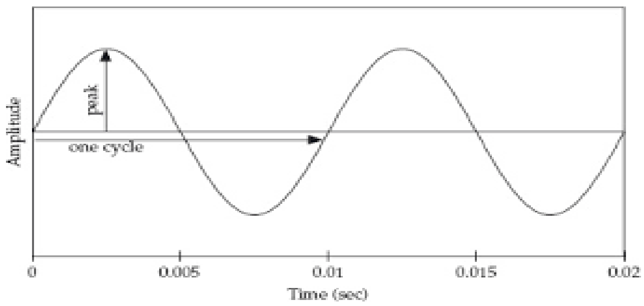

Figure: Sine curve referred to light wave

Let the equation of the sine curve be f(x,t)=0 (8)

First it will be shown that F: f(x,t) -----→z is a linear functional.

Let $Ff(x_1,t_1) = z_1$, $Ff(x_2,t_2) = z_2$ Ff(x,t)=z (9)

Let $Ff(x,t) = F[\alpha f(x_1,t_1) + \beta f(x_2,t_2)]$ (10)

And let $z = \alpha z_1 + \beta z_2$ (11)

Now $Ff(x,t) = F[\alpha f(x_1,t_1) + \beta f(x_2,t_2)] = \alpha z_1 + \beta z_2$
$= \alpha F(x_1,t_1) + \beta Ff(x_2,t_2)$ (12)

Therefore

$$F[\alpha f(x_1,t_1) + \beta f(x_2,t_2)] = \alpha F[f(x_1,t_1)] + \beta F[f(x_2,t_2)] \qquad (13)$$

Or $F[f(x_1,t_1) + f(x_2,t_2)] = F[f(x_1,t_1)] + F[f(x_2,t_2)]$ (14)

Hence the functional is linear. Therefore F linearly transform the curve into a quantity.

Let the sine curve in the interval $(0,b)$ be divided into equal interval say $(0,\lambda),(\lambda,2\lambda)........((n-1)\lambda + n\lambda = b)$ (15)

Since curve was divided in equal intervals hence $\alpha = \beta = 1$ therefore the condition for linearity will be

$$F[f(x_1,t_1) + f(x_2,t_2)] = F(f(x_1,t_1)) + F(f(x_2,t_2)) \qquad (16)$$

Thus the domain has n small curves. Now we shall make 1 assumptions:

1) The F image of $f(x,t)$ will fall in the same interval of co domain (X,T) i.e the curve $f(x,t)$ is in $(0,\lambda)$ then z will also be in the interval $(0,\lambda)$ thus the mapping will be one-one.

Hence, Co domain will have only F images of n curves i.e co domain = range. Hence F will onto mapping. Thus F will be one-one onto mapping. Hence inverse mapping will exist.

Since the mapping F is a one-one onto mapping hence $F^{-1} : z \rightarrow f(x,t)$ exists.

Now I shall prove that

$$F^{-1}(\alpha z_1 + \beta z_2) = \alpha F^{-1} z_1 + \beta F^{-1} z_2 \qquad (17)$$

Let $Ff(x,t) = z, \therefore F^{-1}z = f(x,t)$, $Ff(x_1,t_1) = z_1$,

$\therefore F^{-1}(z_1) = f(x_1,t_1)$, $Ff(x_2,t_2) = z_2 \therefore F^{-1}z_2 = f(x_2,t_2)$ (18)

Let $z = \alpha z_1 + \beta z_2$ (19)

Now

$$F^{-1}(z) = F^{-1}(\alpha z_1 + \beta z_2) \qquad (20)$$

Let $f(x,t) = \alpha f_1(x_1,t_1) + \beta f_2(x_2,t_2)$ (21)

$$\therefore F^{-1}(\alpha z_1 + \beta z_2) = \alpha F^{-1} z_1 + \beta F^{-1} z_2 \qquad (22)$$

$$= \alpha F^{-1} z_1 + \beta F^{-1} z_2 \qquad (23)$$

Hence F^{-1} is also a linear functional therefore the transformation is a linear transformation.

Conclusion

Light wave is a path of particle. This path is transformed into a quantity. Hence practically the quantity shows the position of the particle. All these n positions are in a straight line thus the the wave is transformed into positions of the particles in a straight line. Since F^{-1} exists and is linear functional hence the transformation F^{-1} transform the particle into wave.

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