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Application of Fourier Transform in Determining the Velocity Profile of HIV/AIDS in the Human Blood Circulating System

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Abstract:
In this work, the mechanism of Fourier transform technique in determining the characteristics of the velocity profile of HIV/AIDS in the Human blood circulating system is here presented. We utilized the known dynamical characteristics of the vibrations of HIV 'parasitic wave' and those of Man 'host wave' obtained from a previous study to determine quantitatively the velocity of HIV/AIDS in the human system. It is shown, how adequate and effective the constituted carrier wave (CCW) with time dependent oscillating phase could explain the coexistence of HIV/AIDS and Man. We also determined the possible time taken for the HIV infection to degenerate to AIDS due to alteration in the velocity of the 'host wave'. This study revealed that the spectrum of the velocity profile of the CCW become parasitically monochromatic with slow varying frequency beyond 69 months (6 years) and the velocity of the CCW finally fluctuates to zero after about 126 months (10 years). It is also established that reduction in the velocity of the CCW causes a delay or a slow down process in the energy transfer mechanism which eventually leads to energy attenuation in a HIV/AIDS patient. The average survival time after infection with HIV is found in this study to be 6 to 10 years.

***Keywords**: latent vibration, 'host wave', 'parasitic wave', CCW, HIV/AIDS, 'third world approximation'*

1. Introduction

Since the advent of the human immunodeficiency virus (HIV) several theoretical methods have been propounded by scientists in different fields of knowledge in view of finding a cure to the deadly disease. However, none of these measures have been able to take Man beyond the threshold of this prevalent disease. It is therefore sufficient to say that the concepts advanced so far by scientists about the HIV/AIDS are still inadequate and needs further evaluation. Advancements in medical procedures and devices require a better understanding of the dynamical properties of HIV/AIDS and its formation.

The role of Human-Immunodeficiency Virus (HIV) in the normal blood circulating system of Man (host) has in general been poorly understood. However, its role in clinical disease has attracted increasing interest. Human immunodeficiency virus (HIV) infection / acquired immunodeficiency syndrome (AIDS) is a disease of the human immune system caused by HIV [1]. During the initial infection a person may experience a brief period of influenza-like illness.

This is typically followed by a prolonged period without symptoms. As the illness progresses it interferes more and more with the immune system, making people much more likely to get infections, including opportunistic infections, which do not usually affect people with immune systems [2]. In the absence of specific treatment, around half of the people infected with HIV develop AIDS within 10 years and the average survival time after infection with HIV is estimated to be 9 to 11 years [3].

According to the literature of clinical diseases, the HIV feeds on and in the process kills the active cells that make up the human immune system. This is a very correct statement but not a unique understanding. There is also a cause (vibration) that gives the HIV its own intrinsic characteristics, activity and existence. It is not the human system that gives the HIV its life and existence, since the HIV itself is a living organism and with its own peculiar characteristics even before it entered the system of Man. It is the vibration of the unknown force that causes life and existence. Therefore, for any active biological matter to exist it must possess vibration. The human heart stands as a transducer of this vibration and fortunately the blood stands as a means of conveying this vibration to all units of the human biological system [4].

Every material contains particles. When a wave travels through a material, the oscillating field in the wave will set some of these particles into forced vibration, and the vibrating particles will generate new waves of their own. If the participating particles are sufficiently close together, they will be driven coherently, with quite different results. In this case, the scattered waves can be superposed with the direct wave, giving rise to a new disturbance which will be the wave in the material.

Human blood is a liquid tissue composed of roughly 55% fluid plasma and 45% cells. The three main types of cells in blood are red blood cells, white blood cells and platelets. 92% of blood plasma is composed of water and the other 8% is composed of proteins, metabolites and ions [5]. The density of blood plasma is approximately 1025 kg/m^3 and the density of blood cells circulating in the blood is approximately 1125 kg/m^3. Blood plasma and its contents are known as whole blood [6].

The average density of whole blood for a human is about 1050 kg/m^3. Blood viscosity is a measure of the resistance of blood to flow, which is being deformed by either shear or extensional strain [7]. The dynamic viscosity of the human blood at 37^{0}C is usually between 0.003 and 0.004 kgm^{-1}s^{-1}, while the arterial blood perfusion rate, which is the delivery of arterial blood to a capillary bed in the human biological tissue, is 0.5 kgm^{-3}s^{-1}[8]. The viscosity of blood thus depends on the viscosity of the plasma, in combination with the particles. However, plasma can be considered as a Newtonian fluid, but blood cannot due to the particles which add non-idealities to the fluid.

Fourier series has long provided one of the principal methods of analysis for mathematical physics, engineering, and signal processing. It has spurred generalizations and applications that continue to develop right up to the present. While the original theory of Fourier series applies to periodic functions occurring in wave motion, such as with light and sound, its generalizations often relate to wider settings, such as the time-frequency analysis underlying the recent theories of wavelet analysis and local trigonometric analysis. Periodic functions arise in the study of wave motion, when a basic waveform repeats itself periodically [9].

We also introduced a new method of approximation, otherwise, called the 'third world approximation' to derive the velocity of the CCW. The approximation we adopted here has the advantage of converging results easily by direct analysis of the region of space of interest.

In this work, we utilized the known dynamical characteristics of the vibration of HIV and those of Man from a previous study to determine quantitatively the velocity profiles of HIV/AIDS in the human circulating blood system. The HIV vibration is referred to as the 'parasitic wave' while that of Man as the 'host wave' and the combined effect of the two interfering waves is the constituted carrier wave [10].

The aim of the present study was to characterize the mechanism of Fourier transform technique in determining the velocity profiles of HIV/AIDS in the Human blood circulating system. Also we want to establish the adequacy and effectiveness of the CCW with time dependent oscillating phase $E(t)$ in explaining the coexistence of HIV/AIDS in the Human system. It is our interest also to show in this study, the possible time taken for the HIV infection to degenerate to AIDS due to the alteration in the velocity process.

This paper is outlined as follows. Section 1, illustrates the basic concept of the work under study. The mathematical theory is presented in section 2. The results obtained are shown in section 3. While in section 4, we present the analytical discussion of the results obtained. The conclusion of this work is shown in section 5. This is immediately followed by appendix of some useful identities and a list of references.

1.1. Research Methodology

In this current study, we first superposed a 'parasitic wave' on a 'host wave' and we used the 'third world approximation' to derive the velocity of the CCW, which is the combined effect of the superposition of the two waves. Finally, we then applied the Fourier transform technique to study the behaviour of the CCW as it propagates between the time interval of 0 and 126 months.

2. Mathematical Theory

2.1. Dynamical theory of superposition of two incoherent waves

The activity of the HIV is everywhere the same within the human blood circulating system, mutation if at all does not affect its activity. That the HIV kills slowly with time shows that the wave functions of the HIV and that of the host were initially incoherent. As a result, the amplitude, angular frequency, wave number and phase angle of the host which are the basic parameters of vibration were initially greater than those of the HIV parasite.

The interference of one wave y_2 say 'parasitic wave' on another one y_1 say 'host wave' , the interference could cause the 'host wave' to decay to zero if they are out of phase. The decay process of y_1 can be gradual, over-damped or critically damped depending on the rate in which the amplitude is brought to zero. However, the general understanding is that the combination of y_1 and y_2 would first yield a third stage called the resultant wave y, before the process of decay sets in.

In this work, we refer to the resultant wave as the constituted carrier wave (CCW). That the HIV kills slowly with time shows that the wave functions of the HIV and that of Man (host) were initially incoherent. As a result, the amplitude, angular frequency, wave number and phase angle of the host which are the basic parameters of wave and vibration were initially greater than those of the HIV. Now let us consider two incoherent waves defined by the non-stationary displacement vectors

$$y_1 = a\beta \cos\left(\vec{k}\beta\,.\,\vec{r} - n\beta\, t - \varepsilon\, \beta\right) \qquad (2.1)$$

$$y_2 = b\lambda \cos\left(\vec{k}'\lambda\,.\,\vec{r} - n'\lambda\, t - \varepsilon'\, \lambda\right) \qquad (2.2)$$

where all the symbols have their usual wave related meaning. In this study, (2.1) is regarded as the Human 'host wave' whose propagation depends on the inbuilt multiplier β(= 0, 1, 2, . . . β_{max}). While (2.2) represents the HIV 'parasitic wave' with an inbuilt multiplier λ(= 0, 1, 2, . . . λ_{max}). The inbuilt multipliers are both dimensionless and as the name implies, they have the ability of gradually raising the basic parameters of both waves respectively with time. We have established in a previous paper [10] that when (2.2) is superposed on (2.1) accordingly we get after some algebra that

$$y = y_1 + y_2 = a\beta \cos\left(\vec{k}\beta . \vec{r} - n\beta\, t - \varepsilon\, \beta\right) + b\lambda \cos\left(\vec{k}'\lambda . \vec{r} - n'\lambda\, t - \varepsilon'\, \lambda\right) \qquad (2.3)$$

$$y = \left\{(a^2 - b^2\lambda^2) - 2\left(a - b\lambda\right)^2 \cos\left((n - n'\lambda)\, t - (\varepsilon - \varepsilon'\lambda\right)\right\}^{\frac{1}{2}} \cos\left(\vec{k}_c . \vec{r} - (n - n'\lambda)\, t - E(t)\right) \qquad (2.4)$$

In this study, equation (2.4) is regarded as the constituted carrier wave (CCW) and it is the equation that governs the dynamical behaviour of the coexistence of the HIV parasite in the human blood circulating system. Note that the multiplier β is assumed to be a constant in this work, hence β =1. It is clear from the equation that once the multiplier λ raises the parameters of the HIV parasite to become equal to those of Man (host), then the CCW goes to zero and the host system ceases to exist. However, for clarity of purpose we shall redefine in this work some of the parameters appearing in (2.4).

The total phase angle of the CCW is represented by $E(t)$, $\vec{k}_c . \vec{r}$ is the coordinate position vector. However, in this work we made the displacement vector represented by the CCW independent of space by simply using $\vec{k}_c . \hat{r}$ instead of $\vec{k}_c . \vec{r}$ where we already know that $\hat{r} = \vec{r} / r = \cos\varphi + \sin\varphi$ is a unit vector.

$$E(t) = \tan^{-1}\left(\frac{a \sin\varepsilon + b\lambda \sin\left(\varepsilon'\lambda - (n - n'\lambda)\, t\right)}{a \cos\varepsilon + b\lambda \cos\left(\varepsilon'\lambda - (n - n'\lambda)\, t\right)}\right) \qquad (2.5)$$

The variation of the total phase angle with time gives the characteristic angular velocity $Z(t)$ of the CCW.

$$\frac{dE(t)}{dt} = -Z(t) = -\left((n - n'\lambda)\right)\left(\frac{b^2\lambda^2 + ab\lambda \cos\left((\varepsilon - \varepsilon'\lambda) + (n - n'\lambda)\, t\right)}{a^2 + b^2\lambda^2 + 2ab\lambda \cos\left((\varepsilon - \varepsilon'\lambda) + (n - n'\lambda)\, t\right)}\right) \qquad (2.6)$$

We should understand at this point that $\vec{k}_c . \vec{r} = (k - k'\lambda)\, r\, (\cos\varphi + \sin\varphi)$ or $\vec{k}_c . \hat{r} = (k - k'\lambda)\, (\cos\varphi + \sin\varphi)$ is a two dimensional (2D) space vector and $\varphi = \pi - (\varepsilon - \varepsilon'\lambda)$ from the geometry of the two interfering waves. By definition: $(n - n'\lambda)$ the modulation angular frequency, the modulation propagation constant $(k - k'\lambda)$, the phase difference δ between the two interfering waves is $(\varepsilon - \varepsilon'\lambda)$, the interference term is $2\left(a - b\lambda\right)^2 \cos\left((n - n'\lambda)\, t - (\varepsilon - \varepsilon'\lambda\right)$, while waves out of phase interfere destructively according to $\left(a - b\lambda\right)^2$ and waves in-phase interfere constructively according to $\left(a + b\lambda\right)^2$. In the regions where the amplitude of the wave is greater than either of the amplitude of the individual wave, we have constructive interference that means the path difference is $(\varepsilon + \varepsilon'\lambda)$, otherwise, it is destructive in which case the path difference is $(\varepsilon - \varepsilon'\lambda)$. We can decompose the constituted carrier wave CCW into two functions; function of the oscillating amplitude $f(A)$ and the function of the spatial oscillating phase $f(\theta)$, where

$$f(A) = \left\{(a^2 - b^2\lambda^2) - 2\left(a - b\lambda\right)^2 \cos\left((n - n'\lambda)\, t - (\varepsilon - \varepsilon'\lambda\right)\right\}^{\frac{1}{2}} \qquad (2.7)$$

$$f(\theta) = \cos\left(\vec{k}_c . \hat{r} - (n - n'\lambda)\, t - E(t)\right) \qquad (2.8)$$

2.2. Application of the "third world approximation" on the oscillating amplitude $f(A)$ of the CCW

Equation (2.7) is comprehensively valid in the macroscopic scale. However, if we implement the "third world approximation" which we developed in a previous paper [10] and then the function can be made valid for both macroscopic and microscopic scale. The "third world approximation" states that

$$\left(1 + \xi\ f(\phi)\right)^{\pm\, n} = \frac{d}{d\phi}\left(1 + n\ \xi\ f(\phi) + \frac{n\,(n-1)}{2!}\left(\xi\ f(\phi)\right)^2 + \frac{n\,(n-1)(n-2)}{3!}\left(\xi\ f(\phi)\right)^3 + \ldots\right) - n\frac{d}{d\phi}\left(\xi\ f(\phi)\right) \qquad (2.9)$$

We should emphasize here that ϕ is a function of any variable which depends upon the dimension of the physical parameter we are investigating. However, in this study ϕ is taken as the time. In this approximation, the first term in the series or 'first world' is usually a constant while the rest of the series is based on the choice of the parameter under evaluation.

For instance, the dimension of (2.7) is meters and if we apply (2.9) on it, then the first two terms, otherwise, the 'first world' and the 'second world' terms are both switched off leaving the third term or the 'third world' in m/s or rad/s which is the dimension of velocity or angular velocity respectively. This approximation has the advantage of converging results easily by taking us to the region of space of our interest and also to produce the expected minimized results.

Now let us rearrange (2.7) for the utilization of (2.9) that is

$$f(A) = \left(a^2 - b^2\lambda^2\right)^{\frac{1}{2}}\left\{1 - \frac{2\left(a - b\lambda\right)^2}{(a^2 - b^2\lambda^2)}\cos\left((n - n'\lambda)\, t - (\varepsilon - \varepsilon'\lambda)\right)\right\}^{\frac{1}{2}} \qquad (2.10)$$

It can be shown that after a careful implementation of (2.9) in the parenthesis of (2.10) then the result is

$$\left\{1 - \frac{2\left(a - b\lambda\right)^2}{(a^2 - b^2\lambda^2)}\cos\left((n - n'\lambda)\, t - (\varepsilon - \varepsilon'\lambda\right)\right\}^{\frac{1}{2}} = \frac{\left(a - b\lambda\right)^4 (n - n'\lambda)}{2(a^2 - b^2\lambda^2)^{3/2}} \sin 2\left((n - n'\lambda)\, t - (\varepsilon - \varepsilon'\lambda)\right) \qquad (2.11)$$

That is, we have used the fact that $\sin 2\theta = 2\sin\theta\cos\theta$ in the simplification to get the result. Hence

$$f(A) = \frac{(a-b\lambda)^4 (n-n'\lambda)}{2(a^2-b^2\lambda^2)^{3/2}} \sin 2\left((n-n'\lambda)t-(\varepsilon-\varepsilon'\lambda)\right) = Q(n-n'\lambda)\sin 2\left((n-n'\lambda)t-(\varepsilon-\varepsilon'\lambda)\right) \qquad (2.12)$$

Where for the purpose of linearity we have decided to introduce the a new parameter as

$$Q = \frac{(a-b\lambda)^4}{2(a^2-b^2\lambda^2)^{3/2}} \qquad (2.13)$$

2.3. Fourier series expansion of the oscillating amplitude $F\left[f(A)\right]$ of the CCW

The cornerstone of Fourier theory is a theorem which states that almost any periodic function can be analyzed into a series of harmonic functions with periods τ, $\tau/2$, $\tau/3$, ... , where τ is the period of the function under analysis. Expansion of an oscillating function by Fourier series gives all modes of oscillation (fundamental and all overtones) which is extremely useful in physics [9], [11]. In particular, astronomical phenomena are usually periodic, as are animal heartbeats, tides and vibrating strings, so it makes sense to express them in terms of periodic functions. Now, by expanding the oscillating term of (2.12) in terms of Fourier series we get

$$F\left[f(A)\right] = C_0 + C_1\left(\sin 2\left(1(n-n'\lambda)t-(\varepsilon-\varepsilon'\lambda)_1\right)\right) + C_2\left(\sin 2\left(2(n-n'\lambda)t-(\varepsilon-\varepsilon'\lambda)_2\right)\right) +$$
$$C_3\left(\sin 2\left(3(n-n'\lambda)t-(\varepsilon-\varepsilon'\lambda)_3\right)\right) + \ldots + C_\alpha\left(\sin 2\left(\alpha(n-n'\lambda)t-(\varepsilon-\varepsilon'\lambda)_\alpha\right)\right) \qquad (2.14)$$

$$F\left[f(A)\right] = C_0 + \sum_{\alpha=1}^{\infty} C_\alpha\left(\sin 2\left(\alpha(n-n'\lambda)t-(\varepsilon-\varepsilon'\lambda)_\alpha\right)\right) \qquad (2.15)$$

The constant term C_0 may be thought of as a harmonic with zero frequency. Each term in the series has amplitude and a phase constant; by adjusting these we can expand the various harmonics vertically, or shift them horizontally, to make the superposition fit the function $F\left[f(A)\right]$. Harmonic analysis consists essentially of finding C_α and $(\varepsilon-\varepsilon'\lambda)_\alpha$ for each value of α. From (2.15) it is however not always convenient to specify amplitude and phase [12], we can decompose the last term as

$$C_\alpha\left(\sin 2\left(\alpha(n-n'\lambda)t-(\varepsilon-\varepsilon'\lambda)\right)\right) = A_\alpha \cos 2\alpha(n-n'\lambda)t + B_\alpha \sin 2\alpha(n-n'\lambda)t \qquad (2.16)$$

By specifying the modulation amplitudes A_α and B_α as components of the variable phase angle we get

$$\left.\begin{aligned} A_\alpha &= C_\alpha \cos 2(\varepsilon-\varepsilon'\lambda) \\ B_\alpha &= -C_\alpha \sin 2(\varepsilon-\varepsilon'\lambda) \end{aligned}\right\} \Rightarrow \quad C_\alpha = \sqrt{A_\alpha^2 + B_\alpha^2} \qquad (2.17)$$

The negative sign indicates complex conjugate of the real part and the inclusions will make the dynamic components of the phase angle real. Thus (2.17) represents the amplitude of the nth harmonic. Where α is the Fourier index. From (2.16), if $\alpha = 0$, then

$$C_0 = -\frac{1}{\sin 2(\varepsilon-\varepsilon'\lambda)} A_0 \qquad \because\ (\sin(-x) = -\sin x) \qquad (2.18)$$

Consequently the series given by (2.15) can be rewritten using (2.16) and (2.18) as

$$F\left[f(A)\right] = -\frac{1}{\sin 2(\varepsilon-\varepsilon'\lambda)} A_0 + \sum_{\alpha=1}^{\infty}\left(A_\alpha \cos 2\left(\alpha(n-n'\lambda)t\right) + B_\alpha \sin 2\left(\alpha(n-n'\lambda)t\right)\right) \qquad (2.19)$$

where A_0, A_α and B_α are the Fourier coefficients of the series expansion. The first term in the RHS of (2.19) is the fundamental oscillating amplitude, while the other two terms represent the even and odd series respectively. However, in this work our calculation was based on the convergence of both the even and odd series.

2.4. Determination of the Fourier coefficients of the oscillating amplitude $F\left[f(A)\right]$ of the CCW

The Fourier components C_α in (2.15) which is specified in (2.17) and (2.19) are given by the Euler formulas

$$A_0 = \frac{1}{\tau}\int_0^\tau f(A)\,dt = \frac{1}{\tau}\int_0^\tau Q(n-n'\lambda)\sin 2\left((n-n'\lambda)t-(\varepsilon-\varepsilon'\lambda)\right)dt \qquad (2.20)$$

$$A_\alpha = \frac{1}{\tau}\int_0^\tau f(A)\cos 2\left(\alpha(n-n'\lambda)t\right)dt = \frac{1}{\tau}\int_0^\tau Q(n-n'\lambda)\sin 2\left((n-n'\lambda)t-(\varepsilon-\varepsilon'\lambda)\right)\cos 2\left(\alpha(n-n'\lambda)t\right)dt \qquad (2.21)$$

$$B_\alpha = \frac{1}{\tau}\int_0^\tau f(A)\sin 2\big(\alpha\,(n-n'\lambda)\,t\big)\,dt = \frac{1}{\tau}\int_0^\tau Q(n-n'\lambda)\sin 2\big((n-n'\lambda)\,t-(\varepsilon-\varepsilon'\lambda)\big)\,\sin 2\big(\alpha\,(n-n'\lambda)\,t\big)dt \qquad (2.22)$$

where τ is the period of the function under analysis, here it is the period of the latent vibration of the CCW generated by the beating of the human heart. In this work, we define $\tau(n-n'\lambda)=2\pi$. Let us now evaluate (2.20) for A_0 as follows. Direct integration and rearrangement gives

$$A_0 = \frac{Q}{2\tau}\left\{\cos 2(\varepsilon-\varepsilon'\lambda) - \cos 2\big((n-n'\lambda)\,\tau-(\varepsilon-\varepsilon'\lambda)\big)\right\} \qquad (2.23)$$

$$A_0 = \frac{(a-b\lambda)^4(n-n'\lambda)}{8\pi(a^2-b^2\lambda^2)^{3/2}}\left\{\cos 2(\varepsilon-\varepsilon'\lambda) - \cos 2\big(2\pi-(\varepsilon-\varepsilon'\lambda)\big)\right\} \qquad (2.24)$$

Where we have used the fact that $\cos(-\theta)=\cos\theta$ (even and symmetric function), thereby leaving the dimension of A_0 in m/s. Also upon the substitution of (2.24) into (2.18), we get

$$C_0 = -\frac{(a-b\lambda)^4(n-n'\lambda)}{8\pi(a^2-b^2\lambda^2)^{3/2}\sin 2(\varepsilon-\varepsilon'\lambda)}\left\{\cos 2(\varepsilon-\varepsilon'\lambda) - \cos 2\big(2\pi-(\varepsilon-\varepsilon'\lambda)\big)\right\} \qquad (2.25)$$

By invoking the rule of compound angles in trigonometry, see appendix, we can further simplify (2.25) to yield

$$C_0 = \left(\frac{(a-b\lambda)^4(n-n'\lambda)}{4\pi(a^2-b^2\lambda^2)^{3/2}\sin 2(\varepsilon-\varepsilon'\lambda)}\right)\left\{\sin 2(\pi)\sin 2\big((\varepsilon-\varepsilon'\lambda)-\pi\big)\right\} \qquad (2.26)$$

Hence, C_0 has the dimension of velocity. Also from (2.21) we can solve for A_α as follows. Let us first use trigonometric identity given by $2\sin x\cos y = \sin(x+y)+\sin(x-y)$, to further reduce (2.21) so that

$$A_\alpha = \frac{Q(n-n'\lambda)}{2\tau}\int_0^\tau \left\{\sin 2\big((1+\alpha)(n-n'\lambda)\,t-(\varepsilon-\varepsilon'\lambda)\big)+\sin 2\big((1-\alpha)(n-n'\lambda)\,t-(\varepsilon-\varepsilon'\lambda)\big)\right\}dt \qquad (2.27)$$

$$A_\alpha = \frac{Q(n-n'\lambda)}{2\tau}\left\{-\left(\frac{1}{2(1+\alpha)(n-n'\lambda)}\Big(\cos 2\big((1+\alpha)(n-n'\lambda)\,\tau-(\varepsilon-\varepsilon'\lambda)\big)-\cos 2(-(\varepsilon-\varepsilon'\lambda))\Big)\right)\right\} -$$
$$\frac{Q(n-n'\lambda)}{2\tau}\left\{-\left(\frac{1}{2(1-\alpha)(n-n'\lambda)}\Big(\cos 2\big((1-\alpha)(n-n'\lambda)\,\tau-(\varepsilon-\varepsilon'\lambda)\big)-\cos 2(-(\varepsilon-\varepsilon'\lambda))\Big)\right)\right\} \qquad (2.28)$$

The second term on the right side of (2.28) is ignored since if $\alpha=1$ according to the summation rule the expression in the parenthesis will otherwise be infinite and will not be useful. So that

$$A_\alpha = \frac{(a-b\lambda)^4(n-n'\lambda)}{16\pi(a^2-b^2\lambda^2)^{3/2}(1+\alpha)}\left\{\cos 2(\varepsilon-\varepsilon'\lambda) - \cos 2\big((1+\alpha)\,2\pi-(\varepsilon-\varepsilon'\lambda)\big)\right\} \qquad (2.29)$$

$$A_\alpha = -\frac{(a-b\lambda)^4(n-n'\lambda)}{8\pi(a^2-b^2\lambda^2)^{3/2}(1+\alpha)}\left\{\sin 2\big((1+\alpha)\,\pi\big)\sin 2\big((\varepsilon-\varepsilon'\lambda)-(1+\alpha)\,\pi\big)\right\} \qquad (2.30)$$

where $\alpha = 1, 2, 3, \ldots, \infty$, and therefore leaving the dimension of A_α in m/s. Finally by following the same step that led to (2.30) we can solve for B_α as follows.

$$B_\alpha = \frac{Q(n-n'\lambda)}{2\tau}\int_0^\tau \left\{\cos 2\big((1-\alpha)(n-n'\lambda)\,t-(\varepsilon-\varepsilon'\lambda)\big)-\cos 2\big((1+\alpha)(n-n'\lambda)\,t-(\varepsilon-\varepsilon'\lambda)\big)\right\}dt \qquad (2.31)$$

$$B_\alpha = \frac{Q(n-n'\lambda)}{2\tau}\left\{\frac{1}{2(1-\alpha)(n-n'\lambda)}\Big(\sin 2\big((1-\alpha)(n-n'\lambda)\,\tau-(\varepsilon-\varepsilon'\lambda)\big)-\sin 2(-(\varepsilon-\varepsilon'\lambda))\Big)\right\} -$$
$$\frac{Q(n-n'\lambda)}{2\tau}\left\{\frac{1}{2(1+\alpha)(n-n'\lambda)}\Big(\sin 2\big((1+\alpha)(n-n'\lambda)\,\tau-(\varepsilon-\varepsilon'\lambda)\big)-\sin 2(-(\varepsilon-\varepsilon'\lambda))\Big)\right\} \qquad (2.32)$$

The first term in (2.32) is ignored since if $\alpha=1$ according to the summation rule the expression in the parenthesis is infinite and will not be useful.

$$B_{\alpha} = -\frac{(a-b\lambda)^4 (n-n'\lambda)}{16\pi(a^2-b^2\lambda^2)^{3/2}(1+\alpha)} \left\{ \sin 2(\varepsilon-\varepsilon'\lambda) + \sin 2\left((1+\alpha)\,2\pi - (\varepsilon-\varepsilon'\lambda)\right) \right\} \qquad (2.33)$$

$$B_{\alpha} = -\frac{(a-b\lambda)^4 (n-n'\lambda)}{8\pi(a^2-b^2\lambda^2)^{3/2}(1+\alpha)} \left\{ \sin 2\left((1+\alpha)\,\pi\right) \cos 2\left((\varepsilon-\varepsilon'\lambda) - (1+\alpha)\,\pi\right) \right\} \qquad (2.34)$$

$\alpha = 1, 2, 3, \ldots, \infty$. Where we have used the fact that $\sin(-\theta) = -\sin\theta$ (odd and antisymmetric function) thereby leaving the dimension of B_{α} the same as m/s . Finally upon the substitution of the values of C_0, A_{β} and B_{β} into (2.19) we realize after simplification

$$F\left[f(A)\right] = \left(\frac{(a-b\lambda)^4 (n-n'\lambda) \sin 2(\pi) \sin 2\left((\varepsilon-\varepsilon'\lambda)-\pi\right)}{4\pi(a^2-b^2\lambda^2)^{3/2} \sin 2(\varepsilon-\varepsilon'\lambda)} \right) - \left(\frac{(a-b\lambda)^4 (n-n'\lambda)}{8\pi(a^2-b^2\lambda^2)^{3/2}} \right) \sum_{\alpha=1}^{\infty} \left(\frac{1}{(1+\alpha)} \right) \times$$
$$\sin 2((1+\alpha)\,\pi) \left\{ \sin 2\left((\varepsilon-\varepsilon'\lambda) - (1+\alpha)\,\pi\right) \cos 2\left(\alpha(1+\alpha)\,t\right) + \cos 2\left((\varepsilon-\varepsilon'\lambda) - (1+\alpha)\,\pi\right) \sin 2\left(\alpha(1+\alpha)\,t\right) \right\} \quad (2.35)$$

$$F\left[f(A)\right] = \left(\frac{(a-b\lambda)^4 (n-n'\lambda) \sin 2(\pi) \sin 2\left((\varepsilon-\varepsilon'\lambda)-\pi\right)}{4\pi(a^2-b^2\lambda^2)^{3/2} \sin 2(\varepsilon-\varepsilon'\lambda)} \right) - \left(\frac{(a-b\lambda)^4 (n-n'\lambda)}{8\pi(a^2-b^2\lambda^2)^{3/2}} \right) \sum_{\alpha=1}^{\infty} \left(\frac{1}{(1+\alpha)} \right) \times$$
$$\sin 2\left((1+\alpha)\pi\right) \sin 2\left((\varepsilon-\varepsilon'\lambda) - (1+\alpha)\,\pi + \alpha\,(1+\alpha)\pi\right) \qquad (2.36)$$

Equation (2.36) represents the Fourier transform of the oscillating amplitude of the CCW with respect to the combined cosine (even) and sine (odd) functions respectively assumed to converge for large value of the Fourier index β . However, in the absence of HIV in which case $\lambda = 0$ the Fourier analysis of the oscillating amplitude of the latent vibration of the human system resulting from the beating of the human heart becomes

$$F\left[f(A)\right]_{\lambda=0} = \left(\frac{a\,n \sin 2(\pi) \sin 2(\varepsilon-\pi)}{4\pi \sin 2(\varepsilon)} \right) - \left(\frac{a\,n}{8\pi} \right) \sum_{\alpha=1}^{\infty} \left(\frac{1}{(1+\alpha)} \right)$$
$$\sin 2\left((1+\alpha)\pi\right) \sin 2\left(\varepsilon - (1+\alpha)\,\pi + \alpha\,(1+\alpha)\pi\right) \qquad (2.37)$$

2.5. Fourier series expansion of the spatial oscillating phase (θ) of the CCW

$$F\left[f(\theta)\right] = C_0 + C_1 \cos\left(\vec{k}_c.\hat{r} - \left((n-n'\lambda)\,t + E(t)\right)\right) + C_2 \cos\left(\vec{k}_c.\hat{r} - 2\left((n-n'\lambda)\,t + E(t)\right)\right) +$$
$$C_3 \cos\left(\vec{k}_c.\hat{r} - 3\left((n-n'\lambda)\,t + E(t)\right)\right) + \ldots + C_{\beta} \cos\left(\vec{k}_c.\hat{r} - \beta\left((n-n'\lambda)\,t + E(t)\right)\right) \qquad (2.38)$$

$$F\left[f(\theta)\right] = C_0 + \sum_{\beta=1}^{\infty} C_{\beta} \cos\left(\vec{k}_c.\hat{r} - \beta\left((n-n'\lambda)\,t + E(t)\right)\right) \qquad (2.39)$$

However, there is need to separate the function in the summation sign into two components.

$$C_{\beta} \cos\left(\vec{k}_c.\hat{r} - \beta\left((n-n'\lambda)\,t + E(t)\right)\right) = A_{\beta} \cos\beta\left((n-n'\lambda)\,t + E(t)\right) + B_{\beta} \sin\beta\left((n-n'\lambda)\,t + E(t)\right) \qquad (2.40)$$

With assumption that

$$\left. \begin{aligned} A_{\beta} &= C_{\beta} \cos\left(\vec{k}_c..\hat{r}\right) \\ B_{\beta} &= -C_{\beta} \sin\left(\vec{k}_c.\hat{r}\right) \end{aligned} \right\} \Rightarrow \quad C_{\beta} = \sqrt{A_{\beta}^2 + B_{\beta}^2} \qquad (2.41)$$

With the approximation that from equation (2.40), we assume $\beta = 0$, so that

$$C_0 = \frac{1}{\cos\left(\vec{k}_c.\hat{r}\right)} A_0 \qquad (2.42)$$

Consequently the Fourier series given by (2.39) can be rewritten using (2.40) and (2.42) as

$$F\left[f(\theta)\right] = \frac{1}{\cos\left(\vec{k}_c.\hat{r}\right)} A_0 + \sum_{\beta=1}^{\infty} \left\{ A_{\beta} \cos\beta\left((n-n'\lambda)\,t + E(t)\right) + B_{\beta} \sin\beta\left((n-n'\lambda)\,t + E(t)\right) \right\} \qquad (2.43)$$

where A_0, A_{β} and B_{β} are the Fourier coefficients of the series expansion of the CCW to be determined.

2.6. Determination of the Fourier coefficients of the spatial oscillating phase $F\left[f(\theta)\right]$ of the CCW.

The Fourier coefficients, A_0, A_β and B_β of $F\left[f(\theta)\right]$ in (2.43) are given by the Euler formulas

$$A_0 = \frac{1}{\tau}\int_0^\tau f(\theta)\,dt \quad = \frac{1}{\tau}\int_0^\tau \cos\left(\vec{k}_c.\hat{r} - (n-n'\lambda)\,t - E(t)\right)dt \qquad (2.44)$$

$$A_\beta = \frac{1}{\tau}\int_0^\tau f(\theta)\cos\beta\left((n-n'\lambda)\,t + E(t)\right)dt = \frac{1}{\tau}\int_0^\tau \cos\left(\vec{k}_c.\hat{r} - (n-n'\lambda)\,t - E(t)\right)\cos\beta\left((n-n'\lambda)t + E(t)\right)dt \qquad (2.45)$$

$$B_\beta = \frac{1}{\tau}\int_0^\tau f(\theta)\sin\beta\left((n-n'\lambda)\,t + E(t)\right)dt = \frac{1}{\tau}\int_0^\tau \cos\left(\vec{k}_c.\hat{r} - (n-n'\lambda)\,t - E(t)\right)\sin\beta\left((n-n'\lambda)\,t + E(t)\right)dt \qquad (2.46)$$

To integrate (2.44) we should know that the total phase angle E is also a function of time t. Thus by substitution method we simply write

$$u = \vec{k}_c.\hat{r} - (n-n'\lambda)\,t - E(t) \;\Rightarrow\; \frac{du}{dt} = -(n-n'\lambda) + Z(t) \;\Rightarrow\; dt = -\left(\frac{1}{(n-n'\lambda) - Z(t)}\right)du \qquad (2.47)$$

Then

$$A_0 = -\frac{1}{\tau}\left\{\frac{\sin\left(\vec{k}_c.\hat{r} - (n-n'\lambda)\tau - E(\tau)\right)}{\left((n-n'\lambda) - Z(\tau)\right)} - \frac{\sin\left(\vec{k}_c.\hat{r} - E(0)\right)}{\left((n-n'\lambda) - Z(0)\right)}\right\} \qquad (2.48)$$

$$A_0 = \frac{(n-n'\lambda)}{2\pi}\left\{\frac{\sin\left(\vec{k}_c.\hat{r} - E(0)\right)}{\left((n-n'\lambda) - Z(0)\right)} - \frac{\sin\left(\vec{k}_c.\hat{r} - 2\pi - E(\tau)\right)}{\left((n-n'\lambda) - Z(\tau)\right)}\right\} \qquad (2.49)$$

$$C_0 = \frac{(n-n'\lambda)}{2\pi\cos\left(\vec{k}_c.\hat{r}\right)}\left\{\frac{\sin\left(\vec{k}_c.\hat{r} - E(0)\right)}{\left((n-n'\lambda) - Z(0)\right)} - \frac{\sin\left(\vec{k}_c.\hat{r} - 2\pi - E(\tau)\right)}{\left((n-n'\lambda) - Z(\tau)\right)}\right\} \qquad (2.50)$$

Also to evaluate (2.45) we first use trigonometric relations it so that

$$A_\beta = \frac{1}{2\tau}\left\{\int_0^\tau \cos\left(\vec{k}_c.\hat{r} - (1-\beta)(n-n'\lambda)\,t - (1-\beta)E(t)\right)dt + \int_0^\tau \cos\left(\vec{k}_c.\hat{r} - (1+\beta)(n-n'\lambda)\,t - (1+\beta)E(t)\right)dt\right\}$$

(2.51)

$$A_\beta = \frac{1}{2\tau}\left\{-\left(\frac{\sin\left(\vec{k}_c.\hat{r} - (1-\beta)\left((n-n'\lambda)\tau + E(\tau)\right)\right)}{(1-\beta)\left((n-n'\lambda) - Z(\tau)\right)}\right) + \left(\frac{\sin\left(\vec{k}_c.\hat{r} - (1-\beta)E(0)\right)}{(1-\beta)\left((n-n'\lambda) - Z(0)\right)}\right)\right\}$$

$$\frac{1}{2\tau}\left\{-\left(\frac{\sin\left(\vec{k}_c.\hat{r} - (1+\beta)\left((n-n'\lambda)\tau + E(\tau)\right)\right)}{(1+\beta)\left((n-n'\lambda) - Z(\tau)\right)}\right) + \left(\frac{\sin\left(\vec{k}_c.\hat{r} - (1+\beta)E(0)\right)}{(1+\beta)\left((n-n'\lambda) - Z(0)\right)}\right)\right\} \qquad (2.52)$$

The first term on the right side of (2.52) is ignored since it becomes infinite if $\beta = 1$. As a result,

$$A_\beta = \frac{(n-n'\lambda)}{4\pi}\left\{\left(\frac{\sin\left(\vec{k}_c.\hat{r} - (1+\beta)E(0)\right)}{(1+\beta)\left((n-n'\lambda) - Z(0)\right)}\right) - \left(\frac{\sin\left(\vec{k}_c.\hat{r} - (1+\beta)\left(2\pi + E(\tau)\right)\right)}{(1+\beta)\left((n-n'\lambda) - Z(\tau)\right)}\right)\right\} \qquad (2.53)$$

Finally, when we follow the same approach that led to (2.53) we can solve for B_β in (2.46).

$$B_\beta = \frac{1}{2\tau}\left\{\int_0^\tau \sin\left(\vec{k}_c.\hat{r} - (1-\beta)\left((n-n'\lambda)\,t - E(t)\right) - (1-\beta)E(t)\right) - \int_0^\tau \sin\left(\vec{k}_c.\hat{r} - (1+\beta)(n-n'\lambda)\,t - (1+\beta)\,E(t)\right)\right\}dt \qquad (2.54)$$

$$B_\beta = \frac{(n-n'\lambda)}{4\pi}\left\{\left(\frac{\cos\left(\vec{k}_c.\hat{r} - (1+\beta)\left(2\pi + E(\tau)\right)\right)}{(1+\beta)\left((n-n'\lambda) - Z(\tau)\right)}\right) - \left(\frac{\cos\left(\vec{k}_c.\hat{r} - (1+\beta)E(0)\right)}{(1+\beta)\left((n-n'\lambda) - Z(0)\right)}\right)\right\} \qquad (2.55)$$

Finally, upon the substitution of the values of C_0 A_β and B_β into (2.43) we realize the Fourier series expansion of the spatial oscillating phase of the CCW.

$$F\left[f(\theta)\right] = \frac{(n-n'\lambda)}{2\pi\cos\left(\vec{k}_c.\hat{r}\right)}\left\{\frac{\sin\left(\vec{k}_c.\hat{r} - E(0)\right)}{\left((n-n'\lambda) - Z(0)\right)} - \frac{\sin\left(\vec{k}_c.\hat{r} - 2\pi - E(\tau)\right)}{\left((n-n'\lambda) - Z(\tau)\right)}\right\} +$$

$$\sum_{\beta=1}^{\infty}\frac{(n-n'\lambda)}{4\pi}\left\{\left(\frac{\sin\left(\vec{k}_c.\hat{r}-(1+\beta)E(0)\right)}{(1+\beta)\left((n-n'\lambda)-Z(0)\right)}\right)-\left(\frac{\sin\left(\vec{k}_c.\hat{r}-(1+\beta)\left(2\pi+E(\tau)\right)\right)}{(1+\beta)\left((n-n'\lambda)-Z(\tau)\right)}\right)\right\}\cos\beta\left((n-n'\lambda)t+E(t)\right)+$$

$$\sum_{\beta=1}^{\infty}\frac{(n-n'\lambda)}{4\pi}\left\{\left(\frac{\cos\left(\vec{k}_c.\hat{r}-(1+\beta)\left(2\pi+E(\tau)\right)\right)}{(1+\beta)\left((n-n'\lambda)-Z(\tau)\right)}\right)-\left(\frac{\cos\left(\vec{k}_c.\hat{r}-(1+\beta)E(0)\right)}{(1+\beta)\left((n-n'\lambda)-Z(0)\right)}\right)\right\}\sin\beta\left((n-n'\lambda)t+E(t)\right) \quad (2.56)$$

$$F\left[f(\theta)\right]=\frac{(n-n'\lambda)}{2\pi\cos\left(\vec{k}_c.\hat{r}\right)}\left\{\frac{\sin\left(\vec{k}_c.\hat{r}-E(0)\right)}{\left((n-n'\lambda)-Z(0)\right)}-\frac{\sin\left(\vec{k}_c.\hat{r}-2\pi-E(\tau)\right)}{\left((n-n'\lambda)-Z(\tau)\right)}\right\}+$$
$$\sum_{\beta=1}^{\infty}\frac{(n-n'\lambda)}{4\pi}\left\{\left(\frac{\sin\left(\vec{k}_c.\hat{r}-(1+\beta)E(0)\right)\cos\beta\left((n-n'\lambda)t+E(t)\right)}{(1+\beta)\left((n-n'\lambda)-Z(0)\right)}\right)-\right.$$
$$\left.\left(\frac{\cos\left(\vec{k}_c.\hat{r}-(1+\beta)E(0)\right)\sin\beta\left((n-n'\lambda)t+E(t)\right)}{(1+\beta)\left((n-n'\lambda)-Z(0)\right)}\right)\right\}+$$
$$\sum_{\beta=1}^{\infty}\frac{(n-n'\lambda)}{4\pi}\left\{\left(\frac{\cos\left(\vec{k}_c.\hat{r}-(1+\beta)\left(2\pi+E(\tau)\right)\right)\sin\beta\left((n-n'\lambda)t+E(t)\right)}{(1+\beta)\left((n-n'\lambda)-Z(\tau)\right)}\right)-\right.$$
$$\left.\left(\frac{\sin\left(\vec{k}_c.\hat{r}-(1+\beta)\left(2\pi+E(\tau)\right)E(0)\right)\cos\beta\left((n-n'\lambda)t+E(t)\right)}{(1+\beta)\left((n-n'\lambda)-Z(\tau)\right)}\right)\right\} \quad (2.57)$$

$$F\left[f(\theta)\right]=\frac{(n-n'\lambda)}{2\pi\cos\left(\vec{k}_c.\hat{r}\right)}\left\{\frac{\sin\left(\vec{k}_c.\hat{r}-E(0)\right)}{\left((n-n'\lambda)-Z(0)\right)}-\frac{\sin\left(\vec{k}_c.\hat{r}-2\pi-E(\tau)\right)}{\left((n-n'\lambda)-Z(\tau)\right)}\right\}+\sum_{\beta=1}^{\infty}\left(\frac{(n-n'\lambda)}{4\pi(1+\beta)\left((n-n'\lambda)-Z(0)\right)}\right)\times$$
$$\left\{\sin\left(\vec{k}_c.\hat{r}-(1+\beta)E(0)\right)\cos\beta\left((n-n'\lambda)t+E(t)\right)-\cos\left(\vec{k}_c.\hat{r}-(1+\beta)E(0)\right)\sin\beta\left((n-n'\lambda)t+E(t)\right)\right\}+$$
$$\sum_{\beta=1}^{\infty}\left(\frac{(n-n'\lambda)}{4\pi(1+\beta)\left((n-n'\lambda)-Z(\tau)\right)}\right)\left\{\cos\left(\vec{k}_c.\hat{r}-(1+\beta)\left(2\pi+E(\tau)\right)\right)\sin\beta\left((n-n'\lambda)t+E(t)\right)-\right.$$
$$\left.\sin\left(\vec{k}_c.\hat{r}-(1+\beta)\left(2\pi+E(\tau)\right)E(0)\right)\cos\beta\left((n-n'\lambda)t+E(t)\right)\right\} \quad (2.58)$$

Thus after further rearrangement of (2.58), using identities, see appendix, it can be shown that

$$F\left[f(\theta)\right]=\frac{(n-n'\lambda)}{2\pi\cos\left(\vec{k}_c.\hat{r}\right)}\left\{\frac{\sin\left(\vec{k}_c.\hat{r}-E(0)\right)}{\left((n-n'\lambda)-Z(0)\right)}-\frac{\sin\left(\vec{k}_c.\hat{r}-2\pi-E(\tau)\right)}{\left((n-n'\lambda)-Z(\tau)\right)}\right\}+$$
$$\frac{(n-n'\lambda)}{4\pi}\sum_{\beta=1}^{\infty}\frac{1}{(1+\beta)}\left\{\left(\frac{\sin\left(\vec{k}_c.\hat{r}-(1+\beta)E(0)-\beta\left((n-n'\lambda)t+E(t)\right)\right)}{\left((n-n'\lambda)-Z(0)\right)}\right)+\right.$$
$$\left.\left(\frac{\sin\left(\vec{k}_c.\hat{r}-(1+\beta)\left(2\pi+E(\tau)\right)-\beta\left((n-n'\lambda)t+E(t)\right)\right)}{\left((n-n'\lambda)-Z(\tau)\right)}\right)\right\} \quad (2.59)$$

Equation (2.59) represents the Fourier transform of the spatial oscillating phase of the CCW. It is the convergence of the cosine (even) and sine (odd) functions, which is assumed to converge for large value of the Fourier index β. It is clear that (2.59) has no unit of dimension. We have from (2.5 and (2.6) that

$$E(\tau)=\tan^{-1}\left(\frac{a\sin\varepsilon+b\lambda\sin(\varepsilon'\lambda-2\pi)}{a\cos\varepsilon+b\lambda\cos(\varepsilon'\lambda-2\pi)}\right);\quad E(0)=\tan^{-1}\left(\frac{a\sin\varepsilon+b\lambda\sin(\varepsilon'\lambda)}{a\cos\varepsilon+b\lambda\cos(\varepsilon'\lambda)}\right) \quad (2.60)$$

$$Z(t)=(n-n'\lambda)\left(\frac{b^2\lambda^2+ab\lambda\cos\left((\varepsilon-\varepsilon'\lambda)+(n-n'\lambda)t\right)}{a^2+b^2\lambda^2+2ab\lambda\cos\left((\varepsilon-\varepsilon'\lambda)+(n-n'\lambda)t\right)}\right) \quad (2.61)$$

$$Z(0)=(n-n'\lambda)\left(\frac{b^2\lambda^2+ab\lambda\cos(\varepsilon-\varepsilon'\lambda)}{a^2+b^2\lambda^2+2ab\lambda\cos(\varepsilon-\varepsilon'\lambda)}\right);\ Z(\tau)=(n-n'\lambda)\left(\frac{b^2\lambda^2+ab\lambda\cos\left((\varepsilon-\varepsilon'\lambda)+2\pi\right)}{a^2+b^2\lambda^2+2ab\lambda\cos\left((\varepsilon-\varepsilon'\lambda)+2\pi\right)}\right) \quad (2.62)$$

2.7. Convolution of the Fourier analysis of the amplitude and the spatial oscillating phase of the CCW

Now that we have separately determined the Fourier series expansion of the oscillating amplitude $F\left[f(A)\right]$ and the spatial oscillating phase $F\left[f(\theta)\right]$ respectively, the necessary requirement now is to convolute them in order to obtain a concise equation of the CCW in the frequency time domain. Convolution here means multiplying (2.36) by (2.59) term by term. Let us represent the result of the convolution of these functions by H and then with the same velocity displacement vector v which represents the CCW.

$$v = H\left\{F\left[f(A)\right]; F\left[f(\theta)\right]\right\} = F\left[f(A)\right] \otimes F\left[f(\theta)\right] \qquad (2.63)$$

$$v = H\left\{F\left[f(A)\right]; F\left[f(\theta)\right]\right\} = \left(\frac{(a-b\lambda)^4 (n-n'\lambda)^2 \sin 2(\pi) \sin 2\left((\varepsilon-\varepsilon'\lambda)-\pi\right)}{8\pi^2 (a^2-b^2\lambda^2)^{3/2} \sin 2(\varepsilon-\varepsilon'\lambda)\cos\left(\vec{k}_c.\vec{r}\right)}\right)\times$$

$$\left\{\frac{\sin\left(\vec{k}_c.\hat{r}-E(0)\right)}{\left((n-n'\lambda)-Z(0)\right)} - \frac{\sin\left(\vec{k}_c.\hat{r}-2\pi-E(\tau)\right)}{\left((n-n'\lambda)-Z(\tau)\right)}\right\} + \left(\frac{(a-b\lambda)^4 (n-n'\lambda)^2 \sin 2(\pi)\sin 2\left((\varepsilon-\varepsilon'\lambda)-\pi\right)}{16\pi^2 (a^2-b^2\lambda^2)^{3/2}\sin 2(\varepsilon-\varepsilon'\lambda)}\right)\sum_{\beta=1}^{\infty}\left(\frac{1}{1+\beta}\right)\times$$

$$\left\{\left(\frac{\sin\left(\vec{k}_c.\hat{r}-(1+\beta)E(0)-\beta\left((n-n'\lambda)t+E(t)\right)\right)}{\left((n-n'\lambda)-Z(0)\right)}\right) + \left(\frac{\sin\left(\vec{k}_c.\hat{r}-(1+\beta)\left(2\pi+E(\tau)\right)-\beta\left((n-n'\lambda)t+E(t)\right)\right)}{\left((n-n'\lambda)-Z(\tau)\right)}\right)\right\} -$$

$$\left(\frac{(a-b\lambda)^4 (n-n'\lambda)^2 \sin 2(\pi)\sin 2\left((\varepsilon-\varepsilon'\lambda)-\pi\right)}{16\pi^2 (a^2-b^2\lambda^2)^{3/2}\cos\left(\vec{k}_c.\hat{r}\right)}\right)\left\{\frac{\sin\left(\vec{k}_c.\hat{r}-E(0)\right)}{\left((n-n'\lambda)-Z(0)\right)} - \frac{\sin\left(\vec{k}_c.\hat{r}-2\pi-E(\tau)\right)}{\left((n-n'\lambda)-Z(\tau)\right)}\right\}\sum_{\beta=1}^{\infty}\left(\frac{1}{(1+\beta)}\right)\times$$

$$\left\{\sin 2\left((1+\beta)\ \pi\right)\sin 2\left((\varepsilon-\varepsilon'\lambda)-(1+\beta)\pi+\beta\,(1+\beta)\,\pi\right)\right\} - \left(\frac{(a-b\lambda)^4 (n-n'\lambda)^2}{32\pi^2 (a^2-b^2\lambda^2)^{3/2}}\right)\times$$

$$\sum_{\alpha=1}^{\infty}\left(\frac{1}{(1+\beta)}\right)^2 \left\{\sin 2\left((1+\beta)\ \pi\right)\sin 2\left((\varepsilon-\varepsilon'\lambda)-(1+\beta)\pi+\beta\,(1+\beta)\pi\right)\right\}\times$$

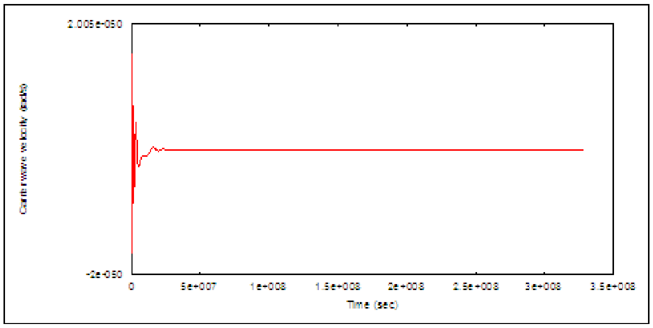
$$\left\{\left(\frac{\sin\left(\vec{k}_c.\hat{r}-(1+\beta)E(0)-\beta\left((n-n'\lambda)t+E(t)\right)\right)}{\left((n-n'\lambda)-Z(0)\right)}\right) + \left(\frac{\sin\left(\vec{k}_c.\hat{r}-(1+\beta)\left(2\pi+E(\tau)\right)-\beta\left((n-n'\lambda)t+E(t)\right)\right)}{\left((n-n'\lambda)-Z(\tau)\right)}\right)\right\} \qquad (2.64)$$

In this work, we only considered situation where the constraints are of equal weights, that is $\alpha = \beta$. Otherwise, if we apply the double summation rule as it stands, that means, we shall first allow α take the value of one and let β run from one to infinity, again we allow α take the value of two and let β run from one to infinity and the process is repeated. However, since both constraints are of the same source function we can equate them so as to save us computation time and unnecessary difficult task. The graphs of the result emanating from (2.64) are shown in section 3.

2.8. Calculated values of the dynamic characteristics of the latent vibration of Man represented by the 'host wave' and that of the HIV represented by the 'parasitic wave'.

We have in a previous study [] presented a model for determining the dynamic mechanical characteristics of HIV/AIDS in the human blood circulating system. Our work assumes that the physical dynamic components of the HIV responsible for their destructive tendency are $b\lambda$, $n'\lambda$, $\varepsilon'\lambda$ and $k'\lambda$ been influenced by the multiplicative factor λ whose physical range of interest is 0 $\le \lambda \le$ 13070. In this study, we calculated values of the amplitude $b = 1.60\times 10^{-10} m$, angular frequency $n' = 1.91\times 10^{-11} rad./s$, phase angle $\varepsilon' = 0.0000466 rad$, the wave number or the spatial frequency $k' = 0.0127 rad./m$ of the HIV parameters and with a slow varying interval of the multiplier $\lambda = 0, 1, 2, 3, \ldots, 13070$. While the dynamical characteristics of the latent vibration of the human blood circulating system caused by the beating of the human heart are; amplitude $a = 2.1\times 10^{-6} m$, angular frequency $n = 2.51\times 10^{-7} rad./s$, phase angle $\varepsilon = 0.6109 rad$, wave number $k = 166 rad./m$. We also established in the study that the average survival time for HIV/AIDS patient is about 11 years (126 months) counting from the moment the HIV is contacted. However we classified the time interval in seconds as $0 \le t \le 328479340 s$, with a slow varying time interval $t = 0, 1, 2, 3, \ldots, 328479340 s$.

3. Presentation of Results



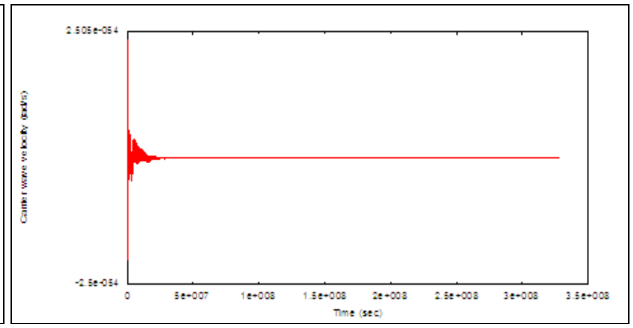
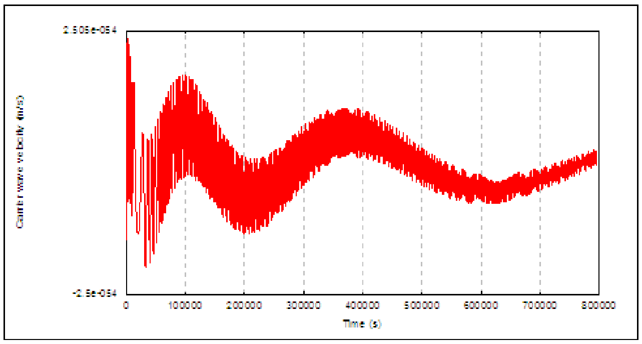


Figure 3.1: Represents the multiplier λ *[0, 13070], and time [0, 126 months],* $\beta = 0$.

Figure 3.2: Represents the multiplier λ *[0, 13070] and time [0, 126 months],* $\beta = 13070$.



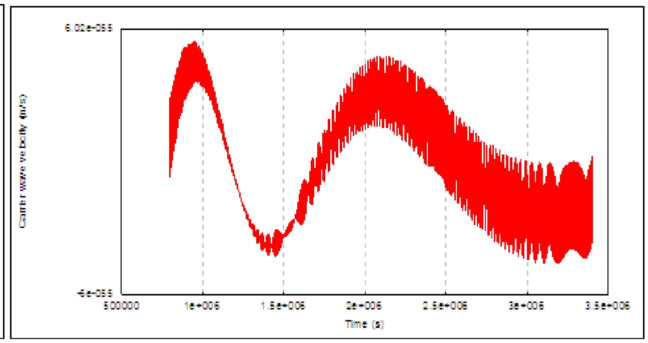
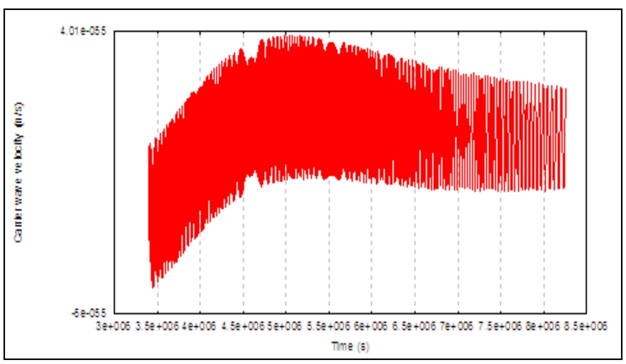


Figure 3.3: Represents the multiplier λ *[0 – 1500] and time [0 – 9.2 days],* β *= 13070.*

Figure 3.4: Represents the multiplier λ *[1500 – 3000] and time [9.2 – 1.3 months],* β *= 13070.*



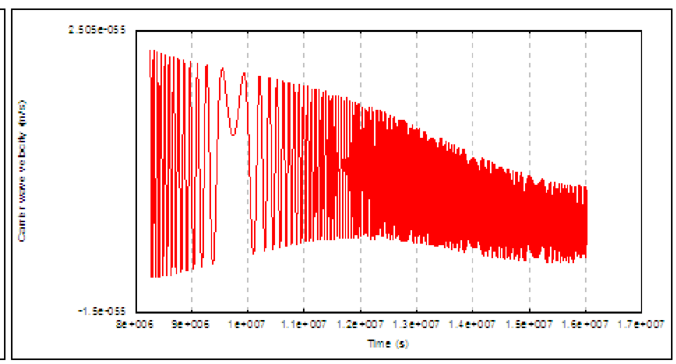
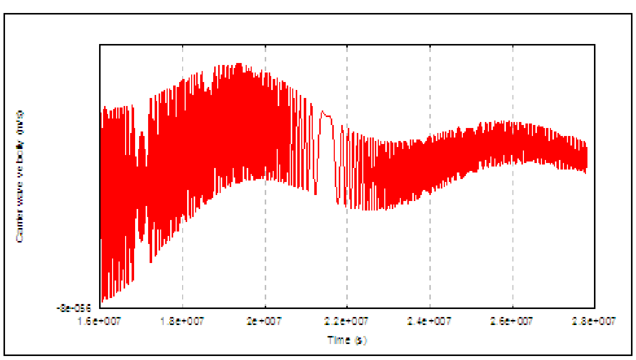


Figure 3.5: Represents the multiplier λ *[3000 – 4500] and time [1.3 – 3 months],* β *= 13070.*

Figure 3.6: Represents the multiplier λ *[4500 – 6000] and time [3 – 6 months],* β *= 13070.*



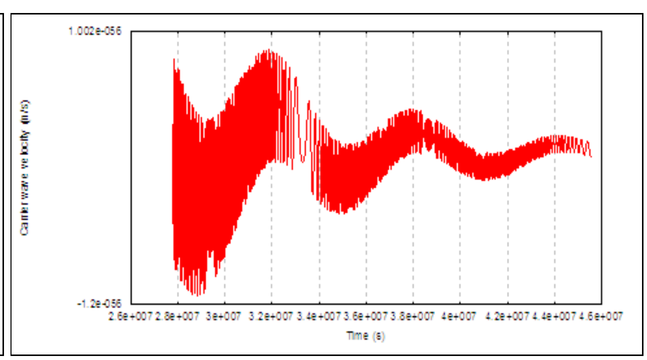
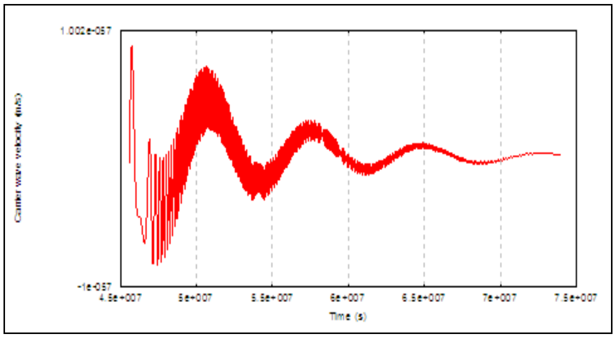


Figure 3.7: Represents the multiplier λ *[6000 – 7500] and time [6 – 10.7 months],* β *= 13070.*

Figure 3.8: Represents the multiplier λ *[7500 – 9000] and time [10.7 – 17.5 months],* β *= 13070*



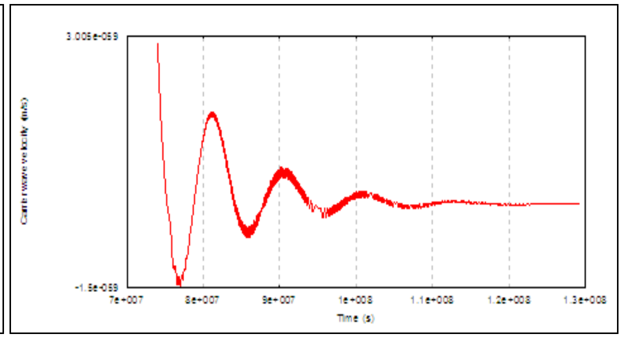


Figure 3.9: Represents the multiplier λ [9000 – 10500] and time [17.5 – 28.5 months], β = 13070.
Figure 3.10: Represents the multiplier λ [10500 – 12000] and time [28.5 – 49.8 months], β = 13070.

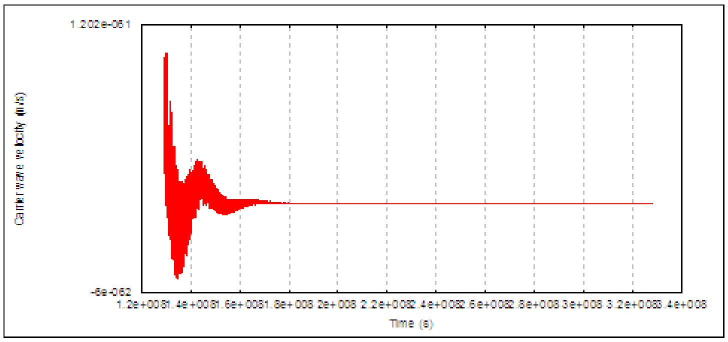


Figure 3.11: Represents the multiplier λ [12000 – 13070] and time [49.8 – 126 months], β = 13070

4. Dicussion of Results

The graph of the velocity gradient of the constituted carrier wave is represented by figs 3.1 – 3.11. It is clear from fig. 3.2, that because of the numerous waveforms involved when the Fourier index β =13070 for every value of the multiplier λ, the figure could not really reflect all the possible wavelets available for the given period of time 0 – 126 months that the CCW lasted, as a result, the figure almost displayed a straight line. Consequently, we classified our work based on the interval of the multiplier [0 – 1500]. Although, our work was confined to only when the Fourier index was 13070, since we believe that this is the region of most relevant interest of our study. Note that fig. 3.1 which is the first term of equation (2.64) is the harmonic analysis of the CCW velocity or the fundamental velocity of the CCW in which case the Fourier index β = 0.

Generally, all the figures show sinusoidal waveform which reveals the velocity amplitude fluctuations resulting from a spread in the component frequencies of the CCW. The CCW has initial maximum positive velocity of about 2.505 x 10^{-54} m/s at time t = 0 and a final minimum positive velocity of about 6.02 x 10^{-68} m/s at time t = 126 months, while an initial maximum negative radial velocity of about -2.5 x 10^{-54} m/s at time t = 0 and a final minimum negative velocity of about -6.00 x 10^{-68} m/s at time t = 126 months. Positive velocity means attraction and hence constructive interference between the ‘host wave’ and the ‘parasitic wave’, while negative velocity means repulsion and hence destructive interference between them. This information is shown in figs. 3.2 and 3.11.

It could be read in fig. 3.3, that about 30000 s (8 hours) immediately when one contacts HIV, the velocity profile of the CCW show something different from usual which indicates the presence of strange manifestations of a velocity-like body. However, after this time the anomaly is regulated to a continuous group velocity with high component frequencies. From fig. 3.4 the velocity almost become flattened after about 1.2x10^{6} s (14 days) this also symbolize the initial recognition of a foreign body with a negative influence on the initial velocity of the ‘host wave’. Clearly, the components of the CCW regroup into a continuum velocity with high frequencies as indicated in fig. 3.5. This is synonymous with the fact that the process of degeneracy in the human system after the HIV infection is not immediate, and that the host system would by itself tends to annul the destructive effect of the interfering HIV parasite.

It is observed that there are certain regions of discontinuity in the velocity profiles of the CCW as shown in figs. 3.6, 3.7, 3.8, and 3.9. These regions are remarkably characterised by a reduced frequencies or depletion in the velocity of the CCW, also this formation indicates certain advances made by the effect of the HIV vibration in the human system. The time for these remarkable discontinuities in the velocity profiles are 4, 6, 8, 13, and 18 months respectively. To be consistent with the literature of clinical diseases, these times are regarded as the window periods. The window period defines the time when the human biological system is now reacting fully to the presence of the HIV due to the noticeable impairment it would have done to the velocity of the CCW. Consequently, the window period differs from one individual to another due to different immune system. However, while the effect of the interfering HIV may appear in some individual after 4 months, others could be 6 months or so.

The effect of the HIV parasite on the human system deepens and become more pronounced between 10.7 – 17.5 months after infection and the multiplier ranges between λ[7500 – 9000]. This information is shown in fig. 3.10. The spectrum of the velocity of the CCW is almost showing a line quadratic curve in this region. The frequencies and the bandwidth of the velocity profiles of the CCW is highly reduced. The spectrum of the velocity profiles becomes parasitically monochromatic beyond 1.8 x 10^8 s or about 69 months (6 years) as shown in fig. 3.11 this however, indicates the prominence of the HIV active components in the CCW. Thus within this region all the active components of the 'host wave' would have been completely destroyed by the interfering HIV 'parasitic wave' thereby rendering the immune system of the host ineffective and non restorable. This situation depicts the possible period of time when the HIV infection degenerates to AIDS. Finally, the velocity of the CCW is brought to rest after 126 months (10 years) as shown in fig. 3.11 and ones this stage is reached the phenomenon called death of the host is imminent.

5. Conclusion

The cessation of the CCW due to the slow-down effect in the velocity profile is not instantaneous but gradual. The spectrum shows region of high positive velocity profile which means constructive interference and high negative velocity profiles which means destructive interference between the vibration of the HIV and Man, The constituents of the velocity of the CCW becomes monochromatic after a period of time and this indicates a predominance of the HIV 'parasitic wave' in the CCW. Hence all the active components of the human 'host wave' in the CCW are now undergoing a depletion process. This study further revealed that in the absence of specific treatment, people infected with HIV develop AIDS within 69 months (6 years) and the average survival time after infection with HIV is found to be 6 to 10 years. It is the reduction in the velocity of the CCW that causes a delay or a slow down process in the energy transfer mechanism which eventually leads to energy attenuation in HIV/AIDS patient.

6. Appendix

The following is the list of some useful identities which we implemented in the study.

(1) $\sin x + \sin y = 2\sin\frac{x+y}{2}\cos\frac{x-y}{2}$; (2) $\sin x - \sin y = 2\cos\frac{x+y}{2}\sin\frac{x-y}{2}$

(3) $\cos x + \cos y = 2\cos\frac{x+y}{2}\cos\frac{x-y}{2}$; (4) $\cos x - \cos y = -2\sin\frac{x+y}{2}\sin\frac{x-y}{2}$

(5) $2\sin x\cos y = \sin(x+y) + \sin(x-y)$; (6) $2\cos x\sin y = \sin(x+y) - \sin(x-y)$

(7) $2\cos x\cos y = \cos(x+y) + \cos(x-y)$; (8) $2\sin x\sin y = \cos(x-y) - \cos(x+y)$

(9) $\sin(x \pm y) = \sin x\ \cos y\ \pm \cos x\ \sin y$; (10) $\cos(x \pm y) = \cos x\ \cos y\ \mp \sin x\ \sin y$

(11) $\sin 2x = 2\sin x\cos x$; (12) $\sin(-x) = -\sin x$; (13) $\cos(-x) = \cos x$

7. References

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