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1. From Editor's Desk	1
2. Selected Papers from BSC, 2010	
2.1 Analytical Study of EM Waves in Multilayered Cylinder Filled With Double Negation and Positive Materials	2
<i>Janardan Prasad Singh, Ashok Kumar Singh, Ara, India</i>	
2.2 In Vitro Antibody Production Enables HIV Infection Detection In Window Period - Key To Safer Blood	10
<i>Diwakar Tejaswi,, Patna, India</i>	
2.3 Modeling the Impact of increased CO ₂ levels on Wheat and Rabi Maize for Different Climate Change Scenarios in selected locations of Bihar	11
<i>A. Abdul Haris, M.A. Khan, R. Elanchezhian, S.Biswas, V.Chhabra, Patna, India</i>	
2.4 Application of Radial Wave Equation for HCB Mode	16
<i>Navin Sinha, Binod Kumar Choudhary, Pankaj Kumar Muzafferpur, Ranchi, India</i>	
2.5 Understanding Proteins: The Wonder Molecules	20
<i>Ranjeet Kumar, Lucknow, India</i>	
2.6 Implementation of Wireless Telecommand Systems	22
<i>Somsing Rathod, New Delhi, India</i>	
2.7 Contribution of Cybernetics to Management Science	26
<i>Poonam Kumari, Patna, India</i>	
2.8 Psychological Analysis of Scientific Temper	30
<i>Gautam Kumar Sinha, Gaya, India</i>	
2.9 Students as Participants in Learning Process	31
<i>Bijay Kumar Sharma, Patna, India</i>	
2.10 Is Folic Acid a Better Supplement to Prevent Neural Tube Defects Caused by Mutation in mthfr Gene During Early Preganancy	36
<i>Kamal Kumar Anand, Sujata Mishra, Lucknow, India</i>	
2.11 Chaos to Logistic Map	39
<i>Sumita Singh, Patna, India</i>	
2.12 Metal Oxide Humidity Sensors	44
<i>N. K. Pandey, Lucknow, India</i>	
2.13 Effect of Annealing Temperature on Zinc Substituted Cobalt Ferrite (Zn _{1%} Co _{99%} Fe ₂ O ₄) Nanoparticles Synthesized Using Chemical Method	47
<i>Rakesh Kumar Singh, A. Yadav, A. Narayan, Patna, Purnea, India</i>	

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From Editors desk

Global Scientific Council of BBrains Development Society organized third time international conference "Third Bihar Science Conference 2010 (BSC 2010)" in association with Magadh University at its Gaya College, Gaya (India) from Feb 11 to 13, 2010. The theme of the conference was "Improvement of Research Quality towards Sustainable Development". On this occasion, around 600 delegates of India and abroad were participated and eminent scientists of from various universities. The highlight of this conference was the inauguration and keynote lecture by his Excellency Dr APJ Abdul Kalam along with CM, Bihar, Shri Nitish Kumar and Prof. Ehtesham Hasnain.

The list of participating universities (who have participated in the past and participating in this year) are NASA (USA), Colorado state university (USA), Ohio state university (USA), University of Leeds (UK), Ryerson University (Canada), University of oxford (UK), Chosun University (Korea), Max Planck Research Institute (Germany), JNU (Delhi), IIT (Mumbai), IIT (Delhi), IIT (Kanpur), IISER (Bangalore), University of Hyderabad (Hyderabad), IIT (Patna), Aligarh Muslim University (Aligarh), Banaras Hindu University (Varanasi), Indian Institute of Packaging (Hyderabad), CCMB (Hyderabad), NIT (Patna), Tata Institute of Fundamental Research (Mumbai), IIM (Ahmadabad) and all Bihar and Jharkhand based universities etc.

This conference has become platform for the scientific development of the state as well as the nation. And now global members use this society as forum to help and support research activities of the colleges and universities of Bihar. These all are possible because of the effort of the global members from different parts of India and abroad who wish to contribute for their mother land. I salute all those who contribute for the noble cause.

This SPECIAL 11th Issue of **Manthan** is the supplement of BSC 2010 which covers selected full length papers/articles of delegates, keynote speakers and young scientist awardees of the said conference.

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Bibhuti Bikramaditya
Chief Editor

Analytical Study of EM Waves in Multilayered Cylinder Filled With Double Negation and Positive Materials

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Abstract

In this paper, a multilayered cylinder filled with double negative (DNG) material and double positive (DPS) material is studied. General formulas of electromagnetic fields in each region are derived using the eigenfunction expansion method. The expansion coefficients are determined by a recursive system that is derived from boundary conditions at the multiple interfaces. The reflection by a cylinder with (ϵ_0, μ_0) (where ϵ_0 and μ_0 denote the permittivity and permeability in free space, respectively) is found to be quickly diminished with its electric size. For an infinite line source, the image property is observed when the radius of this cylinder is much larger than the wavelength. The distributions of electromagnetic fields are presented when a line source is placed near a two-layered cylinder alternately filled with DNG and DPS material. Numerical results confirm that the developed formulas are suitable to analyze the other multilayered cylindrical structures with DNG and DPS materials.

1. Introduction

The permeability and permittivity of materials are two fundamental parameters of the constitutive relations which determine how the media interact with electromagnetic (EM) waves propagating in the materials. In 1968, Veselago [1968] theoretically studied wave characteristics in a special medium whose permittivity and permeability are both negative simultaneously. These hypothetical materials exhibit a left-handed rule defining the polarizations of electric and magnetic fields and the propagation vector constant and the media are thus referred to as left-handed materials (LHM) in literature [Chen et al., 2004; Grbic and Eleftheriades, 2004; Katsarakis et al., 2004; Ziolkowski and Kipple, 2003; Panoiu and Osgood, 2003; Kuznuiak and Maradudin, 2002; Markos and Soukoulis, 2002; Yao et al., 2005a, 2005b]. The double negative (DNG) material has shown special optical properties, and could lead to a perfect lens [Pendry, 2000; Zhang et al., 2002; Pendry and Rana, 2003; Pendry, 2003; Ye, 2003; Rainakrishna and Pendry, 2004].

For EM waves propagating through a stratified DNG medium, reflection and refraction of the waves

were formulated by Kong [2002]. The objective of this paper is to extend the existing application from planar structures to cylindrical structures, so as to gain more insight into the hybrid effects of metamaterials and cylindrical curvature. Potential applications of the results in this work include the conformal antenna radome analysis and design, two-dimensional microwave and optical imaging, etc. In this paper, we first derive a general formula of EM fields in all regions of a multilayered cylinder with DNG and DPS materials in this paper. The eigenfunction expansion method is applied to express the EM fields in this structure. To verify our formulations and validate our analysis, the distant scattering sections for a two-layered cylinder with double positive medium are first shown. Next, we consider some special cases to characterize the DNG materials. The first example that we consider is a dielectric cylinder with $(-\epsilon_0, -\mu_0)$ which has a refractive index of $n = -1$.

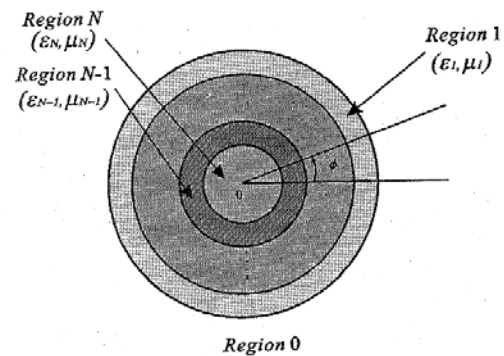


Figure 4.1. Geometry a multilayered cylinder with different materials.

For the incidence wave of transverse magnetic polarization, the reflection visibly diminishes when the electric size of the cylinder is increased. When a parallel line source is placed nearby, focus phenomenon is observed clearly inside the cylinder, provided that the electric size of the cylinder is much larger than the wavelength. Finally, distributions of field components are shown to confirm applicability of these formulas.



2. Formulations

We consider an N-layered infinitely long cylinder situated in free space (ϵ_0, μ_0), as depicted in Figure 1. In each layer, it is filled with DNG or DPS homogeneous material of different permittivity and permeability. In the following analysis the time dependence, $e^{-j\omega t}$ is suppressed. The permittivity and permeability of material in region f ($f=0, \dots, N$) are denoted as follows:

$$\epsilon_f = u |\epsilon_f| \quad (1)$$

$$\mu_f = u |\mu_f| \quad (2)$$

where

$$u = \begin{cases} -1, & \text{DNG material} \\ 1, & \text{DSP material} \end{cases} \quad (3)$$

An incident wave of transverse electric (TE) or transverse magnetic (TM) polarization is assumed to illuminate the layered cylinder in free space at an arbitrary oblique angle. In the cylindrical coordinates system, the vector wave functions are given in [Li et al., 2000], and rewritten as follows:

$$M_n^{(p)}(k_z) = \left[\hat{\rho} \frac{jn}{\rho} V_n^{(p)}(k_\rho \rho) - \hat{\phi} \frac{dB_n^{(p)}(k_\rho \rho)}{d\rho} \right] e^{j(n\phi + k_z z)} \quad (4)$$

$$N_n^{(p)}(k_z) = \frac{1}{k} \left[\hat{\rho} jk_z \frac{dB_n^{(p)}(k_\rho \rho)}{d\rho} - \hat{\phi} \frac{nk_z}{\rho} B_n^{(p)}(k_\rho \rho) + \hat{z} k_\rho^2 B_n^{(p)}(k_\rho \rho) \right] e^{j(n\phi + k_z z)}, \quad (5)$$

where $B_n^{(p)}(k_\rho \rho)$ represents the cylindrical Bessel functions of order n , the superscript p equals 1 or 3 representing the Bessel function of the first kind and the cylindrical Hankel function of the first kind, and $k^2 = k_\rho^2 + k_z^2$. If the electromagnetic waves are normally incident on the surface, the vector wave functions expressed in (4) and (5) can be simplified as

$$M_n^{(p)}(k_z) = \left[\hat{\rho} \frac{jn}{\rho} B_n^{(p)}(k\rho) - \hat{\phi} \frac{dB_n^{(p)}(k\rho)}{d\rho} \right] e^{jn\phi} \quad (6)$$

$$N_n^{(p)}(k) = \hat{z} k B_n^{(o)}(k\rho) e^{jn\phi} \quad (7)$$

By using eigenfunction expansion method, the electric and magnetic fields in the region f ($f=1, \dots, N-1$) are formulated as follows:

$$E_f = \sum_{n=0}^{\infty} \{a_{nf} N_n^{(3)}(k_{nf}) + b_{nf} M_n^{(3)}(k_z f) + a'_{nf} N_n^{(1)}(k_{zf}) + b'_{nf} M_n^{(1)}(k_{fz})\} \quad (8)$$

$$H_f = \frac{k_f}{j\omega |\mu_f|} \sum_{n=0}^{\infty} \{a_{nf} N_n^{(3)}(k_{nf}) + b_{nf} M_n^{(3)}(k_z f) + a'_{nf} N_n^{(1)}(k_{zf}) + b'_{nf} M_n^{(1)}(k_{fz})\} \quad (9)$$

where a_{nf} , b_{nf} , a'_{nf} and b'_{nf} are the unknown expansion coefficients.

For the outmost region (i.e., Region 0) and the innermost region (i.e., Region N), the electromagnetic fields can be expanded as

$$E_0 = E^i + E^s \quad E^i = \sum_{n=0}^{\infty} [a_{n0} N_n^{(3)}(k_{z0}) + b_{n0} M_n^{(3)}(k_{z0})] \quad (10)$$

$$H_0 = H^i + H^s \quad H^i = \frac{k_0}{j\omega |\mu_o|} \times \sum_{n=0}^{\infty} [a_{n0} M_n^{(3)}(k_{z0}) + b_{n0} N_n^{(3)}(k_{zN})] \quad (11)$$



and

$$E_N = \sum_{n=0}^{\infty} \left[a'_{nN} N_n^{(1)}(k_{zN}) + b'_{nN} M_n^{(1)}(K_{zN}) \right] \quad (12)$$

$$E_N = \frac{k_N}{j\omega\mu_N} \times \sum_{n=0}^{\infty} \left[a'_{nN} M_n^{(1)}(k_{zN}) + b'_{nN} N_n^{(1)}(k_{zN}) \right] \quad (13)$$

For the electromagnetic fields in all the regions, we have the same longitudinal wave vector k_z because of the phase matching condition, whereas the radial wave vector k_{pf} is discontinuous.

In the above formulas, the expansion coefficients, a_{nf} , b_{nf} , a'_{nf} , and b'_{nf} , and can be determined by enforcing the boundary conditions of the tangential electric and magnetic field components on the cylindrical interfaces at $p = r_f$ (where $f=0,1,\dots,N-1$):

$$\hat{\rho} \times \begin{bmatrix} E_f \\ H_f \end{bmatrix} \hat{\rho} \times \begin{bmatrix} E_{f+1} \\ H_{f+1} \end{bmatrix}. \quad (14)$$

A recursive system for the coefficients can be finally obtained [Li et al, 2000]:

$$C_{f+1} = T_f C_f, \quad (15)$$

where $[C_f]$ is defined by

$$C_f \begin{bmatrix} a_{nf}, B_{nf}, a'_{nf}, B'_{nf} \end{bmatrix}^T, \quad (16)$$

the transmission matrix in the eigenexpansion domain is given by

$$T_f = F_{f+1}^{-1} F_f, \quad (17)$$

and the parameter matrices F_f and F_{f+1} are derived from the boundary conditions.

Employing the coefficients in the region 0 and the Nth region, the scattering coefficients, a_{n0} and b_{n0} can be derived. With the known a_{n0} , b_{n0} , a'_{n0} , and b'_{n0} , in region 0, the scattering coefficients, a_{nf} , b_{nf} , a'_{nf} , and b'_{nf} , in region f can be determined by the recursive relationship as in equation (15). Hence the total electric and magnetic fields in any region can be found.

2.1. Incident TE_z and TM_z Waves

The incident TE_z and TM_z waves, which are expanded in terms of M_n and N_n , have the following forms: for the TM wave,

$$E_{TM}^I = \frac{E_0^{TM}}{k \sin \theta_0} \sum_{n=0}^{\infty} (2 - \delta_{n0}) j^n M_n^{(1)}(k_z) e^{-jn\phi_0}, \quad (18)$$

$$H_{TM}^I = \frac{E_0^{TM}}{j\eta_0 k \sin \theta_0} \sum_{n=0}^{\infty} (2 - \delta_{n0}) j^n M_n^{(1)}(k_z) e^{-jn\phi_0}, \quad (19)$$

and for the TE wave,

$$E_{TM}^I = \frac{E_0^{TM}}{jk \sin \theta_0} \sum_{n=0}^{\infty} (2 - \delta_{n0}) j^n M_n^{(1)}(k_z) e^{-jn\phi_0}, \quad (20)$$

$$H_{TM}^I = \frac{E_0^{TM}}{\eta_0 k \sin \theta_0} \sum_{n=0}^{\infty} (2 - \delta_{n0}) j^n M_n^{(1)}(k_z) e^{-jn\phi_0}, \quad (21)$$



where $\delta_{mn} = 1$ for $m = n$; or 0 for $m \neq n$ while the vector wave functions $\mathbf{M}$ and $\mathbf{N}$ are denoted by equations (4) and (5).

Thus a'_{no} and b'_{no} are represented by

$$a'_{no} = (2 - \delta_{no}) j^n \frac{E_0^{TM}}{k_0 \sin \theta_0} e^{-jn\phi_0} \quad (22)$$

$$b'_{no} = -(2 - \delta_{no}) j^{n+1} \frac{E_0^{TM}}{k_0 \sin \theta_0} e^{-jn\phi_0} \quad (23)$$

The parameter matrix F_f , where $p = r_f$, can be obtained :

$$F_f = - \begin{bmatrix} \frac{nk_z}{k_f \rho} H_n^{(1)}(k_{rf} \rho) & \frac{dH_n^{(1)}(k_{rf} \rho)}{d\rho} & \frac{nk_z}{k_f \rho} J_n(k_{rf} \rho) & \frac{dJ_n(k_{rf} \rho)}{d\rho} \\ \frac{k_{rf}^2}{k_f} H_n^{(1)}(k_{rf} \rho) & 0 & \frac{k_{rf}^2}{k_f} J_n(k_{rf} \rho) & 0 \\ \frac{k_f}{j\omega\mu_f} \frac{dH_n^{(1)}(k_{rf} \rho)}{d\rho} & \frac{nk_z}{j\omega\mu_f} H_n^{(1)}(k_{rf} \rho) & \frac{k_f}{j\omega\mu_f} \frac{dJ_n(k_{rf} \rho)}{d\rho} & \frac{nk_z}{j\omega\mu_f} J_n(k_{rf} \rho) \\ \frac{j\omega\mu_f}{0} & \frac{k_{rf}^2 \rho}{j\omega\mu_f} H_n^{(1)}(k_{rf} \rho) & \frac{j\omega\mu_f}{0} & \frac{k_{rf}^2 \rho}{j\omega\mu_f} J_n(k_{rf} \rho) \end{bmatrix} \quad (24)$$

2.2. Infinitely Long Line Source

For an infinitely long line source placed at (ρ_0, ϕ_0) and parallel to the cylinder, the incident electromagnetic wave can be expressed by

$$E^i = \frac{K^2 I}{4\omega\epsilon_0} \sum_{n=0}^{\infty} (2 - \delta_{no}) H_n^{(1)}(k\rho_0) N_n^{(1)}(k) e^{-jn\phi_0} \quad (25)$$

$$H^i = -(2 - \delta_{n0}) \frac{K^2 I}{4\omega\epsilon_0} \sum_{n=0}^{\infty} (2 - \delta_{no}) H_n^{(1)}(k\rho_0) M_n^{(1)}(k) e^{-jn\phi_0} \quad (26)$$

where I stands for the amplitude of electric current, ρ_0 denotes the distance from the center of cylinder, and the vector wave functions $\mathbf{M}$ and $\mathbf{N}$ are denoted by equations (6) and (7).

Then, a'_{no} and b'_{no} are represented by

$$a'_{n0} = -(2 - \delta_{n0}) \frac{K^2 I}{4\omega\epsilon_0} H_n^{(1)}(k_0\rho_0) M_n^{(1)}(k) e^{-jn\phi_0} \quad (27)$$

$$b'_{n0} = 0 \quad (28)$$

Similarly, F_f , where $\rho = r_f$, can be derived:

$$F_f = - \begin{bmatrix} 0 & \frac{dH_n^{(1)}(kf\rho)}{kfd\rho} & 0 & \frac{dJ_n(kf\rho)}{kfd\rho} \\ H_n^{(1)}(kf\rho) & 0 & J_n(k_f\rho) & 0 \\ \frac{k_f}{j\omega\mu_f} \frac{dH_n^{(1)}(kf\rho)}{kfd\rho} & 0 & \frac{k_f}{j\omega\mu_f} \frac{dJ_n(kf\rho)}{kfd\rho} & 0 \\ \frac{j\omega\mu_f}{0} & \frac{k_f}{j\omega\mu_f} H_n^{(1)}(kf\rho) & \frac{j\omega\mu_f}{0} & \frac{k_f}{j\omega\mu_f} J_n(kf\rho) \end{bmatrix} \quad (29)$$

3. Numerical Results

To verify the correctness of the formulations deduced above, we first calculate the distant scattering pattern of a two-layered (three regions) cylinder filled with different DPS materials and illuminated by the TE and TM waves, and radiated by the parallel line source, respectively. The geometry is shown in Figure 2. The radii of two layers from inside to outside are $a = 0.25\lambda$ and $b = 0.3\lambda$, respectively. The corresponding relative permittivity are $\epsilon_{r1} = 4.0$, and $\epsilon_{r2} = 1.0$. The relative permeability of two layers are $\mu_{r1} = \mu_{r2} = 1.0$. The plane waves are assumed to be at normal incidence. The line source is placed at a distance of $\rho_0 = 0.5\lambda$ from the center of the layered cylinder, and an observation angle ϕ_0 of 0 degree. The distant scattering pattern can be obtained by the asymptotic form of large-argument Hankel functions. The results are shown in Figures 3 and 4, respectively. For the reference, the integral equation solutions, which come from *Richmond* [1965, 1966], are also given. An excellent agreement is observed between the existing solution presented by *Richmond* [1965, 1966] and those that we newly obtain. This partially verified the correctness of our derived theoretical formulas and the developed codes.

Subsequently, we utilize these formulas to calculate the electromagnetic fields in the presence of the multilayered cylinder filled with DNG and DPS materials. In order to illustrate better the usefulness of these general formulas, the constitutive parameters of DNG materials are specified by $(-\epsilon_0, -\mu_0)$ and those of DPS materials are (ϵ_0, μ_0) in the following computations. The cylindrical interfaces are all depicted by circular curves in the figures.

First of all, the normalized scattering cross section σ/μ of a one-layered (two regions) cylinder filled with DNG $(-\epsilon_0, -\mu_0)$ material is calculated under illumination by the incident TM wave with the angles of $\theta^i = \pi/2$ and $\phi^i = \pi$ in the free space. Curves for different radii a of the cylinder are plotted in Figure 5. It is obvious that the reflection by the cylinder is quickly diminished with the increase of the radius. We can also observe that the RCS data at and near $\phi = 0^\circ$ are very large and it is of the impulse shape when the cylindrical radius is large. This phenomenon can be explained as follows.

First of all, in Figure 5, the incident wave (a TM-polarized plane wave) is impinged at an angle of elevation $\theta^i = 90^\circ$ and azimuth $\phi^i = 180^\circ$. In this case, some portion of the wave energy is normally incident upon the cylinder, so the transmitted wave due to this portion propagates entirely through the dielectric cylinder when the impedance is matched ($\epsilon_r = \mu_r = 1$)

This portion of waves contributes to part of bistatic RCS datum of $\phi = 0^\circ$. For a cylinder of large radius, illumination area by normal or nearly normal incident waves is larger than that of a cylinder of smaller radius. In this case, the cylinder tends to be a perfectly matched layer and it is almost transparent to the incident wave (especially when the wave is forward propagating). Therefore the percentage of the energy propagated through the cylinder will be relatively larger.

Beam width: Secondly, the cylinder behaves as a dielectric lens. For RCS computations, we take the observation point at infinity. When the incident wave propagates through the cylinder filled with DNG, the focus point will approach to infinity because of the

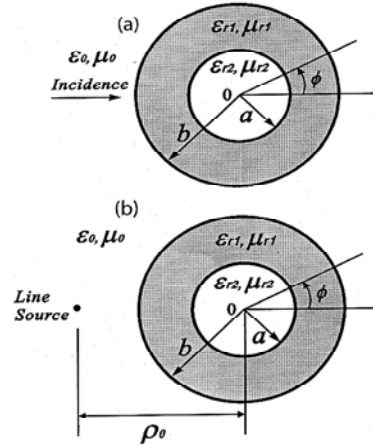


Figure 2. Geometry of a two-layered cylinder with DPS materials.

smoother dielectric curvature. For example, when $ka = 100$, the observation point (infinity) lies to the right of the focus point (which is already sufficiently far away from origin). Thus it can be imagined that the angle of coverage is small at around $\phi = 0^\circ$. When the radius becomes larger and larger, the observation point and the focus point will move closer and closer to each other. In an extreme case, when the cylinder tends to approach a flat slab, the angle of coverage is almost zero to form a delta.

That is why the scattering cross sections around the angle of $\phi = 0^\circ$ are thus much stronger, but confined within a very narrow angle.

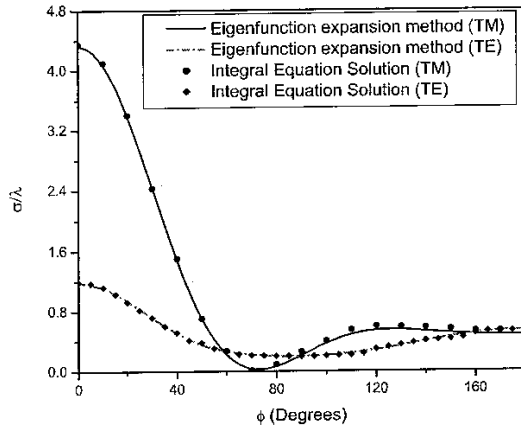


Figure 3. Distant scattering pattern of TE and TM waves illuminating a two-layered cylinder with DPS materials.

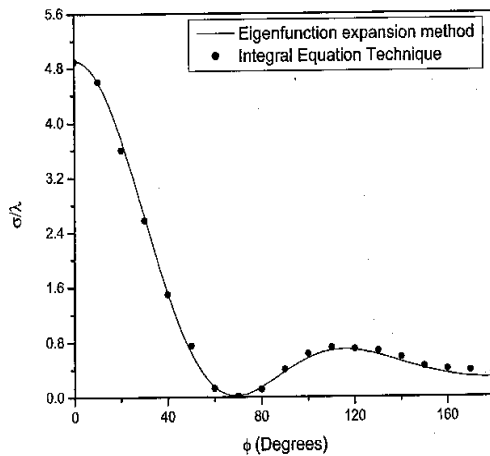


Figure 4. Scattering pattern of a nearby parallel line source in the presence of a two-layered cylinder with DPS materials.

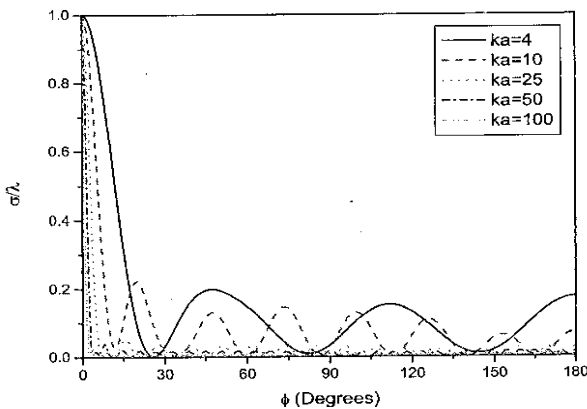


Figure 5. Normalized scattering cross section of a one-layered cylinder of different radii and with $(-\epsilon_0, -\mu_0)$.

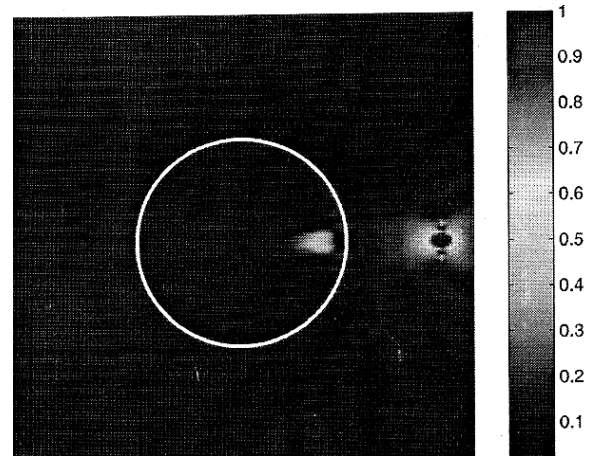


Figure 6. Normalized amplitudes of the time-averaged Poynting power for a one-layered cylinder with $(-\epsilon_0, -\mu_0)$ and $a = 2.5\lambda$.

Then, radiation by a line source in the presence of this cylinder is considered. The different radii for a values are also set. The line source is located at $pt\ 2.3\lambda$ and $\phi_0 = 0$, where p is the distance from the surface of the cylinder. The normalized amplitudes of the time-averaged Poynting power, which is denoted by $\langle S \rangle = \frac{1}{2} \text{Re}(E \times H^*)$ are shown in Figures 6, 7, and 8. From Figures 6 and 7, we observe that a facula is formed inside the cylinder. The formation of the facula is due to the cylinder with $(-\epsilon_0, -\mu_0)$ is not a focusing system. This summary point can be verified by using the theory of arbitrary coordinate transformations [Ward and Pendry, (1996)].

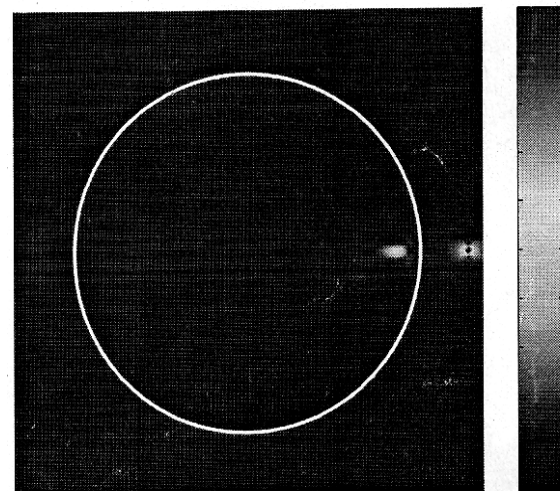


Figure 7. Normalized amplitudes of the time-averaged Poynting power for a one-layered cylinder with $(-\epsilon_0, -\mu_0)$ and $a = 8.5\lambda$.

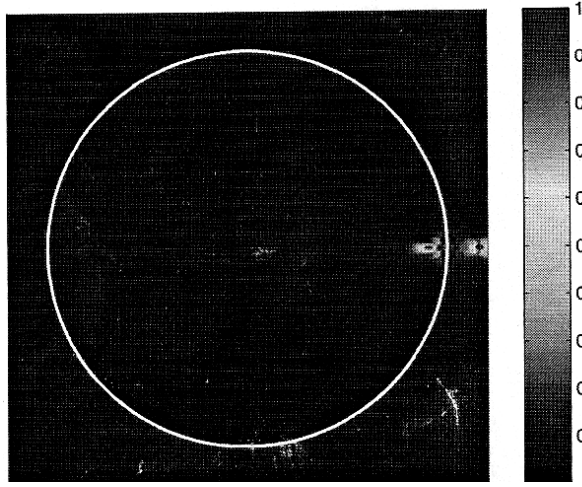


Figure 8. Normalized amplitudes of the time-averaged Poynting power for a one-layered cylinder with $(-\epsilon_0, -\mu_0)$ and $a = 150\lambda$.

According to the theory, if we keep the wave scattering properties unchanged after the geometrical dimension (e.g., the radius) is changed, we have to adjust μ and ϵ accordingly. When the physical problem is changed from a perfect slab lens to a perfect cylindrical lens, the permittivity and permeability in the lens are required to be a function of position. Hence the cylinder with $(-\epsilon_0, -\mu_0)$ cannot focus the light, and it will still reflect waves. However, a phenomenon of focus shown as in Figure 8 and very small reflection shown as in Figure 5 can be obtained when the electric size of calculated problem is far larger than the wavelength.

Finally, the real parts of field components, H_ρ , H_ϕ , and E_z , scattered by a two-layered (three regions) cylinder filled alternately with DNG and DPS material are shown in Figures 9, 10, and 11. In this case, a line source is placed at $\rho_0 = 9.5\lambda$, $\phi_0 = 0$, the radii of two layers are $r_1 = 8\lambda$ and $r_2 = 5\lambda$, respectively. The region 0 is the free space, region 1 and 2 are filled with $(-\epsilon_0, -\mu_0)$ and (ϵ_0, μ_0) respectively. As we expect, the tangential components H_ϕ and E_z are equal on the layered interfaces. While the normal component H_ρ is not, which satisfies by default the continuity of normal component of magnetic flux density $\mathbf{B}$ across the interfaces between the DNG and DPS materials.

Conclusion

In this paper, we applied the eigenfunction expansion method to generally express the fields in a multi-layered cylinder filled by a double negative

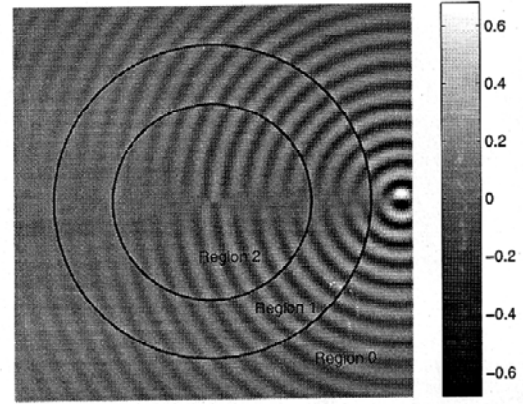


Figure 9. Real part of the H_ρ component of an electromagnetic wave propagating through a two-layered cylinder with DNG and DPS materials.

medium and a double positive medium. The eigenfunction expansion coefficients are determined by enforcing the tangential electric and magnetic field components continuous at the interfaces. By applying the asymptotic form of large-argument Hankel functions, the distant or far-zone scattering patterns for a one-layered cylinder with left $(-\epsilon_0, -\mu_0)$ and different radii are obtained. The results show that the reflection is vanished with the increasing radius. Moreover, the imaging of a line source by this cylinder is observed when the radius $r \gg \lambda$. Finally, field components for a two-layered cylinder alternately filled with DNG and DPS materials are calculated. The normal component is found to be discontinuous at the boundaries, and the tangential components are not, which agrees, as expected, with the boundary conditions.

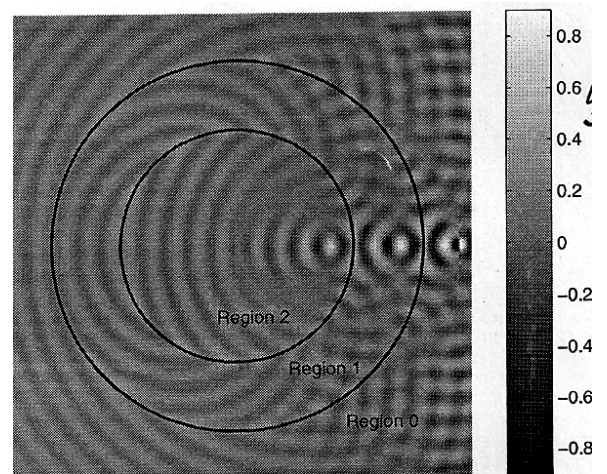


Figure 10. Real part of the H_ϕ component of an electromagnetic wave propagating through a two-layered cylinder with DNG and DPS materials.

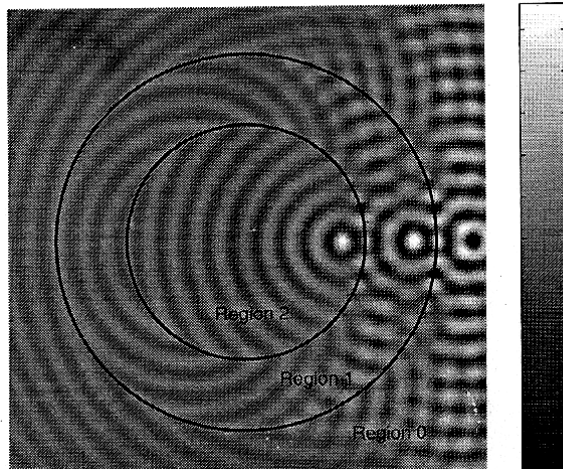


Figure 11. Real part of the E_z component of an electromagnetic wave propagating through a two-layered cylinder with DNG and DPS materials.

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In Vitro Antibody Production Enables HIV Infection Detection In Window Period -- Key To Safer Blood

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Researchers in Israel and Kenya have shown that the contribution of variable degrees of immune suppression, either due to existing chronic infections such as parasitemias and/or nutrition, in different populations may influence and prolong the serological-diagnostic window period of HIV. However, the immunosuppression can be overcome, by in-vitro enhancement of antibody production (termed-Stimmunology). The results, which appear in the August 2009 issue of *Experimental Biology and Medicine*, show that pre-treating the whole blood sample in the SMARTube™ containing immune potentiating agents promoted the synthesis and release of antibodies against HIV-1 prior to their detection in corresponding plasma samples in a group of donors who would otherwise be classified as HIV-1 seronegative blood donors. The identification of techniques that can lead to detection of HIV infection during this window period is of obvious public health importance especially in resource poor settings highlighting the importance of these findings. Overcoming the suppression, in-vitro, led to the production of detectable levels of anti-HIV antibodies in the whole blood sample and to the detection of potentially infectious blood units which were missed by regular HIV serology. Interestingly, the ratio of missed infections among the total HIV infected blood donors was higher among the younger (high-school) donors versus adult donors. The research team, Dr. Jasper Mumo, immunologist from the Department of Human Pathology, University of Nairobi, Kenya, Dr.

Ami Vansover, head of the Virology Laboratory, Public Health Laboratories, Ministry of Health, Israel, and Dr. Tamar Jehuda-Cohen, an immunologist, Faculty of Biomedical Engineering, Technion-Israel Institute of Technology, ran the same HIV antibody tests using both regular plasma and SMART-plasma (plasma after the Stimmunology step) from blood donors in Kenyatta hospital. Dr. Jehuda-Cohen noted that "this study, offers one of the keys to making the blood supply safer, by overcoming the problem of this protracted window period perhaps unique to certain field study sites with a high incidence/prevalence of HIV-1. This is true not only for HIV but also for other infections such as HCV, which has even a longer window period than HIV"

In summary, in-vitro enhancement of antibody production, made simple by the SMARTube™, has been shown to enable the earlier detection of HIV infection. This is critical for saving lives not only via a safer blood supply but also by detection of HIV infection among pregnant women who seem to have a very long window period. "A pregnant women testing false negative for HIV will not be offered ART which could have saved her baby" said Dr. Jehuda-Cohen.

Dr. Steven R. Goodman, Editor-in-Chief of *Experimental Biology and Medicine* said "The article by Mumo and colleagues may lead to a change in testing paradigms and algorithms in HIV and other infections with a diagnostic window period."

Modeling the Impact of Increased CO₂ Levels on Wheat and Rabi Maize for Different Climate Change Scenarios in Selected Locations of Bihar

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Abstract

Agriculture remains dependent on climate and climatic resources, uneven distribution of monsoonal rainfall, due to climate change, around the country may result in some parts getting flooded while others facing drought, leading to mass migration of people and insecurity of availability of food to all. Timely assessment of climate change effects on agriculture might help to adapt suitable farming techniques to maximize agricultural production. The response of C₃ and C₄ crops to elevated CO₂ levels when exposed frequently to water stress or changes in climatic factors such as temperature or rainfall may provide variable results. Current crop growth models, simulate not only the effect of increased temperature but, also consider the effect of increased CO₂ on morphology and phenology of crop. Simulated yield of wheat (HUW 468) decreases from the baseline in 2050 and 2080 while, a meager increase of 3% may occur in 2020 at Pusa. At Madhepura, a decline of 21% in simulated yield of wheat (HD 2733) from the baseline may be observed for 2080. Patna and Sabour may show a decrease in simulated yield of almost 40 % upto 2080s. Simulated yield of rabi maize may increase to 11 %, 25% and 77 % upto 2020, 2050 and 2080 respectively for the stations under study. Reduction in simulated yield of wheat without CO₂ increase is higher than simulation with CO₂ increase for all stations and scenarios. For 2020s difference in reduction percentage between simulated yield with and without CO₂ increment is less as compared to 2050s and 2080s. While, in case of maize an increase in yield is observed with or without CO₂ increase but the increase is more at enhanced CO₂.

Introduction

Climate change refers to the variation in earth's global climate or in regional climates over timescales ranging from decades to millions of years. Greenhouse gases (GHG's), are effective in trapping heat at the earth's surface, without GHG's, most of the currently cultivated regions of the earth would be too cold for agricultural production. However, human activity is contributing to increases in GHG concentrations in the atmosphere and the increases are causing potentially

detrimental changes in temperature and other aspects of climate. The atmospheric concentration of CO₂ in 2005 was 379 ppm compared to the pre-industrial levels of 280 ppm (IPCC 2007). Global annual-mean surface temperature has shown a rapid and widespread increase of 1.4° F (0.7°C) since the early 20th century with about 0.9° F of that increase occurring after 1978. It is also estimated that by 2100, average temperatures will increase by between 1.4° and 5.8°C (IPCC). Agricultural productivity and production is predicted to decline due to climatic changes. 0.5°C rise in winter temperature would reduce wheat yield by 0.45 tonnes per hectare in India (Lal et al., 1998; Kalra et al., 2003). 2 to 5% decrease in yield potential of wheat and kharif maize for a temperature rise of 0.5 to 1.5°C in India (Aggarwal, 2003).

State of Bihar lies between 24° to 27°N, 83° to 88°E with a height of 52.73 m above mean sea level Bihar is having total geographical area of 9.36 million hectares with cultivable land of 0.58 lakh hectares, with normal rainfall of 1176.4 mm (anonymous 2007). The state falls in the middle-Gangetic plains region. It is sub-divided into three agro-ecological zones. These are, Northwest Alluvial Plains (Zone-I), North-East Alluvial Plains (Zone-II) and South Bihar Alluvial Plains (Zone-III A and III B). Major crops grown in agro-ecological zones of Bihar are depicted in table1. Gross cropped area is maximum (30.07 lakh hectares) for zone I and minimum (6.21 lakh hectares) for zone III B, irrigated area ranges from 3.68 lakh hectares to 18.41 lakh hectares, Zone II receives highest annual rainfall (1387 mm) and is also the coldest among the three zones (average temperature: 21.3°C). Zone III receives least rainfall (1104 mm) and is also the warmest of the zones of Bihar (average temperature: 22.45 °C).

Table1: Major crops grown in different locations

Sl. No.	Agro-ecological zones	Major crops
1.	Zone-I	Rice, Wheat, Maize, Gram
2.	Zone-II	Rice, Wheat, Maize, Gram, Lentil
3.	Zone-III (A)	Rice, Wheat, Gram, Potato, Onion, Lentil
4.	Zone-III (B)	Rice, Wheat, Gram

Material and methods

For this study four stations (figure 1) are selected, representing each zone, on the basis of availability of meteorological, soil and crop data. The weather data obtained from different centers was analyzed. The existing data on baseline conditions in the selected locations, crop yields and farmers' practices and yields on the basis of recommended practices are collected. The crop, meteorological and soil data for selected centers are collected from BAC, Sabour (Bhagalpur), IARI, Pusa, TDC, Dholi (Muzaffarpur), IRS, Madhepura, RAU, and Pusa. INFOCROP as a dynamic process growth model is validated and calibrated as per the availability of data for Pusa, Sabour and Patna for wheat, rice, maize and chickpea crop. Info crop model is used to simulate impact of different scenarios of climate change on the basis of available climatic data and crop data. For calibration purpose the input data for model simulation is fixed and consecutively parameterized to the model required form. The model simulates the grain yield and simulated yields are compared with observed yields thus validating the model outputs (table2).

The monthly mean change in maximum and minimum temperature and the monthly percentage change in rainfall given in the HADCM3 GCM projections are incorporated into the baseline (historical weather data) to generate scenarios of 2020, 2050, and 2080.

Table2: Validation results for Pusa location

S.No.	Crop	Coefficient of Efficiency (%)	RMSE (kg/ha)	MAE (kg/ha)
1	Wheat (timely sown)	84	166	137
2	Rabi Maize	70	293	238

Results and Discussion

Variability of climatic parameters of selected stations during rabi season (Nov-April)

Analysis of weather data during the study period showed (table.3) interannual variation in weather variables. Rainfall ranges from 7 to 221.6 mm, 5.8 to 124.1mm, 33.2 to 276.5 mm and 11.8 to 216 mm for Pusa, Patna, Madhepura and Sabour respectively. Rainfall showed almost no significant trend over 30 year period for any station. Rainfall trend shows a decrease in zone I and zone II by 0.46 and 0.42 mm per year respectively, and for zone III A and IIIB, an increase in rainfall by 0.38 and 0.97 per year respectively.

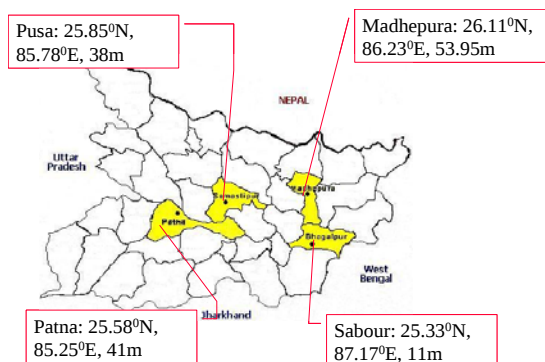


Fig1: selected locations for study

Impacts of climate change on wheat and rabi maize With increased CO₂ levels from 370 (414, 522 and 682ppm) and changing temperature

With the current cultivars, cultivation and management practices, the impacts of climate change on three varieties of wheat namely HD 2733, HUW 468, RW 346 and a variety of maize Ganga-11 under A2 scenario are explored at the selected centers

All the results (figure 2) are taken by comparing the yields between A2 climate change scenario time scales, i.e. 2020, 2050 and 2080, and baseline (1961-1990)

Wheat

Simulated yield of wheat (HUW 468) decreases from the baseline in 2050 and 2080 to 4 and 14% respectively while, a meager increase of 3% may happen upto 2020 at Pusa. At Madhepura, a decline of 5, 13 and 21% in simulated yield of wheat (HD 2733) from the baseline may be observed for 2020, 2050 and 2080 respectively. Patna and Sabour may show a decrease in simulated yield of almost 40 % upto 2080s

Rabi Maize

Simulated yield of rabi maize may increase from 8 to 11 %, 14 to 25 % and 24to 77 % upto 2020, 2050 and 2080 respectively for the stations under study for all the three scenarios from the baseline yield. Maximum increase is observed in Sabour may be due to low baseline yield

With current level of CO₂ but changing temperature

Wheat

Reduction in simulated yield of wheat without CO₂ increase is higher than simulation with CO₂ increase for all stations and scenarios. For 2020s difference in reduction percentage between simulated yield with and without CO₂ increase is less as compared to 2050s and 2080s, considering increase in CO₂ while simulating, has a beneficial effect on the yield upto 10% for 2080 scenario.



Rabi Maize

An increase in yield is observed with or without CO₂ increase but it is more if CO₂ enhancement is considered. The difference in yield is meager for 2020 and 2050, while the difference between the increase percentage for 2080 with and without CO₂ increase shows a marked difference.

Increasing temperature reduces duration of wheat crop (Midmore et al., 1982). Loss of chlorophyll during grain filling has been associated with reduced field performance of wheat in warm environments (Reynolds et al., 2000). Fischer (1985) calculated a kernel number reduction rate of 4% per °C in wheat ranging between 14°C-22°C. Reduced source on yield is confirmed by reduced kernel weight in response to elevated temperature, with kernel weight affected typically by a 2-5% decrease per °C increase (Wardlaw and Wrigly 1994). These are the possible reasons for reduced yield performance of wheat with increased temperature under different climate change scenarios.

Cultivation of Maize is limited by cold sensitivity as manifested by retardation of growth at temp. 10-15°C (Stamp, 1984; Verheul et al., 1996) as well as by leaf necrosis and plant death at temperatures below 10 °C (Janowiak and Markowski, 1994). Maize is a C4 crop and is remarkably tolerant of high temperatures (Jones and Thornton, 2003). Hardacre and Turnbull (1986) observed that relative growth rate and net assimilation rate of maize increased with temperature in controlled environments from 16 to 28 °C. Thus maize possibly benefits from increase in minimum temperature and CO₂ under future scenarios. Elevated CO₂ alone tends to increase growth and yield of most agricultural plants by regulating the opening and closing of stomata, reducing transpiration per unit leaf area thus enhancing photosynthesis as well as water use efficiency (Parry et al., 2004).

From this study it can be concluded that increasing temperature may prove harmful for the wheat crop while it is proving beneficial for the maize crop grown during rabi season. Increasing the levels of CO₂ is affecting the wheat and maize crop beneficially, by bringing an increase in yield. Decrease in yield of wheat in different scenarios, may be attributed to the increase in maximum temperature while the increase in maize yield may be because of the higher night temperatures. Maize crop being sensitive to cold temperature stress and also being more tolerant to higher temperatures is able to thrive well in warmer temperatures that might develop in future. The study is based on present varieties and management practices and does not include the possible effect of pest and diseases and changes in soil parameters with increased temperature.

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Table3: Analysis of weather data for baseline period at selected locations

	Pusa (Zone I)			Madhepura (Zone II)			Patna (Zone IIIA)			Sabour (Zone IIIB)		
	TMIN	TMAX	RAIN	TMIN	TMAX	RAIN	TMIN	TMAX	RAIN	TMIN	TMAX	RAIN
MEAN	12.57	28.30	59.75	12.53	27.80	100.47	13.38	28.24	60.05	13.14	28.26	66.2
SD	1.01	0.56	41.30	1.07	0.60	56.26	0.82	0.62	33.08	0.51	0.63	44.3
MAX	15.93	29.65	221.6	14.85	28.36	276.50	14.70	29.22	124.40	13.91	29.25	216
MIN	10.40	26.92	7.00	10.17	26.16	33.20	11.86	26.80	5.80	12.24	27.03	11.8
RANGE	5.53	2.73	214.6	4.68	2.20	243.30	2.84	2.42	118.60	1.67	2.21	204

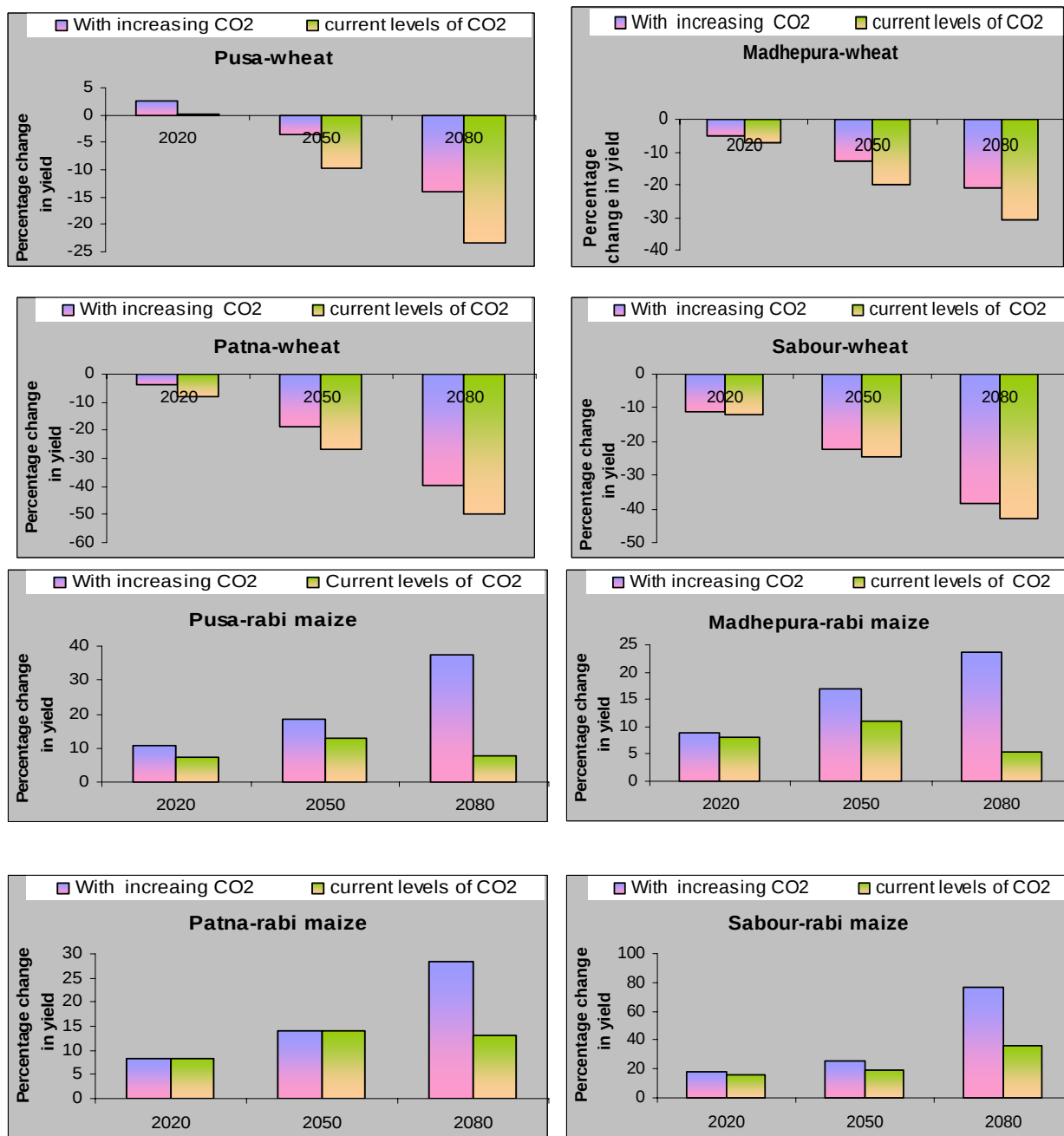


Figure2: Impact of climate change on yield of timely sown wheat and rabi maize at selected centers with increasing CO₂ and without increase in CO₂

Application of Radial Wave Equation for HCB Mode

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Abstract:

The Phase shifts needed for the calculation of the transport properties of hard convex body (HCB) fluid in quantum mechanics is the solution of the radial wave equation described by the HCB coordinate systems. The radial wave equation described by HCB-coordinate system has been deduced and expressed for the pair intermolecular potential specified in terms of the support function $h(x)$ and surface-to-surface coordinate representation. The radial wave equation has been expressed in the reduced form.

Key Words: Radial wave equation, HCB Coordinate System.

Introduction:

In quantum mechanical calculation of the transport phenomena, the major problem is the evaluation of the Radial wave equation. The phase shifts is the solution of the radial wave equation. The expression for the radial wave equation of a HCB Model co-ordinate system has been described first and expressed for the pair intermolecular potential specified in terms of the support function $h(x)$ and surface-to-surface co-ordinate representation. The properties of hard convex bodies (HCB's) necessary for our analysis are due to Kihara [1].

Expression for in terms of HCB co-ordinate

Let us first assume that the convex body has a smooth surface and that each supporting plane has a contact of first order with the convex body. Let $r(\theta, \phi)$ be the radius vector from the origin to the contact point of the body with the supporting plane in the direction (θ, ϕ) . Then by use of the unit vector $k(\theta, \phi)$ in the direction (θ, ϕ) . So, the identity

$$x = (h(x) + K) \sin \theta \cos \phi$$

$$y = (h(x) + K) \sin \theta \sin \phi$$

$$z = (h(x) + K) \cos \theta$$

Thus for, the expression for in terms of the above identities, it is desirable to use the procedure for making the transformation from Cartesian coordinates to the required co-ordinate system. This is done by using the concept of orthogonal curvilinear co-ordinates.

The expression for (Laplacian) in orthogonal curvilinear co-ordinates is given by

$$\nabla^2 \Psi = \nabla \cdot \nabla \Psi$$

$$= \frac{1}{h_1 h_2 h_3} \left[\frac{\partial}{\partial u_1} \left(\frac{h_2 h_3}{h_1} \frac{\partial \Psi}{\partial u_1} \right) + \frac{\partial}{\partial u_2} \left(\frac{h_1 h_3}{h_2} \frac{\partial \Psi}{\partial u_2} \right) + \frac{\partial}{\partial u_3} \left(\frac{h_1 h_2}{h_3} \frac{\partial \Psi}{\partial u_3} \right) \right] \quad (7)$$

Where u_1, u_2 and u_3 are called orthogonal curvilinear co-ordinates and h_1, h_2 and h_3 are called scale factors.

The essential task is determining the explicit form of is that of determining the scale factors.

The condition for this transformation is that the Jacobin

$$J = \det \begin{vmatrix} \frac{\partial x}{\partial u_1} & \frac{\partial x}{\partial u_2} & \frac{\partial x}{\partial u_3} \\ \frac{\partial y}{\partial u_1} & \frac{\partial y}{\partial u_2} & \frac{\partial y}{\partial u_3} \\ \frac{\partial z}{\partial u_1} & \frac{\partial z}{\partial u_2} & \frac{\partial z}{\partial u_3} \end{vmatrix}$$

is non zero.

$$u_1 = K, u_2 = \theta, u_3 = \phi$$

In terms of HCB'S co-ordinates

And $h_1 = 1$

$$h_2 = h(x) + K$$

$$h_3 = \{h(x) + K\} \sin \theta$$

The expression for in terms of HCB'S co-ordinate system is

$$\left[\frac{1}{(h(x)+K)^2} \frac{\partial}{\partial K} \left\{ (h(x)+K)^2 \frac{\partial}{\partial K} \right\} + \frac{1}{(h(x)+K)^2 \sin \theta} \frac{\partial}{\partial \theta} \nabla^2 \psi + \left(J^2 - \frac{2\phi(K)\mu}{\hbar^2} \right) \right] \psi = 0 \quad \text{---(11)}$$

$$\left[\sin \theta \frac{\partial}{\partial \theta} \right] + \frac{1}{(h(x)+K)^2 \sin^2 \theta} \frac{\partial}{\partial \theta^2} \Big] \psi = \nabla^2 \psi \quad \text{---(8)}$$

$$\left[\frac{1}{(h(x)+K)^2} \frac{\partial}{\partial K} \left\{ (h(x)+K)^2 \frac{\partial}{\partial K} \right\} + \frac{1}{(h(x)+K)^2 \sin \theta} \frac{\partial}{\partial \theta} \left(\sin \theta \frac{\partial}{\partial \theta} \right) + \frac{1}{(h(x)+K)^2 \sin^2 \theta} \frac{\partial}{\partial \theta^2} + \left(J^2 - \frac{2\phi(K)\mu}{\hbar^2} \right) \right] \psi = 0 \quad \text{---(12)}$$

Radial Wave Equation

The radial wave equation described by the HCB co-ordinate system is obtained from the expression (2) by the method of separation of variables. This method results the expression in one variable. The method most commonly used work by removing one or more partial derivative terms so that an equation with fewer variables is obtained. This may be repeated until an ordinary differential equation in one variable result.

The Schrodinger equation for two particles interacting according to a potential function $\phi(k)$, may be written as

Substituting (7) into (6) and dividing by Y and multiplying by

$$\frac{1}{\psi(K)} \frac{1}{(h(x)+K)^2} \frac{\partial}{\partial K} (h(x)+K)^2 \frac{\partial \psi(K)}{\partial K} + \frac{1}{y}$$

$$\left[\frac{1}{(h(x)+K)^2 \sin \theta} \frac{\partial}{\partial \theta} \left(\sin \theta \frac{\partial y}{\partial \theta} \right) + \frac{1}{(h(x)+K)^2 \sin^2 \theta} \frac{\partial y^2}{\partial \theta^2} \right] + \left(J^2 - \frac{2\phi(K)\mu}{\hbar^2} \right) = 0$$

$$\frac{-\hbar^2}{2\mu} (\nabla^2 \psi) + \phi(K) \psi = E \psi \quad \text{---(9)}$$

in which E is the total energy of the system.

$$E = \frac{1}{2} \mu g^2 \quad \text{---(10)}$$

g being the relative speed of the colliding pair before the collision take place and μ is the reduced mass. If we define J by $\hbar J = \mu g$, the Schrodinger equation assumes the form [2]

This equation will be solved by the method of separation of variables by putting

$$\psi = \psi(K) y(\theta, \phi) \quad \text{---(13)}$$

where Y (q, f) are the spherical harmonics and Y (K) satisfy the radial wave Equation.

$[h(x) + k]^2$ the expression (6) becomes



Or

$$\left[\frac{1}{(h(x)+K)^2 \sin \theta} \frac{\partial}{\partial \theta} \left(\sin \theta \frac{\partial y}{\partial \theta} \right) + \frac{1}{(h(x)+K)^2 \sin^2 \theta} \frac{\partial y^2}{\partial \phi^2} \right] + \left(J^2 - \frac{2\phi(K)\mu}{\hbar^2} \right) = 0$$

$$= -\frac{1}{y} \left[\frac{1}{\sin \theta} \frac{\partial}{\partial \theta} \left(\sin \theta \frac{\partial y}{\partial \theta} \right) + \frac{1}{\sin^2 \theta} \frac{\partial y^2}{\partial \phi^2} \right] = 0 \text{ --- (14)}$$

The left side of equation (8) depends only on K, and the right side depends only on q and f, both sides must be equal to a constant that is $-l(l+1)$.

Thus equation (8) gives us a radial equation

$$\frac{1}{[h(x)+K]^2} \frac{\partial}{\partial K} \left[(h(x)+K)^2 \frac{\partial \psi(K)}{\partial K} \right] +$$

$$\left(J^2 - \frac{2\phi(K)\mu}{\hbar^2} - \frac{\ell(\ell+1)}{(h(x)+K)^2} \right) \psi(K) = 0 \text{ --- (15)}$$

The radial equation (9), with the change of dependent variable, becomes

$$\frac{d^2 u(K)}{dK^2} + \left[J^2 - \frac{2\phi(K)\mu}{\hbar^2} - \frac{\ell(\ell+1)}{h((x)+K)^2} \right] u(K) = 0 \text{ --- (16)}$$

Where u (k) satisfies the equation (10) and this equation corresponds to the angular momentum quantum

The expression for Intermolecular pair potential [3] for HCB Model, $f(K) = 4E [h(x)]$

The radial wave equation (10) may be written in the reduced form

$$\frac{d^2}{dK^{*2}} (K^* \psi(K)) + \left[J^{*2} + \frac{16\pi^2}{\Delta^{*2}} \left(\frac{1}{K^{*12}} - \frac{1}{K^{*6}} \right) - \frac{\ell(\ell+1)}{(1+K^*)^2} \right] (K^* \psi(K)) = 0 \text{ --- (17)}$$

Where ,

$$K^* = \frac{K}{h(x)} ; \quad J^* = J h(x) \quad \text{and} \quad \mu = \frac{m}{2}$$

m is the mass of the particle, m is the reduced mass and is



$$\mu = \frac{m_1 m_2}{m_1 + m_2}$$

Here $m_1 = m_2$ for identical particle.

$$\Delta^* = \frac{h}{h(x)\sqrt{2E\mu}}$$

$$\Delta^* = \frac{h}{h(x)\sqrt{Em}}$$

is a reduced quantum parameter.

The reduced quantum mechanical parameter

$$\Delta^* = \frac{h}{a(mE)^{\frac{1}{2}}}$$

When $x = \cos q = 1$, the orientation is along semi - major axis 'a' and

$$\Delta^* = \frac{h}{b(mE)^{\frac{1}{2}}}$$

When $x = \cos q = 0$, the orientation is along semi-minor axis 'b'.

Result and Discussion

The asymptotic solution of the radial wave equation for real (interacting) and ideal (non-interacting) pairs of molecules are sinusoidal and differ only in the phase of the sine functions, the difference being the phase shifts, δ_l (J^*). The phase shift depends upon the angular momentum quantum number l and the wave number of relative motion.

It is in general not possible to give an exact solution of the radial wave equation for the phases. The expression for the phase shifts has been given by N. F. Mott [4] and applied by Hulthén to calculate δ_l for different potentials which gives very satisfactory results.

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Understanding Proteins: The Wonder Molecule

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Biological systems are quite intriguing and the enigma called life has puzzled the human rationale since antiquity. The self sustaining biological process called life has been greatly debated and understanding the fine fabric that lies as a common theme to all living forms is still a holy grail yet to be comprehended in great details. In biophysical terminology according to physicists such as John Bernal, Erwin Schrödinger, Eugene Wigner, and John Avery, life is a member of the class of phenomena which are open or continuous systems able to decrease their internal entropy at the expense of substances or free energy taken in from the environment and subsequently rejected in a degraded form[1,2]. The basic organizational unit of all living organisms is cell that finally forms the interwoven communicating assembly providing the platform for genesis of life. The functional pleiotropy of the cells arise from the formation of specific consortium formed by the proteins, sugars, lipids and nucleic acids. The cells in addition contain myriad sea of chemical constituents with water forming the base of life's cocktail and constituents such as small inorganic and organic molecules: K^+ , Na^+ , Ca^{++} , Mg^{++} , Cl^- , PO_4^{--} , organic bases, all vital amines (vitamins) and cofactors floating freely regulating and maintaining the integrity and dynamics of life. If life be considered gods intelligently designed complex engine then these small molecules can be analogical to tiny tools, nuts, bolts and spare parts which facilitates efficient running. The blueprint of the very core of this engine even its design and prototype lies in the well written seminal script of DNA and RNA, but of all the molecules that represents life in all its vitality and vigor protein occupies the centre stage. Proteins are biomolecules that provide the diverse plethora of ingredients for god's finest recipe called life. They form the most abundant molecule in biology other than water [3]. Our body is made up of more than 1,00,000 different protein that virtually govern all the crucial life processes [4]. Thus the present scientific marathon passes the baton on to the firm hands of contemporary researchers to delineate these molecules holistically taking up the systems biology approach.

Proteins drive the nature dynamic machine called life. It has been a challenging bio-molecule to investigate and delineate. The wizardry and diversity

they exhibit are enormous. Central dogma ends on this molecule and what begins there on that very point is puzzle called life. Demystifying the architecture of these wonder molecules and appreciating them in the light of laws of chemistry and physics yield information seminal to their structure-function aspects. Their very nature, the diversity, their ability to interact and act in cascade, drive important metabolic pathway act as defense molecule and intricate involvement in almost every function that a cell carries to sustain thrive exist proliferate and die. Disease and ailments are also by virtue of short-circuiting of these molecules caused by mutation or hostile condition. DNA undergoes transcription to yield RNA the process mediated by RNA polymerases which is further translated to yield the building blocks of life proteins. A fine orchestra of RNA and protein assembly is involved to produce life's key molecular machine ribosomes the site for protein synthesis which is nature's marvelous ergonomic design. The blue print for each amino acid is laid down by sets of three letters known as codons the ribosomes serves as the site where codons are recognized and each amino acid is added to yield the linear primary sequence of the protein which is governed by biological necessity as posed by the cell. The linear sequence is transformed in to functional protein by virtue of its indigenously motivated assembly in to a folded entity by the process of protein folding which finally gives it a three dimensional shape.

The discipline of protein folding "Foldiomics" is an endeavor to understand the diverse biological molecule called proteins. Studying folding in light of sequence to delineate sequence structure relationship reaching a universal folding code, stability flexibility, diversity the involved energetics and smooth transitioning from disordered to well ordered forms is a great scientific pursuit and scintillating academic challenge. The range of human diseases associated with protein misfolding and aggregation which results in cellular malfunctioning [5-7] are focus of contemporary quest. Defects in protein folding have been linked to a number of pathologies where aggregates (amyloids) are observed, including neurodegenerative conditions such as Parkinson's, Alzheimer's and Huntington's diseases[8]



The dynamic personalities of protein have always been an exciting area of research. A nascent polypeptide may reach to its native form traversing many folding intermediates. Its fate may further be governed by its propensity to undergo aggregation and degradation. Another intriguing feature that these aggregate can adopt is to form structured fibrillar topology leading to amyloid fibers. The populations and interconversions of the various states are determined by their relative thermodynamic and kinetic stabilities under any given conditions. In living systems, however, transitions between the different states are highly regulated by control of the environment, and by the presence of molecular chaperones, proteolytic enzymes, and other factors. Failure of such regulatory mechanisms is likely to be a major factor in the onset of misfolding diseases[9].

In nutshell studying these wonder molecules can lead us in better understanding of ourselves. It will also open new vistas to our knowledge of pathophysiology of existing and emerging diseases thereby better therapeutics and ultimately help in improving the quality of life on the planet.

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Implementation of Wireless Telecommand Systems

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Abstract

The Paper presents design and development of a CPLD based wireless telecommand system simulating industrial plant automation, wherein master controller remotely controls the relays/ sensors. Transmitting end comprises of RF module and a CPU hosting a LabVIEW based virtual instrument. Front Panel of the virtual instrument consists of 4 switches, few controls to configure COM port and SEND button. Pressing the SEND button would transmit the status of 4 switches through RF module, interfaced to PC through COM port.

Receiving end comprises of RF module and a CPLD development kit. CPLD hosts VHDL code to receive the transmitted string, decode the command and display the command on the LEDs/ monitor and operate a relay

Keywords—CPLD, RF module, LabVIEW based virtual instrument.

I. INTRODUCTION:

In an automated plant, there are number of parameters of various systems, located in different and distant places, which are sensed by variety of sensors, periodically/ continuously, and the data/ status of these parameters is transmitted regularly to the master station. Master station gathers the information from sensors from the entire plant and takes various decisions to control various actuators, which also are spread across the entire plant. So, based on the feedback from the sensors, it sends signals to various actuators so that they can switch ON/OFF the valves, initiate alarms, etc.

The transfer of information from the sensing and control units to the master and vice versa takes place through cables laid across the entire plant, or in some cases it happens through wireless channel.

This paper simulates this plant automation in a very basic manner. Subsequent sections will explain the functionality and features which have been implemented in the system.

II. DESIGN APPROACH AND IMPLEMENTATION DETAILS

A telecommand system requires transfer of data from one station to the other through wireless channel. So the system consists of two modules. Transmit module will collect the input command/sensory data, multiplex and/or code the data and transmit it over wireless channel. Receiver module receives the RF signal. The transmitted information is retrieved from it and finally some system is switched ON/OFF.

To design such a system there are plethora of technologies available. For wireless channel, we could have used IR modules which are quite sufficient for the range required in the project. Bluetooth and zig bee modules are also available. FM transmitter/receiver modules. DTMF transceivers are also available. Spread spectrum modems and GSM modems could have been used for the project.

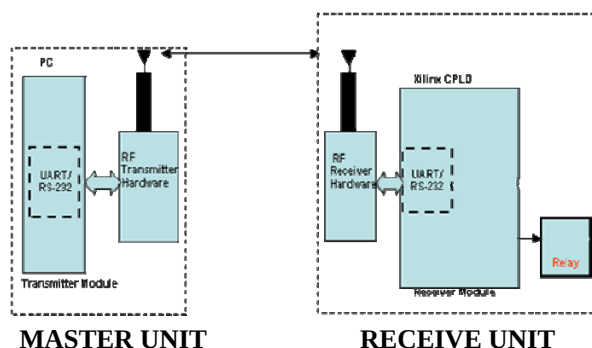
In a same fashion, for acquiring data from sensors and controlling actuators, PLCs or microcontrollers are used. Manu proprietary variants of PLCs/ microcontrollers are also used for this purpose. We have tried to incorporate the best of the industry standard technologies in this project. The block diagram of our system is shown below: For MASTER unit front-end, we have used National Instruments' LabVIEW which has become a de facto standard for instrumentation.

For WIRELESS channel, we have used transceivers operating in 2.4 GHz licence free band. The transceiver we have used is very small, with an integrated on-chip antenna. 2.4 GHz band is also used for number of commercial wireless applications.

At RECEIVER end, we have used Xilinx CPLD board, which again is a world leader in their segment. Thus, Dataflow programming using LabVIEW, VHDL programming, Serial interface for programming transceivers, along with hardware integration and testing, all have been bundled together in this very small project.



SYSTEM BLOCK DIAGRAM:



A. Master Unit

The Master unit is simulated as Master controller and the various commands are issued from this unit. Entire unit is implemented in software, which is developed using LabVIEW. A user friendly Graphical User interface is provided for the operator. Master Unit either takes data from the sensors or control buttons on the front panel. Since, no ADC card is used, analog input signal from the sensor is simulated. Usually sensors, after signal conditioning, have voltage outputs ranging from 0 to 10 V and some control signal, which will switch ON/OFF some device, is also issued based upon the signal output. So, a random number generator along with a multiplier is used to simulate the sensor output. And a comparator is used to compare multiplier output against the user defined threshold. Based upon the output of the comparator, a message string is transmitted to the receiver.

Another form of input at the master unit are the control buttons. To simulate this, three switches are provided on the GUI. Different message strings are transmitted based on the state of the switches.

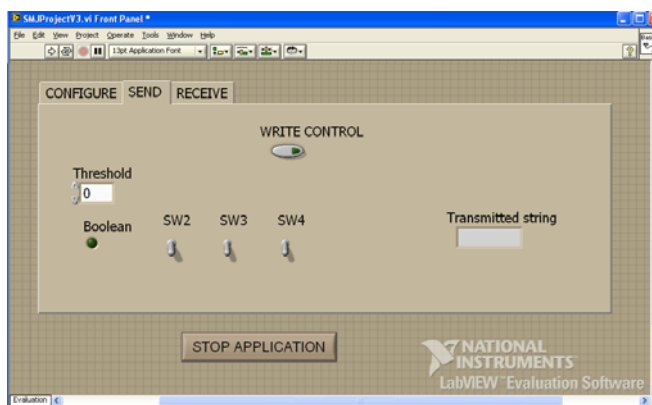
Output of this software module is a message string comprising of states of switches/ simulated sensor output. The string is sent to RS232 interface.

Master unit is implemented using National Instruments' LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench), a dataflow programming environment.

Virtual instrument created using LabVIEW comprises of two parts: Front panel and a block diagram.

Front panel for the Master unit is shown below. The front panel is the user interface and has all the controls and indicators.

Front panel has three tab pages: CONFIGURE, SEND, RECEIVE. CONFIGURE page has controls to configure the serial port.

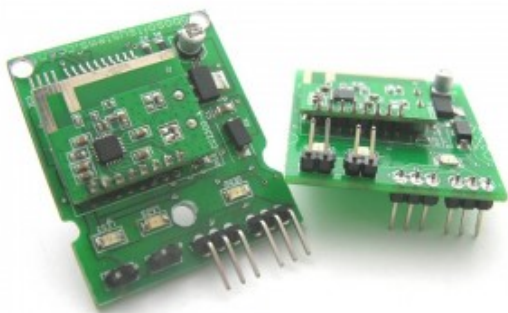


B. Wireless Transceiver

2.4 GHz RF module is used as wireless transceiver. The transceiver has a printed antenna on the chip itself and it operates from 5-12 Vdc. It has RS232 UART interface with variable baud rates. So a pair of such modules, properly configured, act as a cable. The unit has Run mode and CONFIG mode, one of the two can be selected using jumper settings. The RF module can be configured in CONFIG mode.

The transceiver is used in RUN mode. The RS232 output of PC is connected to the RS232 pins on the RF module using the in-house fabricated cable assembly. Similarly, at receiving end, another RF module is used whose RS232 output is connected to CPLD kit, again using the in-house fabricated cable assembly.

The transceiver (CC2500 Module) is a bought out item from M/s Robosoft Systems, Mumbai. Transceiver operates at 2.4 GHz. RF module is a plug and play replacement for the wired Serial Port (UART). This wireless module can work in 255 different channels and can address 255 devices individually.



C. Receive unit

Receive unit comprises of CPLD kit and Solid state relay. CPLD kit is programmed using VHDL. It is programmed to receive data from RS232 port. The received message string is parsed, and depending upon the status messages received, LEDs on the CPLD board are switched ON/OFF using three signals. With one of the status message, voltage output is provided on expansion pin terminals.

TABLE I

Received String	Receiver Operation
Axxx	Status LED 3 ON
Bxxx	Status LED 3 OFF
xxEx	Relay ON
xCxx	Status LED 2 ON
xDxx	Status LED 2 OFF
xxEx	Status LED 1 ON
xxFx	Status LED 1 OFF
xxxG	Status LED 0 ON
xxxH	Status LED 0 OFF

A solid state relay is connected to these pin terminals. So, depending upon the message received, solid state relay is energized/ de-energised. Hence a device connected in a circuit, having relay output terminals in the path, gets switched ON/OFF depending upon the status of the switch at the MASTER.

Receiver uses Xilinx CPLD Board, Solid state relay. At the relay output, any AC/DC device (conforming to the current rating of the relay contacts) to be controlled, may be connected. Software part has been developed in VHDL as a programming language and result has been demonstrated on Xilinx CPLD kit and relay. The Functional module in the Receiver is The UART (universal asynchronous receiver and transmitter) module and Telecommand

controller which provides asynchronous serial communication with external devices.

The UART consists of one receiver module and one transmitter module. Those two modules have separate inputs and outputs for most of their control lines, the lines that are shared by both modules are the bi-directional data bus, master clock (mclkx16) and reset. This implementation of the UART transmits in blocks of 11 bits; 1 leading low start bit, 1 trailing high stop bit, 1 parity bit and 8 data bits. The UART data format is shown below.

The data from the Master are coded strings. The controller reads the serial data, identifies the message and take appropriate actions, which controls relay and status monitoring LEDs.

III. SYSTEM OPERATION

To operate the system is extremely simple.

RF Transceiver is connected to the PC COM port using the cable. It should also be powered using DC source/ AC-DC adapter or battery.

At the other end, similar RF transceiver is used. The serial port output is connected to COM port of CPLD kit. A solid state relay is connected to any of the configured output pins. A device to be operated may be connected in the relay output path.

Once we ensure that CPLD kit has been loaded with correct program, both the transceivers are ON, run the Master unit application.

Depending upon the status of the switches at the Master, LEDs will glow in the CPLD kit. Also the device connected may be switched ON/OFF depending upon the status of the corresponding switch.

IV. CONCLUSION

Innovative Wireless UART Controller and RF Transceiver Combination Eliminates Cable Requirements for Serial or Parallel Interfaces. Addressing the growing market evolution away from cabled to wireless connections, especially in industrial environments, this solution increases equipment mobility, simplifies installations, and accelerates time to market and one of the broadest portfolios of high-performance interface solutions including UARTs, serial transceivers (RS-232, RS-485), and multi-protocol.



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Contribution of Cybernetics to Management Science

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Cybernetics is a mathematical modelling approach for an understanding of regulation and control in any system. Stafford Beer is acknowledged as the first to explicitly apply the principles of cybernetics to management and claim its relevance to Operations Research and Management Science. This paper gives a brief outline of the main manifestation of Beer's work and reflections on management cybernetics-The Viable Systems Model (VSM). Out of the various themes of Beer's work on management cybernetics, only three have been highlighted here. These are communication, variety and participative management. Other developments in management cybernetics have also been discussed in this paper. Cybernetics is applicable to almost any problem area because of its generality, and so the main domains of applications have also been presented here.

Keywords: Cybernetics, Management, Control

1. Introduction

The term "cybernetics" was first used in 1834 by the French physicist Andre-Marie Ampere (1875-1836) to describe "the science of managing processes". Elsewhere, he refers to it as "the science of government".

However, the origins of modern cybernetics as a recognized science are to be found around one hundred years later. The pioneering principles of the new scientific field of regulation, control and communications in systems were developed primarily by Norbert Wiener, Warren McCulloch, William Ross Ashby, Warren Weaver, Claude Shannon, Gregory Bateson, Heinz von Foerster, John von Neumann and Walter Pitts. These pioneers were supported by the Josiah Macy Foundation. The new scientific field of cybernetics emerged from the interdisciplinary and now legendary Macy conferences. In 1948, Norbert Wiener published his book "Cybernetics". He defined cybernetics as "the science of control and communication in the animal and the machine"- in a word, as the art of steersmanship. This original definition points to the relationship between control and communication, and to the existence of general laws affecting equally animate and inanimate systems. The first principle of such general importance to be

recognized was the significance of feedback in all systems, whatever the fabrics of their components.¹

In the words of William Ross Ashby, one of the founding fathers of cybernetics and systems theory, "Cybernetics studies the flow of information through a system and the way in which that information is used by the system as a mean of controlling itself."²

Although the word "cybernetics" comes from the Greek word "kybernetes" meaning steersman, today it is considered more likely to be associated with cyberspace than the Greek kybernetes meaning steersman. Funk and Wagnall (1984) define cybernetics as "the science that treats of the principles of control and communication as they apply both to the operation of complex machines and the functions of organisms".³

2. Management Cybernetics

According to Jackson (2000), "Beer was the first to apply cybernetics to management, defining cybernetics as the science of effective organization". Late 1950s, he published his first book about cybernetics and management, building on the ideas of Norbert Wiener, Warren McCulloch and especially William Ross Ashby for a systems approach to the management of organizations. In the 1960s and early 1970s "Beer was a prolific writer and an influential practitioner" in management cybernetics. It was during that period that he developed the viable system model to diagnose the faults in any existing organizational system. In that time Forrester invented systems dynamics, which "held out the promise that the behavior of whole systems could be represented and understood through modeling the dynamical feedback process going on within them".⁴

Management cybernetics is the application of cybernetic laws to all types of organizations and institutions created by human beings, and to the interactions within them and between them. It is a theory based on natural laws. It addresses the issues that every individual who wants to influence an organization in any way must learn to resolve. This theory is not restricted to the actions of top managers. Every member of an organization and every person



who to a greater or lesser extent communicates or interacts with it is involved in the considerations.

3. Principles of Cybernetics

Beer's work provides the basis for the development of a model for proper functioning of an organization. Beer postulates that the primary long-term objective of Management is the survival of the enterprise which it conducts. His purpose to write the book "Cybernetics and Management" was to convince scientifically trained and imaginative managers that a machine, using the term in its widest sense, could be constructed continuously to adjust the activities of a firm to its environment in such a manner as to attain this objective in an optimum manner. Defining his project as the "science of effective organization", he argued that the cybernetic principles can be applied to all types of organizations and institutions, and to the interactions within them and between them, with the objective of making these systems more efficient and effective. He also claimed that cybernetics is the basis of control in any system and thus provides the foundation for defining organizational control.⁵

There are many themes in Beer's work on management cybernetics, out of which the following three are noteworthy: communication, variety and participative management.

The first of these themes, i.e., communication is drawn from the work and insights of Bavelas who, in terms of the relational structures, described an understanding of how an organization can communicate with itself. One of Bavelas's main insights is the paradox of peripherality (autonomy) versus centrality (control) of actors in an organization.⁶ This insight led Beer to claim that centralised systems often do not work and was further developed in "The Heart of Enterprise"⁷ and later refined in "Beyond Dispute"⁸. This issue has been a common theme for cybernetic research of social systems, particularly in the area of governance.⁹

The second theme-variety is defined by Beer as "the total number of possible states of a system, or of an element of a system". This number grows daily for every organization because of an ever-increasing range of possibilities afforded by education, by technology, by community, by prosperity, and by the way these possibilities interact to generate yet new variety. These produce complexity in organizations and create the possibility of great uncertainty. In order to regulate a system, we have to absorb its variety. If we fail in this, the system becomes unstable. Ashby's Law of

Requisite Variety (LRV) stated as "Only variety can absorb variety" led Beer to suggest that the activities and management of an organization should be such that identifies the minimum number of choices needed to resolve uncertainty. Beer claimed that LRV is fundamental to matching resources to requirements in organizations and to measurement of performance. He also claimed that it can be used to allocate the management resources necessary to maintain process viability or survival. There are many examples of the use of LRV in the management science literature covering a range of topics such as a strategic planning, production and control, and the environment.¹⁰

The third theme is participative management. Beer was concerned to insure that every member of an organization and every person who to a greater or a lesser extent communicates or interacts with it is involved in the organization's matters. Participative management builds on the two themes described above and is concerned with seeking more effective ways to manage the complexity that would arise with an increase in communication. This would require people within the organization setting to have adequate autonomy in order to prevent the hazardous inadequacy of richly connected system. Beer consistently argued for decentralisation and devolved decision-making and he suggested that as much autonomy as possible must be provided to the lower levels of the organization which would deploy requisite variety effectively.¹¹

As cybernetics is the scientific study of nature of control, a proper interpretation of the fundamental nature of control is essential for the modern understanding of cybernetic theory. Beer explains the meaning of control as self-regulation or self-emergence surfacing from a system. It means that managers use the word "control" in an abstract sense if they equate "what happens intrinsically" to "what evolves when they (as parts of those systems) decide, react and adapt to the situations they normally encounter on a daily basis". Cybernetics needs to be clearly interpreted by managers from this perspective of self-regulation existing within. It must be seen as surfacing from whole organizational systems. To interpret it in the narrow sense of the giving of orders and directions to various parts of the organization is to lose this important sense. From the readings of Beer's initial text "Cybernetics and Management", we can conclude that the four elements of a systems approach, interactivity, interconnectivity recursive layers (viewing processes as circular) and self-regulation play an important role in organizational control for today's managers.



Beer classified systems into three categories- Simple, Complex and Exceedingly Complex, each being either probabilistic or deterministic. Under this categorization, control referred to the management of modern companies viewed as exceedingly complex, probabilistic systems. Control is manifested in its emergent organizational sense when a desired output is achieved by self-regulation, i.e., both output and input calm down and stabilize so that the operation exists in a steady equilibrium state.

Beer's aim was to strive for the "ideal company control system". For Beer, this search naturally involved the interdisciplinary nature of cybernetics. He pondered over naturally occurring and seemingly intrinsic control mechanisms, specifically from a biological sense. He summarized these control mechanisms as homeostats (control devices for maintaining variables between preferred limits) and thus described the ideal control company system as "a homeostatic machine for regulating itself". Today, this "homeostatic machine" description generates a crucial point to an appropriate interpretation of cybernetic theory. The portrayal of the company as a homeostatic machine needs to be considered according to the original Beer appraisal-a machine as a purposive system, albeit exceedingly complex and probabilistic. Any search for "a homeostatic machine for regulating itself" must recognize that such a control system encompasses a cohesive collection of items, people and information forming some purposive system.

Viable companies act as homeostatic machines. They exhibit exceedingly complex, probabilistic character. They continuously deal with and adapt to events both expected and unexpected. Overtime, adaptation to such events enables managers to recognize some consistent patterns. Beer referred to these types of patterns as stochastic. Today the word stochastic is more appropriate than probabilistic in describing company behaviour..

Beer suggested that some sort of machine must have been producing this continuity and pattern. Beer termed this machine "the secondary machine- the machine that lives inside the first like a parasite". He proposed that if managers apply primary cybernetic thinking, they may be able to investigate the secondary machine/parasite components that produce the stochastic, homeostatic behaviour evident in viable companies.

Seeking congruence with this secondary machine/parasite, Beer introduced the concept of isomorphic (having a similar form) mapping. He suggested that managers should map the information

flows emanating from any level of the company operation.

For Beer, the isomorphic mapping of information flows revealed insight into the parasite components of the stochastic, purposive machine. We agree that the mapping of information flows is essential for managers searching for a better understanding of their company-produced behaviours.¹²

4. An Overview of Cybernetic Models

Beer's most influential model for organization modeling is the Viable System Model (VSM). Other major developments in Beer's work are Syntegrity and POSIWID. The term "Syntegrity" is a portmanteau of "synergistic tensegrity" and "POSIWID" stands for "The purpose of a system is what it does".

Viable System Model

The Viable System Model (1975) is a model of the organizational structure of any viable or autonomous system. A viable system is any system organized in such a way as to meet the demands of surviving in the changing environment. One of the prime features of systems that survive is that they are adaptable or capable of learning. The VSM expresses a model for a viable system, which is an abstracted cybernetic description that is applicable to any organization that is a viable system and capable of autonomy. The model aims to specify the minimum functional criteria through which an organization can be said to be capable of independent existence or to maintain its identity in a changing environment. It was developed to diagnose the deficiencies in an existing organizational system.¹³

Syntegrity

Syntegrity is a formal model presented by Beer in the 1990s and now is a registered trademark. It is a form of non-hierarchical problem solving that can be used in a small team of 10 to 40 people. It is a business consultation product that is licensed out to consulting firms as a model for solving problems in a team environment.

" Syntegrity", "Syntegration", "Team Syntegrity" and "Team Syntegration" are all registered trademarks.¹⁴

POSIWID

Beer coined and frequently used the term POSIWID to refer to the commonly observed phenomenon that the de facto purpose of a system is often at odds with its official purpose. Beer coined the term POSIWID and used it many times in public addresses. Perhaps most forcefully in his address to the University of Valladolid, Spain in October 2001, he said "According to the cybernetician, the purpose of a system is what it does. This is a basic dictum. It stands for bald fact, which makes a better starting point in seeking understanding than the familiar attributions of



good intention, prejudices about expectations, moral judgment or sheer ignorance of circumstances.”¹⁵

5. Applications of Cybernetics

The science of cybernetics has produced much has had an impact on modern life. These include a wide range of mechanical and electronic automata and mechanisms of different types serving a variety of purposes, the invention of the computer, current information theory and the most effective forms of psychotherapy. In addition, many other current methods of problem solving in a wide range of different scientific disciplines are best on discoveries within cybernetics. These include educational science, sociology, communications, mechanical engineering, environmental sciences. Stafford Beer himself in his management theories combines cybernetics with his practical experience and knowledge of neuropsychology, neurophysiology, computer science, communications, operations research, mathematics, formal logic and philosophy. The other areas of applications of cybernetics include control theory, artificial intelligence and artificial neural networks, robotics, adaptive systems, large- scale socio-economic systems and systems science.

6. Conclusion

The techniques of cybernetics guide managers to discover the ability of a system to teach itself optimum behaviour. Beer's ideas about decentralization, devolved decision-making and human relations may be viewed as an antidote to conceptions of scientific management. Beer's models provide managers with interesting insights into the ways in which they can tackle complexity. As a result, their organizations may become more able to react effectively and appropriately when faced with complexity. This, in turn, make for a more stable, sustainable and flexible business.

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Psychological Analysis of Scientific temper

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In the present materialistic and scientific scenario of the world, It is observed that science has advanced tremendously in all the walks of life but, at the same time, It is also found to be suffering from moral and identity crisis. In this atomic age, in the form of groupism, almost each and every country is also threatening to annihilate one another without any delay. What are the psychological factors of it? Why the modern, intellectual, logical and scientific minds of today have almost remained primitive in understanding of itself? How science can turn into perfect joy or bliss (param-ananda) which has been the ultimate aim of each and every living religion of the world? How permanent peace and serenity of mind can be achieved?

It appears clearly that the above discussed issues which we are facing today can be traced to a lop-sided development of human mind. In fact, presently, there has been an explosion of scientific knowledge but, we find little growth in self-knowledge. We can only know the inner essence and beauty of self by removing its impurities like anger, greed, ego, jealousy, hatred, dominance, violence, selfishness, etc. In this way, we

can produce a mind which should be both scientific and full of wisdom. Here, it is appropriate to quote a remark:

"Weapons are the tools of fear; a decent man will avoid them except in the direst necessity and, if compelled, will use them only with the utmost restraint. Peace is his highest value. If the peace has been shattered, how can he be content? His enemies are not demons, but human beings like himself. He doesn't wish them personal harm. Nor does he rejoice in victory. How could he rejoice in victory and delight in the slaughter of men? He enters a battle gravely, with sorrow and with great compassion, as if he were attending a funeral."

(Quoted in the Bhagavad Gita, trans. by Stephen Mitchell, P.207)

Students as Participants in Learning Process

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Abstract:

In technical colleges the biggest challenge before the faculty is to involve the Students in learning process. There has to be a two prong attack on this problem. First is to get the students interested in the subject and second is to develop a good understanding of the basics through practical exercises. In regard to the student's interest, the subject matter in form of text book, references and class notes should be readily available as well as accessible. In this context Rice University Online Publication Program has proved to be particularly useful. One core course Analog Electronics is taught to Electronics, Electrical, Computer Science and Information Technology Students in 5th and 6th Semester under the Course Code EC1X05. It has three hours lecture and three hour practical with 5 Credit hours. The Class notes and Tutorials have been uploaded on <http://cnx.org> as Analog Electronics Lectures. In addition all the related experiments are a part of laboratory schedule in form of training kits as well as self-designed experiments on breadboard. This two layer learning process helps complement one another and in the process a good understanding of the subject should develop but there is a big IF. All this is effective only **IF** the students are actual participants in the tutorial works and experiments in the lab. But more often it has been found that most of the students are mute spectators and bystanders and they reproduce the works of the few who do the actual work. To break this nonchalance and despondency of the students, online quiz tests on our Management Information System Intranet have been conducted as well as the students have been closely quizzed on their lab reports. These two processes, it is hoped, will go a long way in getting the students more involved in the learning process. A way has to be devised to measure the impact of these innovative methods on the students' learning process.

1. Pre-independence and Post-independence Economy in India.

Since Independence India has increased our Education and R & D infrastructure manifolds as is evident from Table 1.

Table 1. Education and R&D Infrastructure before and after Independence.

1947	As on 16/08/2007
15 National R&D facilities	400 National R&D Laboratories
4 Universities	221 State Universities 24 Central Universities 114 Institutions as deemed Universities 13 Institutions of National Importance
?	1300 in-house R&D facilities
50 enrolled in college per 100,000 population	613 enrolled in college per 100,000 population (corresponding figure for USA is 5399 per 100,000 population)

(Rajya Sabha unstarred question No.2805 answered on 10/09/2007)

After Independence we have developed a large and modern infrastructure in areas where Government has willed such as in the field of Space Technology, Computer Technology, Atomic Power Plant, Telecommunication and Software Technology. But our success story stops here.

We were an agrarian economy under British and we still remain an agrarian economy as shown by Table 2.

Table 2.Sectoral Composition of our Economy in 1947 and today.

Year	Primary	Secondary	Tertiary
1947	59%	13%	28%
80-81	42%	22%	36%
02-03	24%	24%	52%
2007	19.9%	19.3%	60%

(Priyanka Kalwa & Sonali Jain, 2009)

Our Private Industrial Asset is \$300 billion. We have 36 business houses who figure in Forbes Billionaires List still none of the top 100 brands belong to Indian Business House. Private business houses have a total of 15% share in total R&D effort and our total R&D outlay is 0.8% of GDP which is dismal compared to



the advanced Nations of the World Community as is evident from Table 3.

Table 3. Expenditure on R & D as percentage of GDP as of 2002-03.

(Lok Sabha unstarred question No. 4224 answered on 04/05/07)

Country	R & D as % of GDP
India	0.8
Israel	5.11
Sweden	4.27
Japan	3.11
USA	2.27
China	1.23

Table 4. Investment in R & D in 2007-08 by India, China and US

(The Hindu, Friday, November 13, 2009)

Country	Investment on R & D in 2006-07
India	\$ 24 billion
China	\$104 billion
USA	\$ 368 billion

2. Generation of Knowledge Wealth in Independent India since 1947 till date.

The Scientific Publication is the measure of Knowledge Wealth of a Nation. The Scientific Publications of top 31 countries and their Citations have been studied in detail from 1981 to 2005. (May, 1997; King, 2004; Glanzel, Debackere & Meyer, (2008)).

Table 5 gives the list of World's 10 Top Countries in Scientific Publication in descending order in the year 1991, 1998 and in 2003.

Table 5. World's 10 Top Countries in Scientific Publication in descending order (King, 2004).

Countries	1991(%)	Countries	1998(%)	Countries	2003(%)
USA	35.6	USA	32.2	USA	30.5
GBR	8.6	JPN	9.2	JPN	8.3
JPN	7.6	GBR	9.2	GBR	8.2
DEU	7.3	DEU	8.7	DEU	8.1
SOV	5.6	FRA	6.3	CHN	7.5
FRA	5.5	CAN	4.2	FRA	5.7
CAN	4.7	ITA	4.0	CAN	4.3
ITA	3.1	RUS	3.5	ITA	4.4
IND	2.4	ESP	2.8	ESP	3.3
AUS	2.2	AUS	2.7	AUS	2.9



As can be seen from Table 4 in 1991, India was at ninth position with 2.4% of share in Global Scientific Publication whereas China had only 0.9% share. By 2005, India completely lost its position of eminence in Scientific Publication whereas China had a meteoric rise surging forward to 5th position with 7.5% share in Global Publication. The same above studies have also shown that Wealth Intensity (= Total GDP/Total Population) is strongly correlated to Citation Intensity(= Total Citations/GDP) and citation intensity is a direct measure of knowledge wealth. See Figure 1. Hence physical prosperity and social well being is directly dependent on our citation intensity.

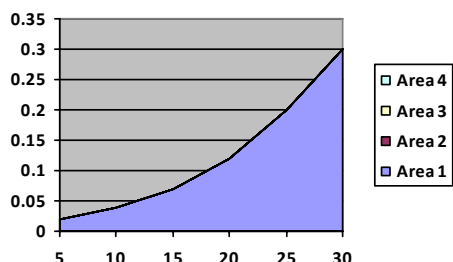


Figure 1. National Science Citation Intensity(y axis) vs Wealth Intensity (x-axis).

Table 6. Nations, their citation intensity and wealth intensity.

Nations	Citation Intensity	Wealth Intensity
India	0.018	2.5
China	0.02	5
S. Africa	0.04	10
S. Korea	0.07	15
Greece	0.1	18
France	0.2	25
Belgium	0.3	30

6th January 2010, New Scientist carries an article “ Get ready for China’s domination of Science”. Based on the article we obtain the following Table 7.

Table 7. Research Publications of China in last one decade.

Year	No. of Publications	Relative Global Position
1998	20,000	Below the first ten countries
2006	83,000	2 nd
2009	120,000	2 nd

Increasingly China is doing collaborative research with other advanced countries such as US, UK, Taiwan and Singapore. These collaborations are being done on equal footing. Capacity for Research and Production is being built up. Expatriates from foreign countries are being attracted for full indigenous development. These foreign returned Scientists are being given free hand to develop things in a manner they think best.

China is engaged in Frontline Research specifically Stem Cell Research and Nano Technology Research. In Stem Cell Research they have been able to develop Pluripotent-induced-Stem Cells. In 2009, Chinese scientists managed to develop Pluripotent-induced-Stem Cells from the skin cells and produced two generations of mice-clones.

China has 5000 researchers and 600 companies. China has been able to make fastest bullet trains operational from Wuhan to Guangzhou over a distance of 1070km . The journey time is 2 hours 45 minutes.

Chinese Government is determined to reverse the brain drain and it is achieving it by infusing national pride in the expatriates and by creating a conducive atmosphere back at home.

The Gross Expenditure on R&D in China has been increasing at an annual rate of 18% for last one decade and today it stands at third position in GERD just behind US and Japan and ahead of all European Nations.

3. The causes of sharp deterioration in our Scientific Quest.

In recent years there has been a definite deterioration in the quality of our Scientific Research and the causes are not far to seek.

Table 7. Investment per student in 1950 and 2000 at 1990 prices.

(The Hindu, 2007)

	1950	2000
Investment per student	Rs 850	Rs 350

Table 8. Students opting for Science Education in 1950 and 2007.

(The Hindu, 2007)

1950	2007
Top 32% of total enrollment in Colleges	Middle 19.7% of the total college enrollment



Table 9. Allocation of percentage GDP in Education, Higher Education and Science Higher Education.
(The Hindu, 2007)

Allocation in Education	% as against 6% recommended by New Education Policy and as against 4.05% in Defense.
Allocation in Higher Education	0.7% as against 2% recommended by NEP.
Allocation in Science Higher Education in India	0.3%
Allocation in Science Higher Education in USA	1.6%
Allocation in Science Higher Education in UK	1.4%
Allocation in Science Higher Education in Japan	1.04%

We have a huge technically trained personnels. We are producing 400,000 Engineering Graduates per year, 300,000 Computer Science Graduates per year, 20,000 MTechs per year and fewer than 1000 PhDs in engineering per year. Most of the Scientific and Technical personnels are going into job market leaving us with a huge deficit of Researchers and Faculty for our Higher Education.

Table 10. Researchers per million of population in India, China and USA in 2007-08
(The Hindu, November 13, 2009)

Country	Researchers per million of population.	Total Number of Researchers
India	56	54,800
China	,423	,423,000
USA	,700	,571,000

A survey of 47 Universities conducted by UGC in 2007-08 revealed that 50% of sanctioned faculty positions were vacant. There are not enough PhDs to meet the faculty requirement of the Universities. As a result over the years the quality of faculty has shown declining trend.

A study by I.I.T., Bombay shows that there will a severe shortage of teacher for Technical Institutes including IITs and NITs in coming years. There will be a shortage of 93,000 teachers by 2012 and a shortage of 1.84 lakhs by 2017. This shortage is primarily due to the fact that we

are not able to attract sufficient number of students for our M.Tech and Ph. D programmes.

Defense has gobbled away our precious resources leaving little for Education and Health Care. From Table 7, 8 and 9 it is evident that quality of Science Education all over India has drastically deteriorated from school level to Post Graduate level. Establishment of IITs and NITs do not help the matter. Most of the ablest and best prepared students are opting for Professional Courses like Engineering, Medical and Business Administration and even those opting for Professional Courses are not aiming at Research but on private consultancies because that is what he sees around. All these changes in basic value system has taken a heavy toll on our basic and development researches.

4. Remedies for the present Research Scenario.

What is today required is a sincere soul searching by our Government regarding our high school education system. The spirit of enquiry and the quest of knowledge is basic to every child. In fact it is his nature but his training through primary and secondary school completely extinguishes this enquiry and quest. All people concerned- Government, Academicians and Teachers have to come together and work out a system whereby the basic urge of enquiry and discovery is kept alive through his school days. It is this ground work which will eventually turn around the scenario in Universities and Institutes of National Importance and pay us back rich dividends in terms of improved citation intensity which will in turn help improve the wealthy intensity of our Nation.

In foreign lands most of the billionaires have dedicated large sum of their wealth towards Research Foundations such as Howard Hughes Foundation, Rockefeller Foundation, Packard Foundation, MacArthur Foundation and Bill Gates Foundation. We also have 52 billionaires but we have one Research Foundation created by Infosys. Govt must take initiative to motivate these billionaires to create the Research Foundations in their respective fields.

5. Faculty Role in Engineering Colleges.

Once the problem of Research Scenario has been put in perspective and while the soul – searching is going on among our Policy Makers, we the faculty members at Engineering Colleges have some urgent tasks begging our attention. We must make our course material interesting and engaging. For this the course material must be made simple, basics must be clarified and all the course material must be readily available and accessible through the library, text books, reference books and through on-line materials. Next we must make our Laboratory Work stimulating and challenging and encourage individual or small groups in the Laboratory Experiments. This will help increase the participation of



students in their basic design work of engineering problems.

6. Faculty members contribution at NIT, Patna.

Here at NIT, Patna, two faculty members participated in Indo-US Collaboration Program in Engineering Education in Summer 2009. Subsequent to this participation, we always keep in mind the slogan “ We are teaching but are our students learning ? ”. With this slogan in mind we have increased the quiz tests in theory as well as in Laboratories. We are using the Management Information System Intranet to conduct regular On-Line class quizzes. These On-Line quizzes require a large data-set which we are building bit by bit.

The Class Note materials of EC1505_Analog Electronics theory and tutorial materials have been uploaded on <http://cnx.org> . All the class notes along with figures, diagrams and tables are available for ready reference by the students. The tutorial upload has exposed the students to the full spectrum of questions and design problems on the topics covered in the class. The on-line quizzes will motivate the students to do the tutorial exercises on their own.

The Practical Laboratory Classes have been remodeled to make it stimulating, thought provoking and challenging. The direct participation of students in bread-board kind design experiments helps develop a better grasp of the subject matter.

The impact of these innovative methods are yet to be seen. A test has to be devised to quantify the true learning process. Once such a test method is developed we can measure the impact of these innovative methods.

Conclusions.

We have seen that after Independence much has been achieved in some specific fields of Science & Technology such as Space, Atomic Power Plants, Telecommunication and Software Development but in general due to lack of Knowledge Wealth Generation our Industries both in Private & Public Sector are heavily dependent on borrowed technology. The low Citation Intensity has led to low Wealth Intensity. The low Citation Intensity is indicative of poor scientific enquiry and scientific quest and the root of this problem lies in school education where the children inquisitiveness is not nurtured and developed. The Policy Makers will have to devise a system of school education whereby the spirit of enquiry becomes a life long quest. Meanwhile we have to do our bit as responsible faculty members of Engineering Colleges. We have to make our delivery of subject matter more rigorous and thoroughgoing so that students develop a command over the subject matter they are taught.

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Is Folic Acid a Better Supplement to Prevent Neural Tube Defects Caused by Mutation in *mthfr* Gene During Early Pregnancy

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ABSTRACT

Neural tube defects (NTDs) are common congenital problem of central nervous system. Even though the epidemiologic link between maternal folate deficiency and fetal NTDs and preventive role of folate supplementation on occurrence and recurrence of these defects is established, the causal mechanism at cellular and molecular level remains undefined. However, an elevated level of homocysteine is an independent risk factor for NTDs due to mutations in *MTHFR* gene which inhibits the production of this enzyme. Supplementation of folic acid 0.4µg per day may reduce the risk of this fetal disease. Hence public awareness program by the government should be built up in India as the occurrence of this fetal disease in North India as high as 4-9 per 1000 births.

INTRODUCTION

Methylenetetrahydrofolate reductase (*MTHFR*) is the name of a gene which is located on chromosome 1 at p^{36.3}. The cDNA sequence is 2.2 kb long and appears to consist of 11 exons. There are two *MTHFR* variants found commonly. The C667T and the A1298C are common in many populations and have been studied in relation to birth defects mainly spina bifida and anencephaly. The C667T allele is a single base pair mutation, in which cytosine is converted to thymine at base pair 677 resulting in an amino acid substitution (alanine to valine) in the enzyme. Functionally, the encoded protein has a reduced enzymatic activity at 37°C and higher, so that the C677T mutation is often termed as “thermolabile”¹. However, in A1298C allele, a point mutation in exon 7 results in the coding of a glutamate instead of an alanine residue².

This gene produces an enzyme called as methylenetetrahydrofolate reductase in normal course. If a person carries the genetic mutation or variations in *MTHFR* activity associated with above discussed variants that inhibits production of this enzyme, it can result in hyperhomocystenemia, which is an elevated level of an enzyme called homocysteine. In healthy, well nourished human being, homocysteine metabolism is well regulated and the concentration of plasma total homocysteine ranges between 5-12µM. Deficiencies of the enzymes or the cofactors involved in the metabolism of homocysteine can lead to its

aberrant intracellular processing, thereby elevating its level. This increased level shows a spectrum of clinical symptom. Older children have been identified with mental retardation, acute psychosis, muscle weakness and ataxia. Adults have presented with gait disturbance. Young infants have been identified with more severe symptoms of hypotonia, failure to thrive, failure of neurological developments and severe apnea. Most infants died at less than one year of age. During the last decade, homocysteine has received increasing attention as elevated levels of this have been implicated as an independent risk factor for neural tube defects. In addition to the genetic factors, environmental factors, including diet also influence the level of homocysteine³.

NEURAL TUBE DEFECTS (NTDs)

Neural tube defects are the defects of central nervous system, which include brain and spinal cord. These defects occurs very early usually in the first month of pregnancy. During the first four weeks of pregnancy, the neural tube is open and then closes to form the spinal cord and brain. Worldwide incidence of NTDs is 1.4-2 per 1000 births. Recurrence risk after one affected child is 30-40 per births and after two affected child is 100 per thousand live births. Ninety percent of babies with NTDs are born into families where this has never happened before³. Examples of NTDs are Anencephaly, Encephalocele and Spina bifida.

Anencephaly: This disorder occurs when most of the head, brain and possibly the spinal cord do not develop normally. New born children with this severe disorder usually die shortly after birth, as this condition is incompatible with life.

Encephalocele: This disorder results in a hole in the skull through which brain tissue protrudes. Although most babies with this disorder do not live or severe retarded. A few children have survived because of surgery early after birth to correct this defect.

Spina bifida: This disorder also known as cleft or open spine is a defect of the spinal column. Normal development of the spina bifida child is possibly with little physically handicap. Often, however, paralysis of the lower limbs repeated urinary tract infections, hydrocephalus and



incontinence occur. The severity depends on the site and the type of the type of the defect.

RISKY GROUP

- ❖ Caucasians with English/Irish ancestry
- ❖ People who do not eat well balanced diet
- ❖ Couples who have already had other NTD affected pregnancies
- ❖ Women who have low folic acid levels before they become pregnant and during the earliest weeks of pregnancy

DETECTION

Tests for neural tube defects include ultrasound examination and measurement of Maternal Serum Alfa-Fetoprotein (MSAFP). Alpha Feto Protein (AFP) is a chemical made by fetus that enters the mother's blood. A large amount of AFP may mean the fetus had NTD⁴. An elevated level MSAFP measured at 16-18 weeks gestation is a good predictor of neural tube defects.

PREVENTION

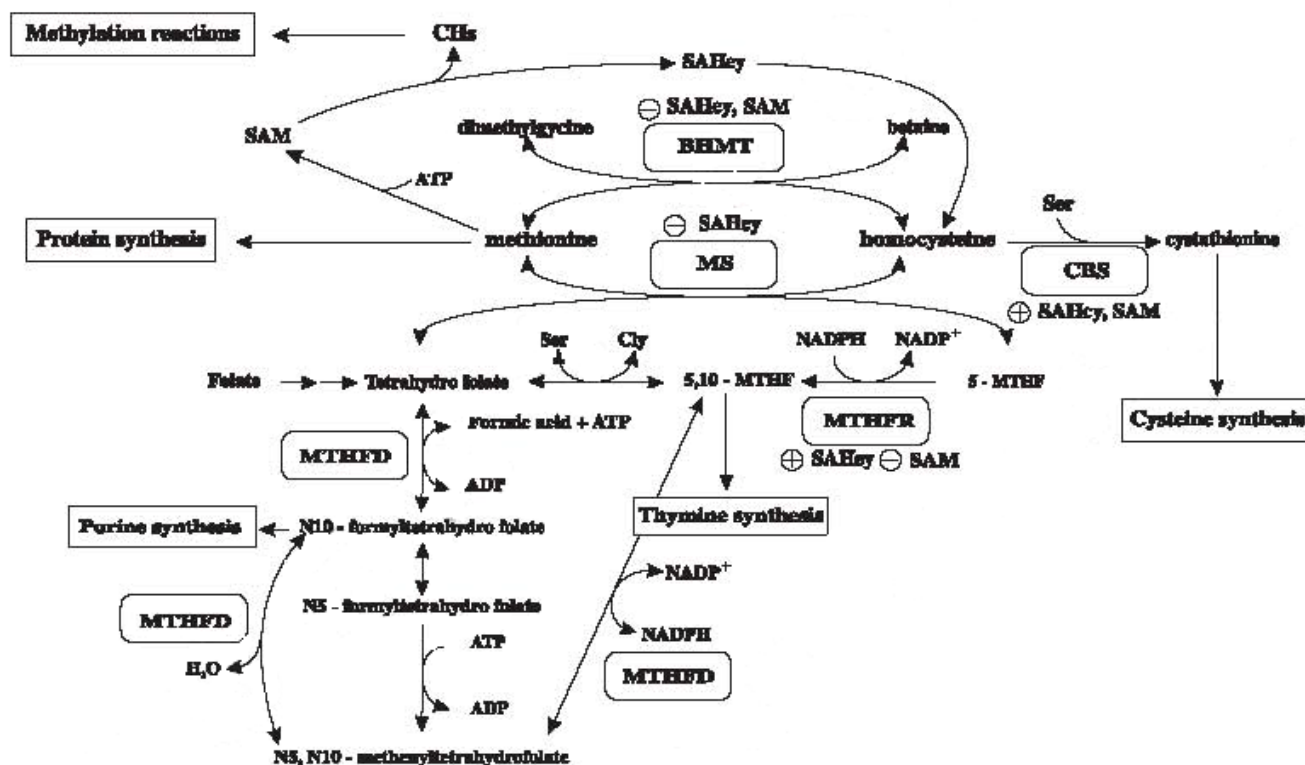
Recent studies have shown that women who take the B vitamin, folic acid before pregnancy and during the first two months of pregnancy can reduce the risk of serious birth defects of the brain and spinal cord. By taking a safe and readily available multivitamin pill with folic acid (400-500µg) every

day there is a 70 percent or greater chance of preventing NTDs⁵.

FUNCTION OF FOLIC ACID OR FOLATE

Folic acid is a group of chemical compounds occurring in nature as polyglutamates. These are hydrolyzed by intestinal enzymes into respective monoglutamate forms before being absorbed preferentially in the jejunum. In the enterocyte it is successively reduced to a dihydro form and finally to tetrahydro folic acid/folate (THFA/THF) by an NADPH dependent reductase enzyme. This THFA/THF is the actual metabolically active folate. It undergoes methylation to generate N5 methyl-THFA which is transported in blood bound to plasma proteins. The key function of folate in humans is carriage of single carbon moieties derived from amino acid metabolism (Fig.1). These one carbon groups participate in diverse biochemical pathways including nucleic acid synthesis⁶. What is pertinent to present paper is the recognition of several defects in the genes and enzymes involved in these reactions which have a putative role in pathogenesis of NTDs. It is an over simplistic but at least a partly true that folate supplementation overcomes these metabolic blocks and prevents the occurrence and recurrence of NTDs.

Fig. 1. Role of folate in aminoacid metabolism





FOLIC ACID SUPPLEMENTATION

Folic acid is essential for the production of methionine, which is co-factor in RNA and DNA synthesis and is required for methylation of proteins, lipids and myelin. Folic acid is essential for growth, differentiation and repair, hence it is essential for fetal development during pregnancy. This vitamin is now considered as an important factor in reducing chances of NTDs, Megaloblastic anaemia of pregnancy and some other complications like spontaneous abortions, Intra Uterine Growth Retardation (IUGR) of baby. Folic acid is a vitamin B also known as folate or folacin. Folic acid is needed to make new cells in the body and it can be found in most multivitamin pills and also in certain foods (peas, corn, dried beans, leafy vegetables, beef liver, banana, orange juice and fortified cereals breakfast). Women whose diets follow the United States Dietary Associations (USDA) food guide pyramid are more likely to eat 0.4 mg of folate daily. It is recommended that all women able to have a baby take a multivitamin pill with folic acid in addition to eating foods high in folate because over cooking can destroy folate in food and the amount of absorbed from food varies. In 2004, Wald estimated that folic acid supplementation (5 mg/day) preconception and continuing till 12 weeks after getting pregnancy reduce the risk of NTDs by 85%. In the women with the previous baby affected by NTDs periconceptional use of folic acid decreases the recurrence by 70%. However, the bigger problem to prevent occurrence of NTDs is that about 50% of all pregnancies are unplanned even in developed countries.

CONCLUSION

Several scientific research based on clinical trial have reinforced the observation that risk of delivering a child with NTDs significantly decreases with ingestion of periconceptional folic acid. US Public Health Service made a strong recommendation that all women of childbearing age, who are capable of becoming pregnant should consume 0.4mg of folic

acid per day. An individual should develop a plan with her doctor to check homocysteine levels periodically and adjust treatment accordingly. The *MTHFR* mutations appear to be medically irrelevant, so as long as an individual's homocysteine level is normal.

Hence public awareness "to plan before you conceive and to take folic acid if you plan a pregnancy", should be built up in India also as the occurrence of this fetal disease in North India as high as 4-9 per 1000 births.

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Chaos & Logistic Maps

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We live in a nonlinear world. The evolution of real life systems is intrinsically nonlinear. The analysis of nonlinear systems is hard and complex but one can't do without that. The lack of periodicity and certainty are common in natural phenomena. They are often unpredictable, despite their simplicity and determinism. They exhibit chaotic behavior. For systems with bounded solutions, it is found that non-periodic solutions are ordinarily unstable with small modifications so that slightly differing initial states can evolve into considerably different states. They are said to be sensitive to the initial conditions of the system. They possess constrained numerical solutions. Solutions of these systems can be best visualized with trajectories in phase space. To be concise- sensitivity, determinism and nonlinearity (or recurrence)- are three simple constraints of chaos.

1. Introduction

Chaos implies an irregular, seemingly random change in time or motion which is too complex to predict in detail or rather compute with any given precision in the long run. We say 'seemingly' random because the physical laws and the forces that govern the motion are all perfectly deterministic and given. The name **Chaos Theory** comes from the fact that systems which the theory describes are apparently disordered and indisciplined. Formally, chaos theory is defined as the study of complex nonlinear dynamic systems. A system is complex if there is something more to say about it. Nonlinear implies recursion and higher mathematical algorithms and dynamic implies non-constant and non-periodic. The first incident of chaos was noticed, accidentally, by **Edward N. Lorenz**, a meteorologist at Massachusetts Institute of Technology, in 1960's and the chaos theory had its birth then. The term 'chaos' was coined by Li and Yorke in 1975.

Chaos bears a very delicate bond with the initial conditions of a system. This hypersensitivity to initial conditions came to be known as the **Butterfly Effect**. Lorenz in one of his address exclaimed- '*The flap of a butterfly's wings in Brazil sets off a tornado in Texas*'. It clearly epitomizes chaos today. Conceiving this idea, Lorenz stated that it is impossible to predict the weather accurately.

Thus **sensitivity**, **determinism** and **nonlinearity** are three simple constraints of chaos. Any system having these constraints will, surely, go chaotic- be it small (simple), large (complex), conservative or dissipative- for given initial conditions at certain threshold values of control parameter(s). It must be noted that all complex systems are not chaotic but all chaotic systems are, indeed, complex. Complex systems invariably involve nonlinearity and are sensitive to initial conditions. Chaos is a 'condition' which when only furnished with, the system results in unpredictability and strange behavior.

Logistic Equation & Mappings

Logistic map is an important classical problem of chaotic dynamics. This has become something of a *poor man's laboratory* to gain hands-on experience with chaos. The logistic map is a difference equation of the form

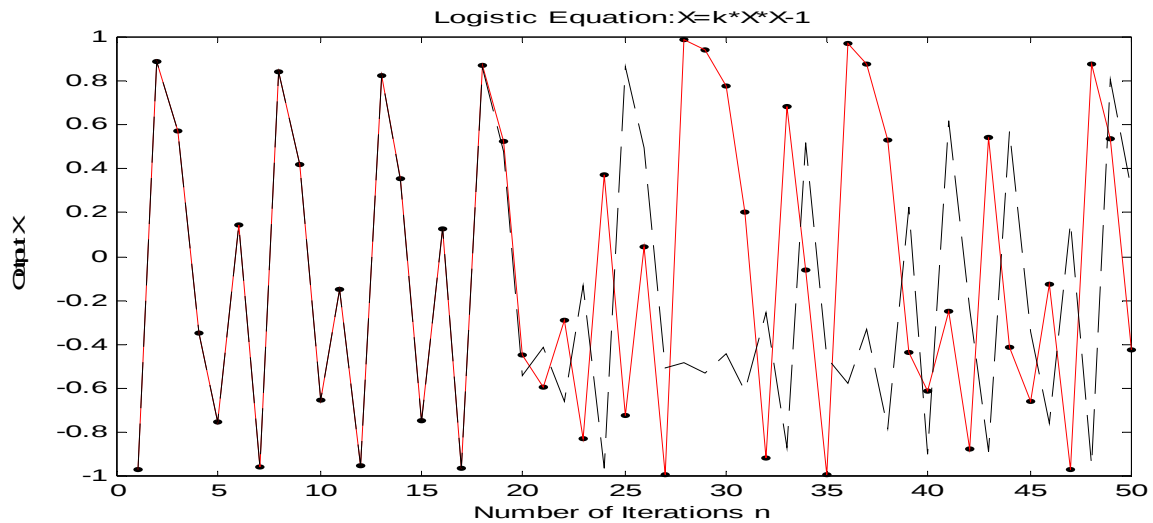
$$X_{n+1} = f(k, X_n), \quad X_n \text{ lying in } [0, 1].$$

It gives the evolution of a variable X as function 'f' of discretised time 'n'. We choose the initial value X_0 and then a set of X 's is generated which when plotted in the phase space gives a trajectory. Here, k is a control parameter which, of course, can be tuned. Varying the parameter k leads to the onset of chaotic behavior through the mechanism of bifurcation. It seems logical to suppose that as the control parameter is raised, the lower dimensional attractors get destabilized in favor of the higher dimensional attractors which eventually lead to chaos.

6.1 Verhulst-May Logistic Map

The difference equation, $X_{n+1} = kX_n(1 - X_n)$, is called the logistic map. The logistic map is the discrete version of the corresponding continuous differential equation given by P.F Verhulst in 1845. He had used it to model population growth subject to limited resources (or logistics). Hence, the qualifier 'logistic'. The discrete version of the logistic map was studied extensively by the physicist turned ecologist-biologist Robert May in 1976. In his words-

'Not only in research but in the everyday world of politics and economics, we would be better off if more people realized that simple systems do not necessarily possess simple dynamic properties'.



For control parameter $k=2$, a difference of 0.0000001 in seed values results in two different trajectories. This shows sensitive dependence on initial conditions.

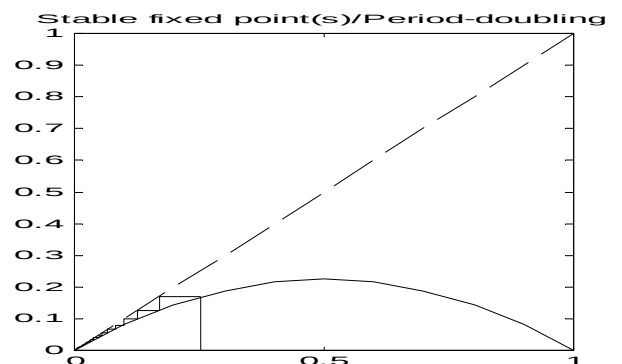
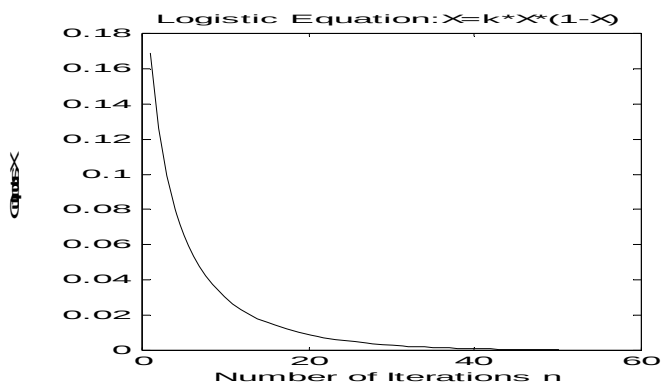
Characteristics of Logistic Map, $X_{n+1}=kX_n(1-X_n)$

Control Parameter k	Features	Figure
0.90 ($k < 1$)	Fixed point at $X=0$	(a)
2.75 ($1 < k < 3$)	Fixed point at $X=1-1/k$	(b)
3.45 ($3 < k < 3.5$)	Period-doubling	(c)
3.60	Infinite periodic-doubling (chaotic)	(d)

$$F(X)=k \cdot X(1-X)$$

(a) For $k=0.90$

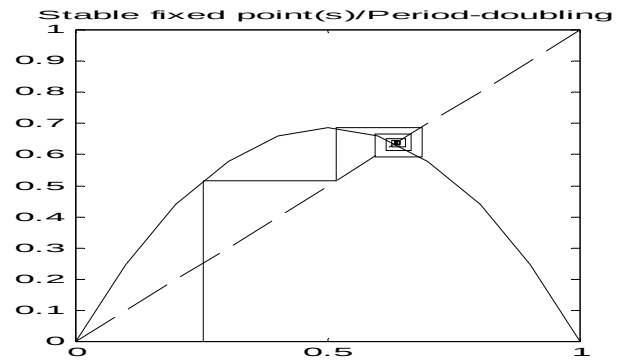
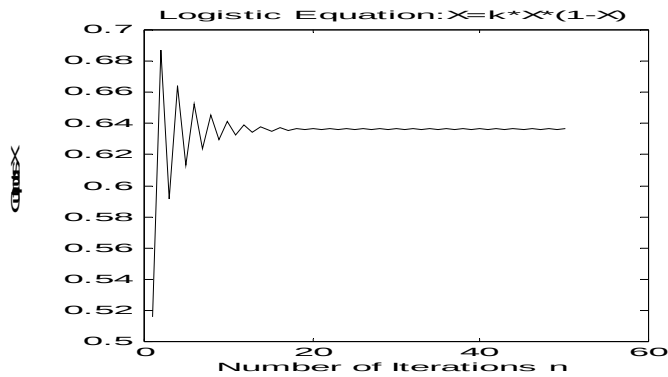
For seed value $X_0=0.25$





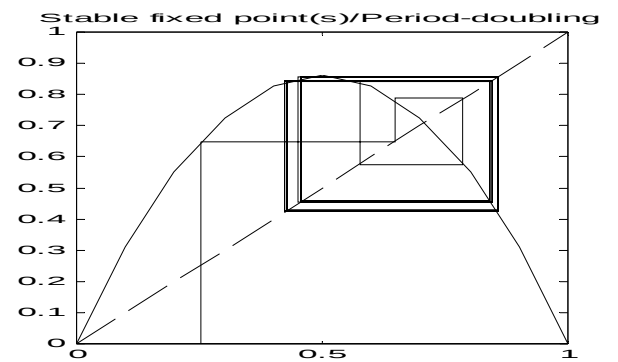
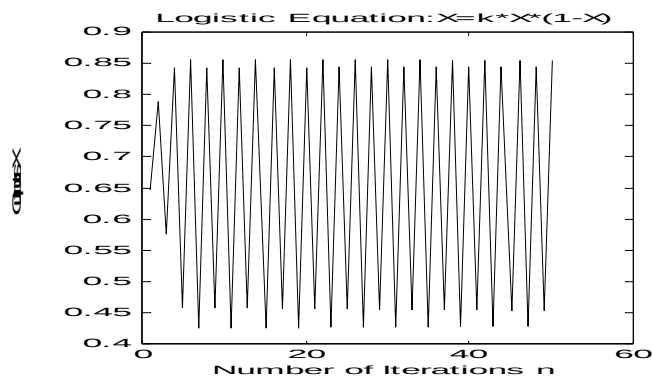
(b) For $k=2.75$

For seed value $X_0=0.25$



(c) For $k=3.45$

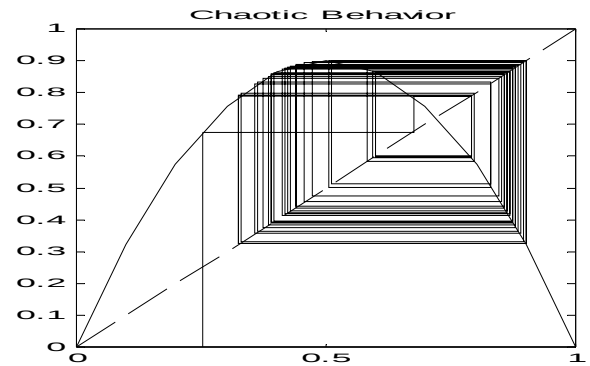
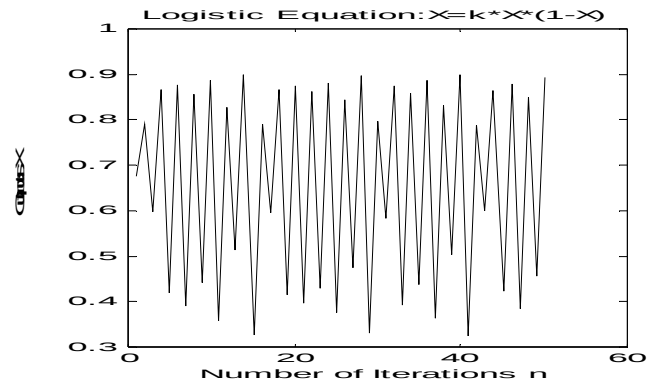
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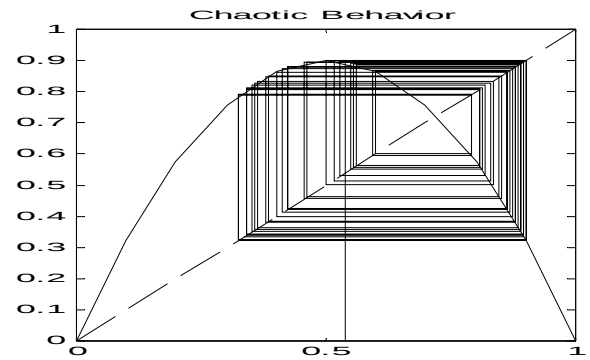
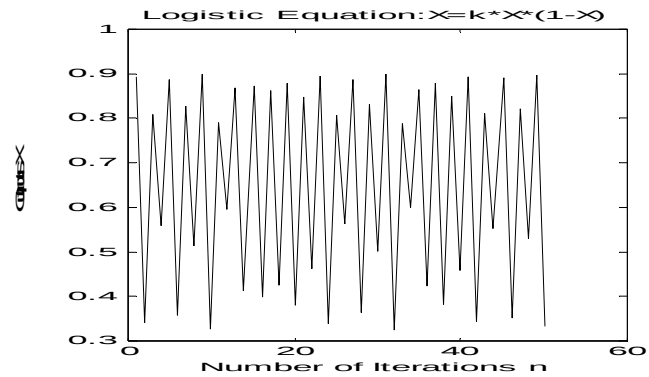


(d) For $k=3.60$

For seed value $X_0=0.25$



For seed value $X_0=0.54$



For seed value $X_0=0.86$

Results

We explored the outputs of different functions with varying values of control parameter and seed values and obtained graphical outputs.

Acknowledgement

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Metal Oxide Humidity Sensors

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Metal oxide ceramic sensors and transducers have been widely used for the measurement and control of humidity in industrial and household environment. They find broad utility due to the ease with which their compositions and microstructures may be optimized and tailored to specific applications, their stability over large temperature range and low cost. Usually features of ceramics that devices utilize for sensing purposes are the bulk grain phenomena, grain boundary phenomena, or controlled pore structure. Generally, all the three micro structural features come into play, with different relative importance. The feature of the ceramic structure that is utilized in humidity and gas sensing is the porosity. Porosity is normally an undesirable micro structural attribute, since it detracts from many useful properties such as strength, conductivity and chemical stability. In some cases, however, porosity may be desirable, e.g. to reduce the elastic modulus, or as in the present situation, to maximize access of the atmospheric constituents to the large surface area of the semiconductor.

Ceramic humidity sensors can be fabricated from a wide variety of semiconducting oxides. Commercial devices based on porous Al_2O_3 have been available for a number of years. The latter are capacitive devices that require relatively complex circuitry and frequent recalibration, especially after exposure to wet ambient. A low cost sensor, with a more stable resistivity humidity characteristic was developed in 1978 for use in microwave ovens [1]. Since then it has been manufactured in significant volume. With the fast growth of nanoscience and nanotechnology, the research in metal oxide sensors has developed more accuracy in results.

A comprehensive examination of the characteristics of a wide range of different humidity sensor materials, salt-doped and undoped, resistive and capacitive, reveals that all operate by means of the same physical mechanisms [2]. The situation at low humidity may be understood by referring to Figure 1. In this example A^+ metal ions are present in the surface layer of the grains. Because of their small ionic size, high local charge density and strong electrostatic field, they represent very good sites for the chemisorptions of H_2O molecules. Upon exposure to the atmosphere, strongly bound water molecules quickly occupy the

available sites. This layer, once formed, is not further affected by exposure to humidity, but it can be thermally desorbed. In undoped sensors, surface cations may still possess high electrostatic charge due to unfilled coordination numbers, and thus present suitable sites that promote adsorption and dissociation of water molecules. Once the first layer has been formed, subsequent layers of water molecules are physically adsorbed. The physisorbed water dissociates due to the high electrostatic fields in the chemisorbed layer:



Charge transport occurs when the hydronium ion releases a proton to a neighboring water molecule which accepts it while releasing another proton, and so forth. This is known as the Grotthuss chain reaction and is illustrated in figure 1. It is thought to represent the conduction mechanism in liquid water as well as in the surface layers of humidity sensitive oxides. At high relative humidity (e.g. $\text{RH} > 40\%$) liquid water condenses in the pores as already described, and electrolytic conduction takes place in addition to the protonic transport in the adsorbed layers. Similar mechanisms are believed to be responsible for the properties of capacitive sensors, the principal distinction being the different substrate and pore geometries.

Metal oxide sensing devices suffer from the significant problem of ageing. Aging mechanisms in humidity sensors may be due to one or multiple factors of the following: (1) prolonged exposure of surface to high humidity, (2) adsorption of contaminants preferentially on the cation sites; (3) loss of surface cations due to vaporization, solubility and diffusion, or annealing to a less reactive structure; and (4) migration of cations away from the surface due to thermal diffusion. Generally, the more sensitive a material is to humidity, the more it tends to be susceptible to aging.

Different compositions of metal oxides have been prepared in our laboratory. 10 % weight of glass powder has been added as binder to increase the strength of the sample. The powders have been pressed in pellet shape by uniaxially applying pressure of 200-500 MPa in hydraulic press machine at room temperature. The samples are having diameter of 4-12 mm and thickness 4 mm. The samples have been

sintered in air at temperature of 200°C-700°C for 3 samples have been exposed to humidity in a specially designed humidity control chamber. Inside the humidity chamber, a thermometer and standard hygrometer are placed for the purpose of calibration. Variation in resistance has been recorded with change in relative humidity. Relative humidity has been measured using the standard hygrometer. Variation in resistance of the pellet has been recorded using a resistance meter. Copper electrode has been used to measure the resistance of the pellet. The resistance of the pellet has been measured normal to the cylindrical surface of the pellet. The electrical resistance at different relative humidity levels of the sensing elements in the form of pellets has been determined by a two-probe method, as the present work is to measure

hours in an electric muffle furnace. After sintering, the changes in surface conductivity as a function of applied field. The electrical contacts have been made on the surface of pellet by means of two thin copper sheets. Given the high resistivity of the materials under consideration, the potential inaccuracy due to contact resistance is assumed negligible. The experimental sample has been electrically connected to a dc power supply and sinometer in series. After studying humidity sensing properties, sensing elements have been kept in laboratory environment and their humidity sensing characteristics regularly monitored. To see the effect of ageing, the sensing properties of these elements have been examined again in the humidity control chamber after six months.

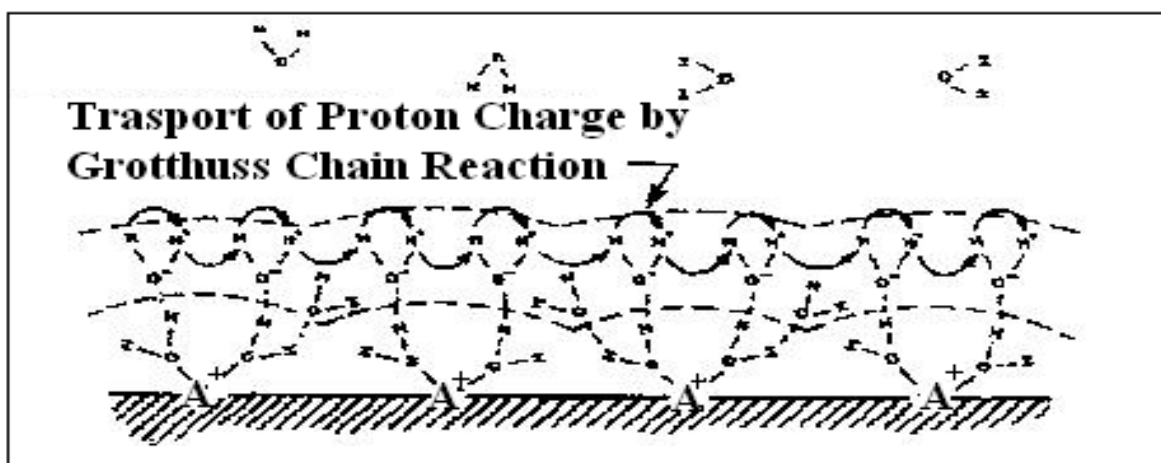


Figure 1 Water adsorption and proton transport on the surface of the humidity sensor

Layer I Underlying layer of water molecules chemisorbed to A= cations. This layer is composed of cation-hydroxyl-water complexes of intermediate structure. **Layer II** Water molecules physisorbed onto layer I.

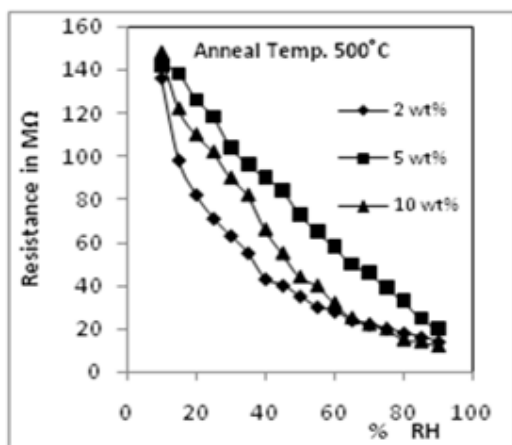


Figure 2 variation in resistance with relative humidity

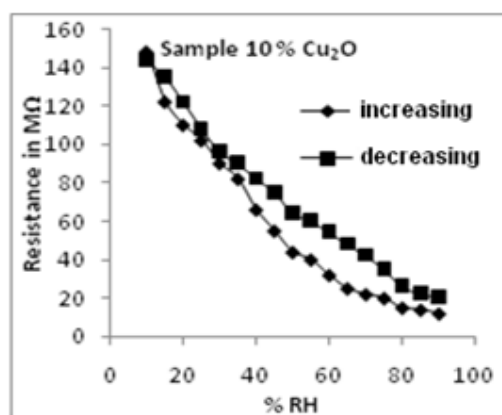


Figure 3 variation in resistance with relative humidity for annealing temperature 500°C

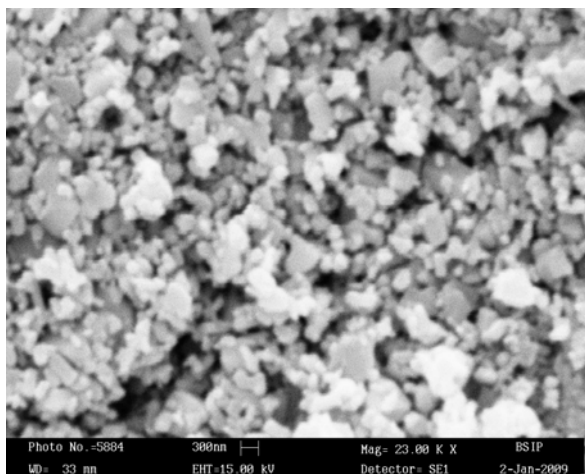


Figure 4 SEM micrograph of sample with 10 % Cu_2O annealed at 500°C

Figure 2 shows one such result with Cu_2O doped ZnO . 2, 5 and 10 weight % of Cu_2O has been doped in ZnO and characterization and humidity sensing properties of these sensing elements studied Figure 2 shows variation in resistance of the these sensing elements with change in relative humidity.

Figure 3 shows the ageing graph and figure 4 the SEM micrograph of the sensing element of 10 % Cu_2O doped ZnO . The results obtained with these samples have been very good with good sensitivity, low hysteresis and high repeatability.

I will be presenting humidity sensing results of these and some other compositions of different metal oxides. I hope my presentation is useful to persons working in the similar field and may result in some collaborative works.

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Effect of Annealing Temperature on Zinc Substituted Cobalt Ferrite ($\text{Zn}_{1\%}\text{Co}_{99\%}\text{Fe}_2\text{O}_4$) Nanoparticles Synthesized Using Chemical Method

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Abstract

Magnetic nanoparticles of Zinc-substituted cobalt ferrite have been synthesized by citrate precursor method using ferric nitrate, cobalt nitrate, Zinc nitrate and citric acid as starting materials. The nanoparticles were prepared by annealing a citrate precursor at temperatures respectively 450°C, 650°C and 700°C. The samples were characterized using X-ray diffraction (XRD) and Vibrating sample magnetometer (VSM). Using Scherrer formula, the crystallite size was found to be respectively 29 nm, 58.1nm and 58.2 nm. The particle size and magnetization increased with annealing temperature. A magnetization value of 86.42 emu/g was observed in the sample annealed at temperature 700°C which is a relatively large value.

Key words: Zn-Co Ferrite, Nanoparticles, Magnetic Properties, Citrate precursor method

Introduction

Cobalt ferrite nanoparticles find applications in several areas including Magneto-optic devices, high density recording media, ferro-fluids and Medical diagnostics (1, 2). The magnetic properties of fine particles is of considerable interest both from scientific and practical point of view. This is due to both size effects and surface effects. The major size effects involve the reduction of domain boundaries, that leads to single domain particles, and a thermal randomization of the total spin system, commonly called superparamagnetism. This superparamagnetic behavior originating from surface effects include canted spin structures and magnetic dead layers at the surfaces. In small particles, saturation magnetization (M_s), Magnetocrystalline anisotropy (K), Coercivity (H_c), Retentivity (M_r) values are found to differ from bulk material values (3,4).

Experimental Procedure

Samples of nanometer-sized Zn-Co ferrite ($\text{Zn}_{1\%}\text{Co}_{99\%}\text{Fe}_2\text{O}_4$) powder were prepared by using the Citrate precursor method. Ferric nitrate, Zinc nitrate and Cobalt nitrate were taken in stoichiometric proportions as starting materials. Aqueous solutions of these salts were prepared separately by dissolving the salt in minimal amount of deionized water while

stirring constantly. The solutions were then mixed together. Aqueous solution of citric acid was prepared in adequate quantity by weight and was added to the prepared salt solutions. The mixture was heated at temperature about 60°C to 80°C for two hours with continuous stirring. This solution was allowed to cool at room temperature and finally it was dried at 90-95°C temperature in an oven until it formed a brown color fluffy mass. The gels were annealed at temperature 450°C, 650°C and 700°C for one hour in a muffle furnace. By this process, the precursor was thermally decomposed to give Cobalt ferrite powder that was later proved to be in nanometer size range.

Results and Discussion

The ferrite samples prepared as described above were structurally characterized using large angle X-Ray Diffractometer. The XRD pattern of the ferrite samples show well defined and sharp peaks with some impurity peaks of very low intensity. Using Scherrer formula, $D = 0.9 \lambda / \Delta \cos \theta$ (5) the crystallite size was found to be in the range 29 nm, 58.1nm and 58.2nm respectively, where D is the mean crystallite diameter in nm, λ is FWHM (Broadening of the diffraction peak intensity in radians), λ is the wavelength of X-ray radiation and θ is the Bragg's diffraction angle. The X-ray diffraction patterns of ferrite samples are shown in **figure 1**. The XRD patterns were obtained using a X-Ray diffractometer for the 2θ range of 10-90° using $\text{Cu K}\alpha$ (Wavelength = 1.5405Å) radiation. XRD studies show that these particle samples have spinel phase (JCPDS: 10-0325).

The ferrite samples were magnetically characterized using VSM. The magnetic parameters obtained from VSM measurements are tabulated in Table1. The magnetic hysteresis curves for these particles are shown in figure 2. In ferrimagnetic materials the net magnetic moment depends on the number of magnetic ions occupying the octahedral and tetrahedral sites. Substitution of diamagnetic Zn alters the magnetization behavior. In our work, the highest magnetization and coercivity were observed as 86.42 emu/g and 1074 G for the sample annealed at 700°C. It was also observed that the area of hysteresis loop decreased with increase in annealing temperature (450°C – 700°C).

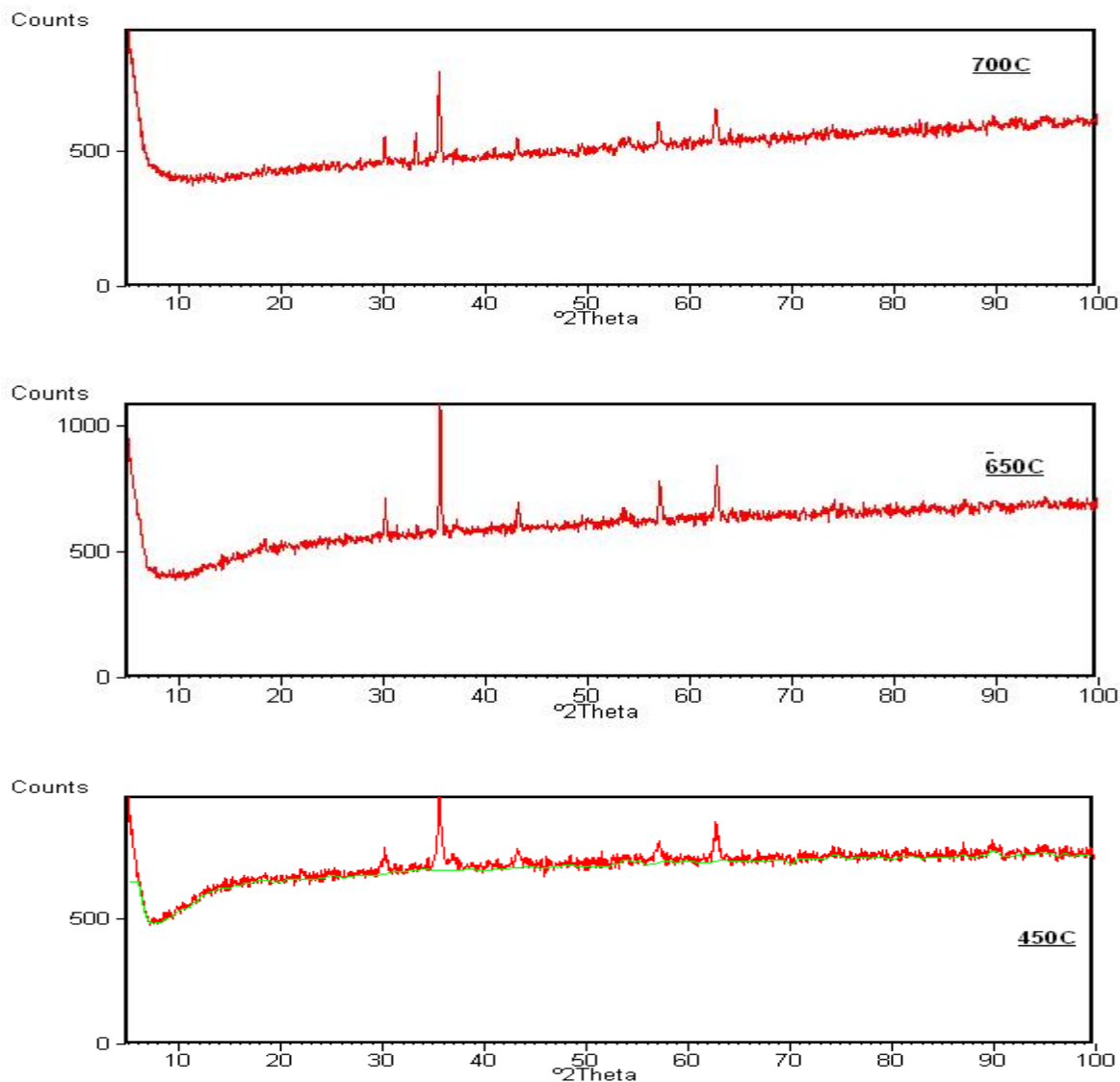


Figure1: X-ray diffraction patterns for $\text{Zn}_{1\%}\text{Co}_{99\%}\text{Fe}_2\text{O}_4$

Annealing Temperatue	Mean particle size(nm)	Coercivity G	Retentivity emu/g	Magnetization emu/g
450°C	29	1074	18.77	41.74
650°C	58.1	431.96	16.80	64.03
700°C	58.2	90	6.29	86.42

Table 1: Magnetic parameters value for $\text{Zn}_{1\%}\text{Co}_{99\%}\text{Fe}_2\text{O}_4$

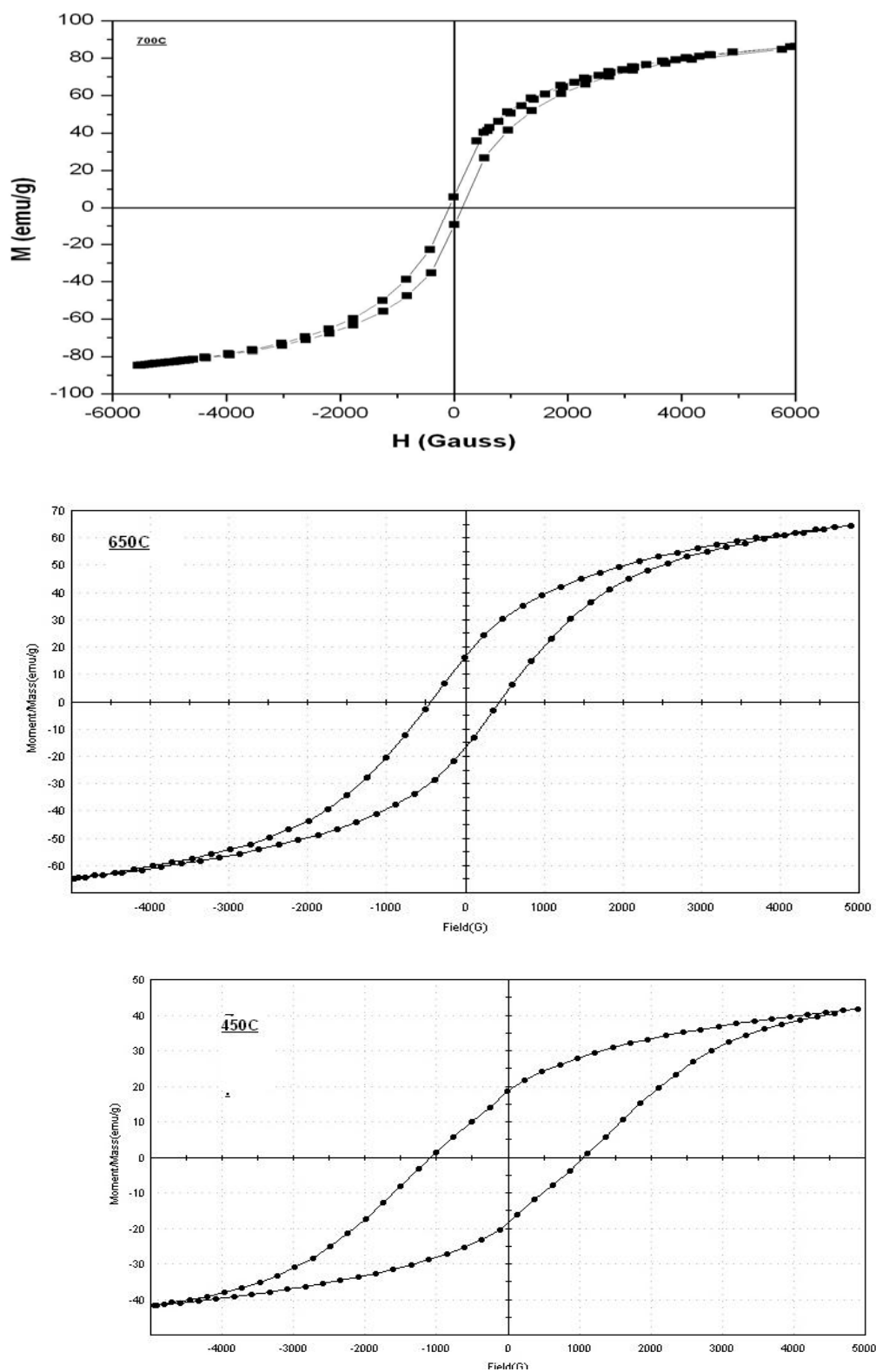


Figure 2: Magnetization Curve for $\text{Zn}_{1\%}\text{Co}_{99\%}\text{Fe}_2\text{O}_4$



Mukta V. Limaye et al. (6) have obtained magnetization values ranging from 7.1 emu/g to 74.2 emu/g and coercivity 9.47 kOe to 0.93 kOe in Cobalt ferrite nanoparticles, (synthesized by a wet chemical route) samples for annealing temperatures ranging from 100°C upto 1200°C. M. Rajendra et. Al (7) reported that Cobalt ferrite , synthesized using redox process on heating, the particle size increased with corresponding increase in magnetization values. At 1073k, all samples achieved magnetization value close to 73 emu/g. The increase in magnetization with increase in annealing temperature is an indication that the mean domain size of the particles is increasing and atomic spins are getting more and more aligned with the direction of the applied field. Vinod kumar et. Al (8) synthesized Cobalt ferrite with chemical route and they annealed the samples from 373k to 1173k and observed maximum magnetization 74 emu/g. Monatana et al. (9) prepared Cobalt ferrite nanofibre using electrodeposition method and have observed magnetization value 61.8 emu/g of CoFe_2O_4 / PVP composite calcined in air for 3hr at 800°C (heating rate- 20°C/ minute) having particle size 54 nm.

Conclusion

The particle size and magnetization were found to increase with annealing temperature. A relatively large magnetization value 86.42 emu/g was observed at annealing temperature 700C. It is worth while to note that this large value has so far not been reported for annealing temperatures of this order. This behavior appears to be a special feature of the citrate precursor method.

Acknowledgement

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