ISSN -2319-3166

STUDENT JOURNAL OF PHYSICS

Volume 5 Number 2 July 2013 - March 2015

Special Issue

Proceedings of the 2[nd] IAPT
National Student Symposium
on Physics

INDIAN ASSOCIATION OF PHYSICS TEACHERS

STUDENT JOURNAL OF PHYSICS

This is a quarterly journal published by Indian Association of Physics Teachers. It publishes researc articles contributed by Under Graduate and Post Graduate students of colleges, universities and simil teaching institutions, as principal authors.

Indian Association of Physics Teachers (IAPT

Central Office :
Indian Association of Physics Teachers
Karve Road, Kothrud, Pune-411038
Phone : 91 20 2545 5504

Registered Office

L 117/302, Naveen Nagar, Kanpur – 208 025

Manuscripts may be submitted in appropriate format t any of the editors.

For more information about subscription, membershi renewals, address changes, etc., enquiries should b addressed to the Managing Editor.

Convener's Address

National Student Symposium on Physics - 2014

At the outset let me thank and express my gratitude to the Vice-Chancellor Prof. Grover and the Dept. of Physics, Panjab University for hosting the second NSSP, in addition to hosting the first one last year. By this series of symposia IAPT is trying to implant a new culture in Physics education in the country replacing the age-old culture of rote learning and excellence in examination. The traditional culture will not adequately enable our students to face the challenges of 21st century in which innovation and creativity plays the key role, heightened by the sweeping phenomena of globalization and liberalization. I must say our present education system is inadequate and slow in rising up to the new reality. This is evident in our poor contribution to the international science in the post-independence era in terms of quality and quantity, and abysmal ranking of our universities and IITs amongst the universities of the world. This new series of NSSP is a modest effort by IAPT to impress upon the student community the urgency and necessity of imbibing a new culture of creativity and innovation. In concrete terms, our students have to be mentally and emotionally equipped to aspire to be successful physicist capable of impacting the international science.

In our present system of emphasis on rote learning and excellence in examination, a student spends 17 years of study to get his M.Sc. degree at the age of about 23. The M.Phil./Pre-doctoral, doctoral and post-doctoral work covers about another 9 years, during which he works under the supervision of a guide mostly on the ideas given by the latter. After this long struggle, at relatively advanced age one is tired to brave into uncharted territory and feels safer to walk on the familiar trodden path. Imported ideas, theories, models and computer-codes come handy to climb the job-ladder. Cultivation of western peers helps this process. The panacea of such ills is to imbibe the spirit of innovation and creativity from younger age while at +2 level when energy is abundant and spirit is not contaminated with commercialism. C. V. Raman and S. Chandrasekhar, while studying B. Sc. in Presidency College in Madras published their own research in international journals. M.N. Saha and S. N. Bose had no opportunity to do M.Sc. in Physics and studied Applied mathematics. They took pioneering role in opening M.Sc. Physics in Calcutta University in 1917, offering themselves to teach, acquiring required knowledge through self-study. Raman and Bose did not do Ph.D. and Saha acquired D. Sc. by his own research. Saha's Theory of Ionization, his famous book Treatise on Heat and Bose statistics resulted from their dedicated teaching in B.Sc. and M.Sc. classes. In the modern times, Bill Gate and Steve Jobs, being fired by the spirit of innovation had to be drop-out from the college. The UG and PG student life is too precious to be devoted fully for excelling in examinations.

It should not be misunderstood that culture of the spirit and innovation is only meant for those who opt for career in research. It is for one and all. The aim of education is to develop the ability to think creatively. This ability properly cultivated in the student days, will help to be successful in every sphere of activities. What is needed is passion for innovation. Our education system will be successful when it succeeds in inducing this passion in the students. It should be a way of life for one and all. I wish all success for the symposium.

L. Satpathy

Convener

FOREWORD

The science based development in the post independent era brought India on the global map of strength and prosperity. The country is participating in the international scientific programs and determined to develop as the future scientific power. However it has been observed that the standard of science education is declining alarmingly. The best minds are not coming to science and those who do, do not remain in science. The Indian contribution to basic sciences in the global context is reducing both in quality and quantity. These are the concerns of our scientific leadership. The Indian Association of Physics Teachers (IAPT) is also equally concerned.

In view of this IAPT decided to motivate the young Under Graduate (UG) and Post Graduate (PG) students to do science by their interaction with learned teachers and scientists and among themselves. This may help in giving the shape to creative and innovative scientific ideas of young students. To achieve this goal IAPT resolved to hold "National Student Symposium on Physics" (IAPT NSSP) each year.

It was planned that there will be quality motivational scientific talks by the learned guest faculty. The major time of symposium will be devoted for the presentation and participation of the UG and PG students. They will present their project / research work and there will be creative and innovative discussions among the students in the presence of learned motivators. The new conceptual and technical ideas will be put forward and the students will be encouraged to take ahead their scientific innovations.

The first IAPT NSSP was organized by IAPT in collaboration with Department of Physics, Panjab University, Chandigarh on Feb. 25-27, 2013. To our surprise, as it was for the first time, more than 150 students from all parts of the country, even from the remote areas applied for the presentation of their work and participation. With limited finances nearly 100 students were supported and these students worked hard for three days with their full intellectual strength. At the end the response of the students was very encouraging for us. The Proceedings of this NSSP is published in "Student Journal of Physics" Vol. 5, April –June 2013.

The enthusiasm and involvement of young students in the scientific research further encouraged us to hold the 2nd IAPT NSSP in Jan 17-19 2014. Again the response and participation of students was enormous and the expectations from IAPT were still higher. We believe we will live up to the expectations of the young students and hold NSSP each year to achieve the goal of excellence in science in India.

Here it is important to mention that Prof. L. Sathpaty initiated the idea to hold the NSSP, however the execution responsibility was given to me. Prof. A.K.Grover, Vice Chancellor, Panjab University kindly agreed to hold NSSP in Panjab University campus and it was done magnificently by Prof. Manjit Kaur, Prof. C.N. Kumar and Dr. Kuldip Kumar along with their colleagues. The expertise of Prof. U.S. Kushwaha, Prof H.C. Pradhan and other members of Advisory Board was the guiding force. The invaluable help of Dr. Bakhshis Chand of NITTTR Chandigarh is gratefully acknowledged. The credit of NSSP success goes to as family involvement of Chairman, Teaching Faculty and Technical Staff of Physics Department, Panjab University.

Satya Prakash

Former President, IAPT

2nd IAPT National Student Symposium on Physics

(17–19 January 2014)

Organised by

IAPT RC-3 (Chandigarh & Himachal Pradesh)
and
Department of Physics, Panjab University, Chandigarh

In order to foster a culture of innovation and creativity among the aspiring young amateur physicists, IAPT has instituted the Annual National Student Symposium on Physics (NSSP). It provides a national platform to the young students for presenting their new ideas and innovative work at an early stage, which will help them grow as creative and original researchers. After the overwhelming response of students to the 1st IAPT NSSP 2013, Indian Association of Physics Teachers in collaboration with Department of Physics, Panjab university, Chandigarh, organised the 2nd IAPT NSSP from 17-19 January 2014.

The relevant announcement with all the necessary information was carried in October and November 2013 issues of the IAPT Bulletin prominently. Also, in order to give wider publicity, about 300 posters were sent to prominent colleges, university physics departments and other institutions (having undergraduate and postgraduate courses in physics) all over the country inviting the UG and PG students to take part in the event. A separate dedicated website (hosted on the web server of Physics Department, Panjab University) was designed, updated and monitored, which made the interaction of the students and experts with the organising committee very effective and efficient. An overwhelming response was received despite the fact that the timing was of extreme cold in Chandigarh in addition to the many students having their examinations in these days. In a few cases, there were as many as 20-25 applications from the same institution and many from the same region. Hence, considering the logistics, budgetary and administrative reasons, around 100 participants were chosen out of them. The selection thus made gave a fair representation to students from all over India. In this way 24 students were selected for oral presentation and 42 were asked to make poster presentation. The rest of them were asked to take part as participants only. The lodging was provided at NITTR guest house/ hostel in Sector-26, Chandigarh. A registration fee of Rs. 400/ was collected from all participants and all participants presenting their papers through oral and poster were provided partial travel assistance. Local hospitality to all participants and resource persons was provided by the hosts.

The format of the symposium consisted, on the pattern of last year, of invited talks by experts and oral and poster presentations by the students. In addition, there were several special lectures by eminent teachers and scientists on topics of current interest. This year the participants also visited the Anveshika Chandigarh Centre at Sri Guru Gobind Singh College, Sector-26 where they enjoyed interacting with Principal M.S. Marwaha and his team, who showcased the simple and innovative experiments in physics.

On a beautiful morning on 17th January 2014, the staff and students of Physics Department, Panjab University welcomed the enthusiastic students and eminent physicists for this event. After a brief period of registration process for the student participants, all gathered at the auditorium of the Department, where most of the academic programmes were carried out. The symposium was inaugurated by Prof.Arun K. Grover, Vice-Chancellor of Panjab University, Chandigarh who welcomed the participants with his inspiring words. Recalling the glorious contributions of Indian scientists in the advancement of pure and applied sciences even before independence, he made special mention of the work of Prof.Ruchi Ram Sahni and his contemporaries; he inspired the enthusiastic participants to work wholeheartedly for the glory of the country and satisfaction of curiosity through pure and applied sciences. He congratulated the organising team of NSSP-2014 for this endeavour and wished the Symposium a great success.

Prof. H.C. Pradhan, President, IAPT in his presidential address enlightened the gathering about IAPT and its various activities, its glorious contributions and achievements since its inception. He talked about his close association with the HomiBhabha Centre for Science Education in nurturing the scientific imagination and innovation of the students and his endearing experiences in Physics Education. He congratulated the students for their enthusiastic participation and hoped that this spirit will be maintained further through such active fora of exploring the innovative potential of the young minds. Earlier, Prof. C.N. Kumar, chief coordinator of the event welcomed all the dignitaries, faculty and students and acquainted them with the philosophy and motivation behind organising NSSP. A warm welcome was extended by Prof.Manjit Kaur, Chairperson of the Physics Department, Panjab University and Regional President of IAPT, who also briefed the audience with the glorious history and inspiring present of the Physics Department.

The message of Prof. L. Satpathy, the National Convener, was read out by Prof. U.S. Kushwaha, Chief Editor of IAPT Bulletin and a very senior founder member of IAPT. In his encouraging message, Prof. L. Satpathy stressed on the scientific temper and dream of taking India ahead in science and technology. He also stressed the need for such efforts in collaboration with other institutions to carry forward the mission of nurturing the scientific talent of the nation. Prof. Satya Prakash, immediate past president of IAPT, gave a motivational talk to the participants and inspired them to work in areas of indigenous sciences also. All these senior dignitaries in their message inspired the students to work hard and dream for adding more names to the list of Indian Nobel Prize winners under the national flag. The inaugural session was attended by IAPT members from the city and the region in large numbers. It was specially graced by the presence of the stalwarts of IAPT from this region, namely Prof. H.S. Hans, Prof. U.S. Kushwaha, Prof. M.P. Khanna, Prof. S.P. Puri and Prof. P.M. Sood and Principal M.S. Marwaha.

Like the 1st NSSP, 2nd NSSP also witnessed talks by eminent scientists, oral and poster presentations by students of various universities and colleges across the country. The abstracts of papers received for oral and poster presentations are given elsewhere in this issue.

The first technical session of the day-1 was chaired by Prof. H.C Pradhan in which two oral presentations of the students were given after a motivating talk by Dr.Sonali Bhatnagar of Dayalbagh Educational Institute, Agra, on the use of ‘Computational Methods and GEANT-4 software Package’ in higher physics and research. This was followed by a group photograph of all the participants outside the auditorium. In the post lunch session, which was chaired by Prof. Satya Prakash, six students presented their papers followed by discussions and a motivating talk by Prof H.C. Pradhan on ‘The History of Gravitational Theory’ and its message for the young students. This was followed by tea and a visit to Sri Guru Gobind Singh College, Sector-26, where the principal, Sh. M.S. Marwaha captivated the attention of participants with his unique demonstration of interesting science experiment with low cost equipment designed by him and his group. This interaction was enjoyed and liked by all the student participants.

2nd Day

The second day started with poster presentation by the participating students followed by interaction with experts in the Department of Physics during the display of posters. It was a very interesting programme as many novel ideas were presented by the students in artistic and logical manner.

The second session of the day-2 started with a captivating lecture by Dr.KavitaDorai from IISER Mohali. In her enriching talk on ‘NMR in Physics and Biology’, she highlighted the contribution of NMR to our understanding of nature in physics and biology and acquainted the audience about the current developments in the field of NMR research as well as its applications in various fields of science, technology and medicine. She explained how this technique can help in exploring the specific properties of medicinal plants and shared her interesting experiences in collaborative research in this context. Her talk was immensely enjoyed by the audience whose questions and captivatingly curious gaze reverberated the auditorium. This was followed by another six oral presentations of participants.

In the post-lunch session of day-2, Dr.Harvinder K. Jassal, IISER Mohali, delivered her talk on ‘Dark Side of the Universe’ in which she explained the Dark Matter, Dark Energy and the Cosmic Expansion to the eager audience. She also shared her own experiences as a student of physics and inspired students to come forward with ideas to lead the way in science and technology with confidence. This was followed by a talk by Dr Sandeep Sahijpal of the Physics Department, Panjab University. In his brilliant lecture on ‘The Cosmic Origin of the Elements’, he explained our current understanding of the cosmic origin of element and told we can further explore our universe. He also mentioned how the study of astronomy makes us humble by reminding us of our true place in the universe.

3rd Day

On the last day of the event, participants visited various research laboratories of the Physics Department, such as High Energy Physics Lab, Cyclotron Laboratory, Condensed Matter lab where they got an opportunity to interact with the research scholars and faculties of the concerned laboratories. It was a nice opportunity for the student to watch science in action. This was followed by a captivatingly simple yet inspiring lecture by Prof.Sudipta Mukherji from Institute of Physics, Bhubaneswar. In his blackboard-based lecture, he explained ‘A Mechanical Model of Phase Transition’ which was well received by the participants. He also explained the uniqueness of this model and its applications in various branches of Physics.

With the hope that energy and brilliant ideas of the enthusiastic students will find a right direction, the closing ceremony took place on the afternoon of 19th January. The Symposium came to an end by concluding session which included feedback by students and distribution of certificates and IAPT Student Journal of Physics to the participants. In their feedback the students spoke about their learning experiences during this symposium and shared how much they were thrilled to attend the expert talks and lab visit. They thanked the organisers and volunteers of NSSP-2014 and NITTTR, Chandigarh for the nice accommodation even in the chilling winter. The final vote of thanks was proposed by Dr. Kuldeep Kumar, the Secretary of the NSSP-2014. The event was widely covered by the leading newspapers in their regional sections.

Titles / Abstracts of Invited talks

Dr. Sudipta Mukherji
Institute of Physics, Bhubaneswar
A MECHANICAL MODEL OF PHASE TRANSITION

Abstract: A close analogy between a mechanical system and a ferromagnetic material will be discussed. In particular, both the system under appropriate quenches will be compared.

Dr. Kavita Dorai
IISER, Mohali
NMR IN PHYSICS & BIOLOGY

Abstract: Nuclear Magnetic Resonance (NMR) has wide applications in several fields of science including quantum computing, materials science, biomolecular structure determination, medical diagnostics, environmental science and nanotechnology. This talk will focus on the basic physics of NMR and will also briefly discuss its applications to quantum computing and to metabolomics.

Dr. Sonali Bhatnagar
Dayalbagh Educational Institute, Agra
COMPUTATIONAL METHODS AND GEANT-4 SOFTWARE PACKAGE

Abstract: Geant4 is a relatively new software package developed by a collaboration of scientists and engineers from CERN and universities around the world. It offers tools for the simulation of the passage of particles through matter and particle detection. Geant4 simulates the different physical processes and particle interactions via collections of experimental cross sections for particle interactions, from "low energies" (e.g. thermal neutrons) up to "high energies" (e.g. heavy ion collisions The software development began as a toolkit with an emphasis in high energy experiments, but other fields have profited from it as well, for example, Geant4 is used commonly in nuclear physics, space and medical applications, and the field of semiconductors. The photon yield of a plastic scintillator and liquid xenon detector using Geant4 toolkit will be discussed and also an application to oncology therapy is presented. The talk also includes the preliminary studies done to setup a muon telescope. It deals with the study

of amplitude dependence of photomultiplier tube (PMT) of double and single fibre detectors with respect to high voltage given on PMT. The light leakage in both the detectors was tested. Further we obtained the optimum discriminator threshold voltage to suppress the noise. The optimum high voltage of PMT for both detectors is determined from the coincidence technique.

Prof. H. C. Pradhan
HBSCE, Mumbai
THE HISTORY OF GRAVITATIONAL THEORY

Dr. Sandeep Sahijpal
Panjab University, Chandigarh
THE COSMIC ORIGIN OF THE ELEMENTS

Dr. Harvinder Kaur Jassal
IISER, Mohali
DARK SIDE OF THE UNIVERSE

Oral Presentations

Analysis of electromagnetic undulator radiation for THz FEL

Roma Khullar*, Geetanjali Sharma, Mona Gehlot, and G. Mishra
School of Physics, Devi Ahilya Vishwavidyalaya, Indore 452001, India.
Corresponding Author: roma_khullar@yahoo.co.in

Abstract: We discuss the spectral properties of the radiation emitted by electrons moving in an electromagnetic undulator and an axial magnetic field. The device yields an interesting property when ever the cyclotron frequency equals to the wiggler wave frequency. In the combined undulator and axial field, the peak undulator radiation intensity is about twice the undulator radiation without an axial magnetic field. The analysis predicts an important free electron laser application at THz frequencies.

1. INTRODUCTION

A free electron laser employs a periodic magnetic field i.e. undulator to impart transverse oscillations to the relativistic electron beam. In the simplest configuration an undulator is a pure permanent magnet or a hybrid type magnetostatic field. During last several years the undulator technology have undergone substantial improvement and up gradation for its increased application in brilliant light source, free electron laser and inverse free electron laser. There have been studies on two frequency undulators [1] to extract free electron efficiency enhancement. There are bi-harmonic undulators and variable period undulator [2] for short wavelength FELs using lower energy electron beams. The optical klystron configuration [3-5] is widely in use to gain enhancement. The electromagnetic and electromagnet undulators are conceived primarily are short undulator period undulators [6,7].

The electromagnetic undulators with an electrostatic field [8] have been used to derive two fold free electron laser gain in comparison for a magnetostatic undulator. The electromagnetic undulator [9,10] has an undulator period half the undulator period of the magnetostatic undulator and generates shorter wavelength in comparison with the magnetostatic case. The spectral properties of radiation emitted by electrons moving in helical undulators and axial magnetic field are discussed independently [11].

The role of an axial magnetic field, electrostatic field with a helical wiggler has been studied for Inverse FEL applications [12].

In this paper, we discuss the spectral properties of undulator radiation emitted by electrons moving in a backward propagating electromagnetic wiggler and axial magnetic field. It is shown that the emission at the cyclotron harmonics can be combined with the harmonics of the electromagnetic undulator to get enhanced radiation by a factor of two in comparison with the electromagnetic undulator without an axial magnetic field. This happens when the cyclotron frequency equals to the wiggler wave frequency. It is seen that the condition is easily achievable at THz frequencies giving the possibility of using the electromagnetic undulator with an axial magnetic field in free electron laser and inverse free electron laser applications at THz frequencies. In section 2, we derive the electron trajectory in a electromagnetic undulator for evaluation of Lienard-Wiechert integral. The motivation of imposing an axial magnetic field is aimed at using gyrotron type emission to get enhanced undulator radiation with a more transparent formalism.

2. UNDULATOR RADIATION

The energy radiated per unit solid angle and frequency interval i.e the brightness is given by [13],

$$\frac{d^2 I}{d\omega d\Omega} = \frac{e^2\omega^2}{4\pi^2 c}\left|\int_{-\infty}^{\infty} dt\left[\hat{n}\times\left(\hat{n}\times\vec{\beta}\right)\right]\exp\left\{i\omega\left(t-\frac{\hat{n}\cdot\vec{r}}{c}\right)\right\}\right|^2 \tag{1}$$

where $\hat{n}$ is a unit vector determining the direction of observation, $\vec{r}$ refers to the particle position, and $\vec{\beta}$ to its reduced velocity. We assume that the relativistic electron moves in a backward propagating electromagnetic wave combined with an axial magnetic field described by,

$$\vec{E}_u = \frac{\omega_u}{ck_u} B_u\left[-\sin\left(k_u z+\omega_u t\right),\cos\left(k_u z+\omega_u t\right),0\right],\ \vec{B}=\hat{z}B_0 \tag{2}$$

B_u is the amplitude of the wiggler magnetic field. ω_u, k_u are the frequency and wave number of the electromagnetic wiggler. B_0 is the axial field. The trajectory is provided by the Lorentz force equation,

$$\frac{d\vec{\beta}}{dt} = \frac{e}{\gamma mc}\left[\left(\vec{\beta}\times B_u\right)+\left(\vec{\beta}\times \hat{z}B_0\right)\right]+\frac{e\vec{E}_u}{\gamma mc} \tag{3}$$

From Eq (3) we write the electron transverse velocities as,

$$\beta_x = \frac{K_c}{\gamma}\left[\cos(\Omega t)-\cos(\Omega_c t)\right]$$

$$\beta_y = \frac{K_c}{\gamma}\left[\sin(\Omega t)+\sin(\Omega_c t)\right] \tag{4}$$

$\Omega_c = \dfrac{B_0 e}{\gamma mc}$ is the relativistic cyclotron frequency. Where we defined modified undulator parameter as,

$$K_c = \frac{eB_u}{mc^2 k_u}\left(\frac{1}{1+b}\right), \quad b = \Omega_c / \Omega, \quad \Omega = \omega_u + k_u v_z$$

In order to evaluate the undulator brightness from Eq (1), first we let $b = 0$ and get the electron trajectories,

$$\vec{r} = \left[\frac{cK}{\gamma}\frac{\sin(\Omega t)}{\Omega}, \frac{-cK}{\gamma}\frac{\cos(\Omega t)}{\Omega}, \beta^* ct\right], \quad \beta^* = 1-\frac{1}{2\gamma^2}\left[1+K^2\right] \tag{5}$$

where $K = \dfrac{eB_u}{mc^2 k_u}$ is the undulator parameter. Since the emission angle is of the order of K/γ, we write, $\hat{n} \equiv \left(\psi\cos\phi, \psi\sin\phi, 1-\frac{1}{2}\psi^2\right)$ and therefore it is easy to show that

$$\frac{d^2 I}{d\omega d\Omega} = \frac{e^2}{4\pi^2 c}\sum_m \omega_m^2 \left|H_m(\upsilon_m)\right|^2 \left(\left|T_m^x\right|^2 + \left|T_m^y\right|^2 + \left|T_m^z\right|^2\right) \tag{6}$$

$H_m(\upsilon_m)$ is the line shape integral and sets the resonance condition. The quantities $T_m^{x,y}$ are the radial and vertical components of the radiated spectrum. For on-axis i.e. $\psi = 0$ we get,

$$T_m^x = -\frac{K}{2\gamma}\left[J_{m-1}(0) + J_{m+1}(0)\right],$$

$$T_m^y = -\frac{K}{2i\gamma}\left[J_{m-1}(0) - J_{m+1}(0)\right] \tag{7}$$

The function $J_m(\xi_u)$ is the cylindrical Bessel function of first kind.

The resonance condition gives,

$$\omega_m = \frac{2\gamma^2 m\Omega}{1 + K^2/2} \tag{8}$$

and on-axis we get intensity for the fundamental frequency i.e. *m*=1. In order to consider the effects of the axial magnetic field on the electromagnetic undulator radiation, we consider the modified electron trajectories as given in Eq (4) a

$$\vec{r} = \left\{ \begin{array}{l} \left[\frac{cK_c}{\gamma}\left\{\frac{\sin(\Omega t)}{\Omega} - \frac{\sin(\Omega_c t)}{\Omega_c}\right\}\right], \left[\frac{-cK_c}{\gamma}\left\{\frac{\cos(\Omega t)}{\Omega} + \frac{\cos(\Omega_c t)}{\Omega_c}\right\}\right], \\ \left[\beta_c * ct + \frac{2cK_c^2}{2\gamma^2}\frac{\sin\{(\Omega+\Omega_c)t\}}{(\Omega+\Omega_c)}\right] \end{array} \right\} \tag{9}$$

For on-axis i.e. $\psi = 0$ we get,

$$\frac{d^2 I}{d\omega d\Omega} = \frac{e^2}{4\pi^2 c}\sum_{m,n,p}\omega_{m,n,p}^2 \left|H_{m,n,p}(\upsilon_m)\right|^2 \left(\left|T_{m,n,p}^x\right|^2 + \left|T_{m,n,p}^y\right|^2 + \left|T_{m,n,p}^z\right|^2\right) \tag{10}$$

$H_{m,n,p}(\upsilon_m)$ is the line shape integral and sets the resonance condition. The quantities $T_{m,n,p}^{x,y}$ are the radial and vertical components of the radiated spectrum,

$$T^{x}_{m,n,p}=\begin{bmatrix}-\frac{K_c}{2\gamma}\left\{J_{m-1}(0)+J_{m+1}(0)\right\}J_n(0)J_p\left(\overline{\xi}_{cu}\right)\\+\frac{K_c}{2\gamma}\left\{J_{n-1}(0)+J_{n+1}(0)\right\}J_m(0)J_p\left(\overline{\xi}_{cu}\right)\end{bmatrix}$$

$$T^{y}_{m,n,p}=\begin{bmatrix}-\frac{K_c}{2\gamma i}\left\{J_{m-1}(0)-J_{m+1}(0)\right\}J_n(0)J_p\left(\overline{\xi}_{cu}\right)\\-\frac{K_c}{2i\gamma}\left\{J_{n-1}(0)-J_{n+1}(0)\right\}J_m(0)J_p\left(\overline{\xi}_{cu}\right)\end{bmatrix} \tag{11}$$

$$\overline{\xi}_{cu}=\frac{\omega K_c^2}{\gamma^2\left(\Omega+\Omega_c\right)}$$

The resonance frequency is obtained from the line shape integral and reads,

$$\omega_{m,n,p}=\frac{2\gamma^2(m\Omega+n\Omega_c+p(\Omega+\Omega_c))}{1+2K_c^{\,2}} \tag{12}$$

Eq(10) gives the modified undulator radiation of an electromagnetic wiggler with an axial magnetic field and has to be compared with Eq(6) without an axial magnetic field.

3. RESULTS AND DISCUSSION

In this paper we discuss the special properties of the radiation emitted by electrons moving in an electromagnet wiggler and an axial magnetic field. We analyse the effects of the axial magnetic field with the ratio parameter i.e. b. $b=0$ denotes the absence of the axial magnetic field and $b=1$ implies that the cyclotron frequency equals the wiggler wave frequency i.e. $\Omega_c=\Omega$. There are two resonant frequencies for $0<b<1.0$. The lower resonant frequency is the cyclotron frequency and the higher resonant frequency is the undulator fundamental frequency. The higher resonant frequency is given by,

$$\omega_m=\frac{2\gamma^2\Omega}{1+2K_c^{\,2}} \quad \text{for} \quad m=1, n=p=0$$

The intensity is,

$$\frac{d^2I}{d\omega d\Omega}=\frac{e^2\omega^2T^2}{4\pi^2c}\left\{\left|T^x_m\right|^2+\left|T^y_m\right|^2\right\},\quad T^x_m=-\frac{K_c}{2\gamma}J_0\left(\overline{\xi}_{cu}\right),\quad T^y_m=-\frac{K_c}{2i\gamma}J_0\left(\overline{\xi}_{cu}\right)$$

Substituting the value of the resonance frequency,

$$\left.\frac{d^2I}{d\omega d\Omega}\right|_{\Omega} = \frac{4e^2N^2\gamma^2}{c}\frac{2K^2\alpha^2}{\left(1+2K^2\alpha^2\right)^2}J_0^2\left(\frac{2K^2\alpha^3}{\left(1+K^2\alpha^2\right)}\right) \ , \quad \alpha = \frac{1}{1+b}$$

The lower resonance frequency reads,

$$\omega_n = \frac{2\gamma^2\Omega_c}{1+2K_c^{\ 2}} \quad \text{for } m=p=0,\ n=1$$

The corresponding intensity reads,

$$\left.\frac{d^2I}{d\omega d\Omega}\right|_{\Omega_c} = \frac{e^2\omega^2T^2}{4\pi^2c}\left\{\left|T_n^x\right|^2+\left|T_n^y\right|^2\right\}, \qquad T_n^x = -\frac{K_c}{2\gamma}J_0\left(\xi_c\right), \quad T_n^y = -\frac{K_c}{2i\gamma}J_0\left(\xi_c\right)$$

Substituing the value of resonance frequency we get,

$$\left.\frac{d^2I}{d\omega d\Omega}\right|_{\Omega_c} = \frac{4e^2N^2\gamma^2}{c}\frac{2K^2\alpha^2}{\left(1+2K^2\alpha^2\right)^2}b^2J_0^2\left(\frac{2K^2\alpha^3}{\left(1+K^2\alpha^2\right)}b\right)$$

The two intensities can be compared to read,

$$\frac{\left.{d^2I}\big/{d\omega d\Omega}\right|_{\Omega_c}}{\left.{d^2I}\big/{d\omega d\Omega}\right|_{\Omega}} = \frac{b^2J_0^2(Ab)}{J_0^2(A)} \quad , \quad A = \frac{2K^2\alpha^3}{1+K^2\alpha^2}$$

The intensity at the lower resonant frequency is lower. These two resonant frequencies are separated by,

$$\Delta\omega = \left|\omega_m - \omega_n\right| = \frac{2\gamma^2\Omega}{1+2K_c^{\ 2}}\left(1-b\right)$$

The intensity at ω_n is significantly smaller than the frequency at ω_m for given value of b i.e. ${\Omega_c}/{\Omega}$.

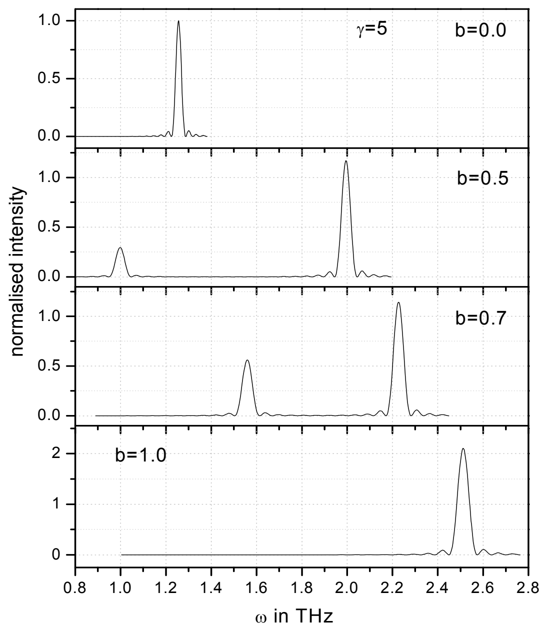


Figure 1. Intensity vs. frequency.

In Fig 1, we plot the intensity versus frequency with the ratio parameter i.e. b. The intensities at $0<b<1.0$ are normalised with the intensity at $b=0$. For $\gamma=5, K=1, b=0$ we get $\omega_m=1.256THz,\ \omega_n=0$. Tuning the axial magnetic field to reach $b=0.5$ we get $\omega_m=1.99THz, \omega_n=1THz$. For $b=0.7$ we get $\omega_m=2.23THz, \omega_n=1.56THz$. For $b=1.0$, $\omega_m=\omega_n=2.51THz$. Then two resonance frequencies merge at $b=1$ i.e. $\Omega_c=\Omega$ and the intensities at these two frequencies add. The intensities at the ω_n slowly increases and equals to the intensity at ω_m thereby the intensities gets doubled for the case at $b=1$. In terms of physical parameters this can be written as, $B_0(KG)=\dfrac{21\gamma b}{\lambda_u(cm)}$.

As an example let us consider the case with $\lambda_u = 5cm$, $\gamma = 5$, $b = 0.5$ implies $B_0 = 10.5KG$. For $b = 0.7$, $B_0 = 14.7KG$. $b = 1.0$ which happens at $B_0 = 21KG$, the two frequencies merge at $\omega = 2.5THz$. The requirement of the axial magnetic field will be prohibitly large with increasing γ or short λ_u. The tuning of the resonant frequency is plotted in Fig 2. There is no cyclotron frequency at $b = 0$. At the axial magnetic field is tuned from $b = 0$, to $b = 1$, the emission at cyclotron frequency emerges and proceeds to higher value of b tends to unity. At $b = 1$, these two frequencies equals. The spectrum is studied in Fig 3. for value of b approach to unity. At exact value of $b = 1$, the spectrum is broad, the bandwidth is twice of the bandwidth with $b = 0$ and with twice the original intensity. The bandwidth at $b = 1$ i.e. $\Omega_c = \Omega$ is shown in Fig 4. where we plot the normalised FWHM for value of b close to unity. The normalised bandwidth implies the bandwidth at $b = 1$ divided with the bandwidth at $b = 0$.

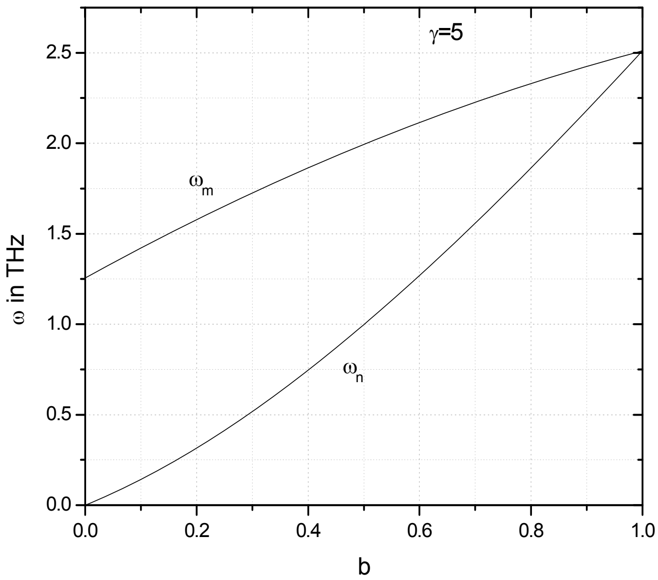


Figure 2. Tuneable resonance frequency versus ratio parameter.

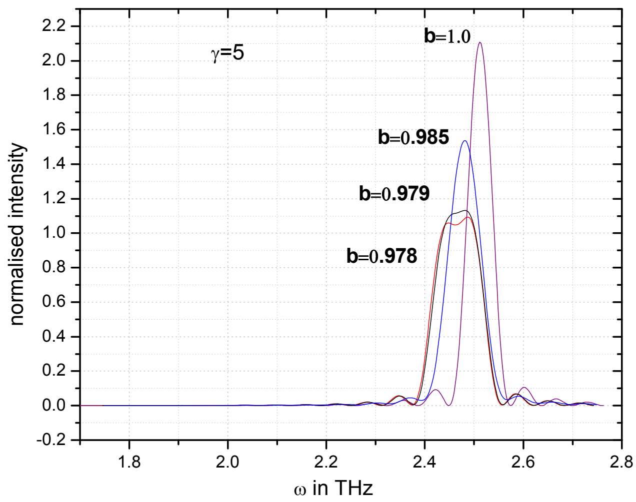


Figure 3. Enhanced undulator intensity resonant frequency near $b = 1$.

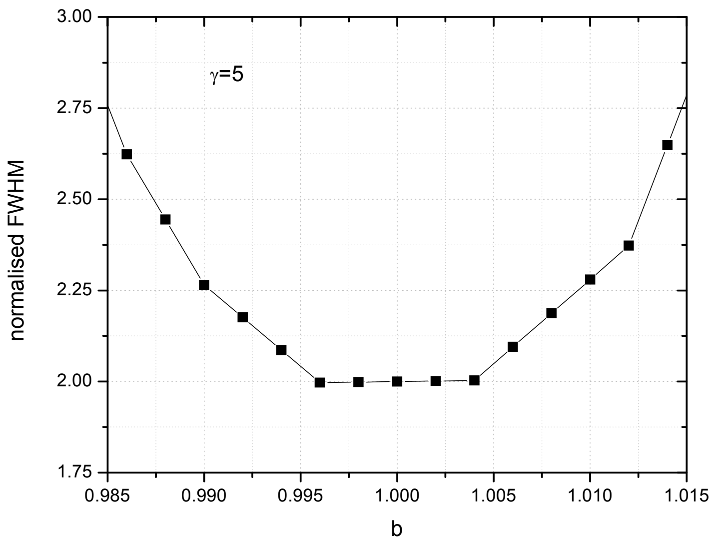


Figure 4. Normalised FWHM versus ratio vrs. Parameter b.

In conclusion we have examined undulator radiation with an electromagnetic undulator and an axial magnetic field. In the presence of the axial magnetic field, there is an additional radiation at the cyclotron frequency. The cyclotron frequency can be tuned to the fundamental undulator frequency to extract two-field intensity. The bandwidth at this frequency is also doubled. The scheme is shown to be useful for free electron laser interaction at THz frequencies.

ACKNOWLEDGEMENT

The work is supported by UGC, New Delhi, India.

REFERENCES

[1] D. Iracane, P. Bamas, Phy Rev. Lett, 67, 3086, 1991.

[2] N.A. Vinakurav, O.A. Shevchenko, V.G. Tcheskidav, Phys. Rv. Spl. Topics-Accelerators and beams, 14, 2011.

[3] G. Dattoli, L. Bucci, Nuclear Instruments and Methods in Physics Research A, 450, 2000, p-479.

[4] G. Dattoli, L. Bucci, Optic communication, 177, 2000, p-323.

[5] G. Mishra, Mona Gehlot, Jeeva Khan Hussain, J. Mod. Opt., Vol. 56, No. 5, 2009, 667-676.

[6] R. Stoner, S. Chi Chen, G. Bekefi, IEEE Trans. Plasma Sc., Vol. 18, No. 3, 1990.

[7] R. Stoner, G. Bekefi, IEEE J & E, vol. 31, No 6, 1995.

[8] M. Ismaeilzadeh, V. Ghafouri, A. Taghavi, Esmaeil Nomver, Phys. of Plasmas, 13, 043103, 2006.

[9] H.P. Freund, R.A. Kehs and V. L. Granatstein, vol. 34, No. 3, 1986.

[10] LU Bo, YU Junsheng, LIU Shenggang, Chinese Phys. Lett., vol. 9, No. 5, 1992, 236.

[11] G. Dattoli, S. Carbrini, L. Giannessi, V. Lareto, IL Nuovo Cimento, vol. 140, No.7, 1992.

[12] R. Khazaeinezhad, M. Esmaeilzadeh, chin. Phys. C, vol. 36, No. 9, 2012.

[13] J.D. Jacson, Classical Electrodynamics, Wiley, New York, 1962.

Inclusive χ_{c1} Reconstruction at BELLE

Monica and Rajeev Kumar
Department of Mathematics, Statistics & Physics, PAU, Ludhiana.
Corresponding Author: rajeevsharma@pau.edu

Abstract: The recent measurement of charmonium production in various high energy physics reactions have brought surprises and challenge in our understanding both of heavy quark production and of charmonium bound state formation. Inclusive *B*-decays to charmonia offer means by which theoretical predictions may be confronted with experimental data. Here, inclusive production of χ_{c1} (which is reconstructed from its radiative decay mode) using a data sample of 387 x 10^6 $B\overline{B}$ events which have been collected at Υ(4S) resonance (bound state of $b\overline{b}$ quarks) with Belle detector at KEKB asymmetric energy $e^{-}e^{+}$ collider is measured and obtained branching fraction is *B.F.*= (0.29±0.001)%.

1. INTRODUCTION

The universe is made chiefly of matter, rather than consisting of equal parts of matter and antimatter as might be expected. How do we really know that the universe is not matter-antimatter symmetric? In fact, there are strong evidences in this context. (i)The Moon: Neil Armstrong did not annihilate, therefore the moon is made of matter. (ii)The Sun: Solar cosmic rays are matter, not antimatter. (iii)The other Planets: We have sent probes to almost all. Their survival demonstrates that the solar system is made of matter. So, there is no evidence for the existence of large amounts of antimatter in the universe. The Milky Way Galaxy appears to consist entirely of matter, as there are no indications for regions where matter and antimatter meet and annihilate to produce characteristic gamma rays. The implication that matter completely dominates antimatter in the universe appears to be in contradiction to Dirac's theory, which, supported by experiment, shows that particles and antiparticles are always created in equal numbers from energy. The energetic conditions of the early universe should have created equal numbers of particles and antiparticles; mutual annihilation of particle-antiparticle pairs, however, would have left nothing but energy.

In the universe today, photons (energy) outnumber protons (matter) by a factor of one billion. This suggests that most of the particles created in the early universe were indeed annihilated by antiparticles, while one in a billion particles had no matching antiparticle and so survived to form the matter observed today in stars and galaxies. The tiny imbalance between particles and antiparticles in the early universe is referred to as matter-antimatter asymmetry, and its cause remains a major unsolved puzzle for cosmology and particle physics. One possible explanation is that it involves a phenomenon known as Charge-Parity (CP) violation in the standard model (SM), which gives rise to a significant difference in the behavior of particles and their antiparticles.

2. FUNDAMENTAL SYMMETRIES AND CP VIOLATION

The concept of symmetry is deeply ingrained in physics. Tests of fundamental symmetries in atomic nuclei play an important role in uncovering nature's basic forces. Particle physicists thought that all fundamental interactions were symmetric under three discrete operations of parity (P), time reversal (T) and charge conjugation (C). A series of discoveries from the mid-1950s caused physicists to alter significantly their assumptions about the invariance of C, P, and T. Prompted by the realization of Lee and Yang [1] that there was no experimental evidence that weak interactions conserved parity; Wu *et al* [2] discovered that weak interactions do not conserve parity in radioactive decay of Cobalt-60. Later on this was confirmed by other authors [3,4]. The violation was separately maximal and thus combined operation CP, remained an unbroken symmetry. Until 1964, however, CP symmetry was assumed to hold in weak interactions as well. One reason for this assumption was the CPT theorem, which states that all quantum field theories must be symmetric under a combined transformation of C, P and T. CP violation therefore implies violation of the time-reversal symmetry, which at the time was beyond imagination. The discovery of CP violation was therefore completely unexpected when Christenson *et al* [5] observed this phenomenon for the first time in the study of the decays of neutral kaons, particles formed by a strange quark and a down anti-quark. The observed effect was small, one part in a thousand, but was extremely important because it proved that matter and anti-matter are intrinsically different. For this discovery Fitch and Cronin were awarded the Nobel Prize in 1980.

3. KOBAYASHI-MASKAWA MECHANISM OF CP VIOLATION

Kobayashi and Maskawa [6] proposed that CP violation would be an inherent prediction of the Standard Model of particle physics if there were six types of quarks (In 2008, Kobayashi and Maskawa were awarded the Nobel Prize for Physics for their "discovery of the origin of the broken symmetry which predicts the existence of at least three families of quarks in nature."). In their famous work, Kobayashi and Maskawa showed that with four quarks there is no reasonable way to include the CP violation. Together with it they also proposed several models to explain CP violation in kaon system, amongst which the six quark model got favored over time. The explanation of CP violation in the six quark model of Kobayashi and Maskawa builds on the idea of quark mixing introduced by Cabibbo. In his hypothesis, Cabibbo proposed that the quantum states of quarks with different mass are the mixtures of the states that the weak interaction sees. The quark mixing introduces difference between eigen states of strong and weak interaction. The CP violation requires a complex phase in order to provide a difference between process and its charge conjugate. In the four quark model, quark mixing is described by 2×2 unitary matrix. With only four quarks, the rotation matrix that transforms one set of quark states into the other is restricted to real numbers states and thus quark mixing cannot accommodate CP violation. A necessary condition for the appearance of the complex phase, and thus for CP violation, is the presence of at least three generation of quarks. With extension to six quarks, the mixing matrix becomes 3×3 unitary matrix, called Cabibbo-Kobayashi-Maskawa matrix [6,7]. In this case one complex phase always remains in the matrix. This complex phase provides the CP violation in the standard model. The idea has two important implications. First, in addition to three quarks known in early 1970's and predicted charm quark, it postulates the existence of other two quarks, called bottom and top. Second, despite the tiny CP violation in the kaon system, proposed mechanism predicts large CP violation in the *B* system. It took almost three decades, but both predictions were experimentally confirmed, first by discovering the bottom quark [8] followed by top quark discovery [9,10] and finally by the measurement of large CP violation in the B^0 system [11,12] at new dedicated electron-positron "B-factories" at KEK (Japan) and SLAC (USA).

4. THE KEKB ACCELERATOR AND BELLE DETECTOR

The goal of the Belle Experiment was to design a particle collider that is perfectly suited for high precision measurements, especially in the area of CP violation in the B meson system. The KEKB [13] accelerator was designed as an electron-positron collider with colliding beams and circular topology, which operates primarily on the $\Upsilon(4S)$ resonance. This resonance is a bound state of $b\bar{b}$ quarks and its rest energy of 10.58 GeV is just above the threshold of B meson pair production. Another important property of the KEKB accelerator is that it is working with asymmetric energies for the colliding $e^- e^+$ pairs. The positrons use a low energy ring (LER) with energy E_+ = 3.5 GeV and a positron current of about 1600 mA. In the high energy ring (HER), electrons are accelerated to an energy of E_- = 8.0 GeV with a current of 1200 mA. The result of the energy asymmetry is that the CMS of the $\Upsilon(4S)$ resonance is not at rest in the lab frame. It is boosted and this boost gives the opportunity to precisely measure the difference of the decay times of the B mesons.

The component closest to the interaction point is the beam pipe itself. It is followed by a silicon vertex detector (SVD), whose task is to determine the starting points of the tracks. The next device is the central drift chamber (CDC). It serves as a track recorder and thus covers an area up to 1.2m from the interaction point. At the end of the CDC follows an aerogel threshold Cherenkov counter (ACC) and a time of flight counter (TOF). These two components are used for particle identification (PID). Neutral particles are detected outside of this inner area. Following the TOF detector in radial direction, the electromagnetic calorimeters (ECL) are used for the reconstruction of photons by detecting electromagnetic showers. In the direction of the beam pipe, the extreme forward calorimeters (EFC) fulfill the same task. The outermost component is a resistive plate counter, which can detect K_L^0 and $\mu^{\pm}$ (KLM). Except for the KLM chambers, the whole detector is surrounded by a superconducting solenoid, which provides a magnetic field of 1.5T.

In order to quantify the physical properties of the above mentioned parts, it is necessary to specify the coordinate system that is commonly used for describing detector components.

The positive z-axis points in the direction of the boosted ϒ(4S) resonance, the so-called forward direction. The y-axis is perpendicular to the accelerator plane, while the x-axis lies within that plane, pointing away from the center. The angle θ is measured with respect to the z-axis and ϕ is measured in the xy-plane with respect to the x-axis.

5. CHARMONIUM MESONS

Charmonium is a bound state of a charm (*c*) quark and a charm anti-quark ($\bar{c}$). The charmonium family has a net charm of zero. A charmonium state J/ψ was discovered in 1974 at SLAC (Stanford Linear Accelerator Center) and BNL (Brookhaven National Laboratory) [14,15]. After the discovery of *J/ψ*, many new charmonium states have been observed such as *ψ(2S)*, η_c and others. The η_c *(1S)* is the ground state of $c\bar{c}$ system. The spins of two quarks are antiparallel (*J*=0). The *J/ψ(1S)* and *ψ(2S)* are 1*S* and 2*S* orbital excitations with quark spins parallel (*J*=1). The χ_c are 1*P* orbital excitations with quark spins parallel. These charmonium states (such as *J/ψ(1S)*, *ψ(2S)* or η_c) are of great interest both from theoretical and experimental points of view because of their clear experimental signature and great simplification caused by their non-relativistic nature. Decays of *B* meson to final states that include charmonium states play an important role in the study of CP violation at *B*-factories. Reconstruction and study of charmonium mesons in *B* decays is a crucial component of the measurement of time-dependent CP violating asymmetries.

6. χ_{c1} RECONSTRUCTION

The χ_{c1} charmonium states are reconstructed via there radiative decays to J/ψ. The χ_{c1} signal is extracted from the data collected at ϒ(4S) by Belle experiment. The total number of events used to extract χ_{c1} signals are 387 X 10^6 $B\bar{B}$. The parameter ΔM (Mass of χ_{c1} - Mass of J/ψ) is used to extract χ_{c1} mass in order to minimize statistical uncertainty so that the distribution is primarily dominated by the gamma energy resolution. The J/ψ candidates used to reconstruct χ_{c1} should have momentum below 2.0 GeV/c and that of gamma should be 60 MeV. The χ_{c1} candidates are selected by requiring the mass difference to lie between 0.370 GeV/c^2 and 0.438 GeV/c^2.

7. RECONSTRUCTION EFFICIENCY

Reconstructed efficiency of $\chi_{c1} \rightarrow J/\psi\ \gamma$ is estimated by Monte Carlo Simulation. A Signal Monte Carlo sample comprising of 15000 events is generated by using EvtGen [16] and these generated events are made to pass through the Belle detector simulation performed using GEANT package [17] which accommodates the geometry of each detector component. The reconstruction efficiency is calculated by performing a fit to $M(\chi_{c1})-M(J/\psi)$ distribution. The signal shape is modeled by the Crystal Ball function [18] and other combinational backgrounds by Chebyshev polynomial of order 3 as shown in Fig. 1. The reconstruction efficiency is calculated out to be (29.9 ± 0.42)% .

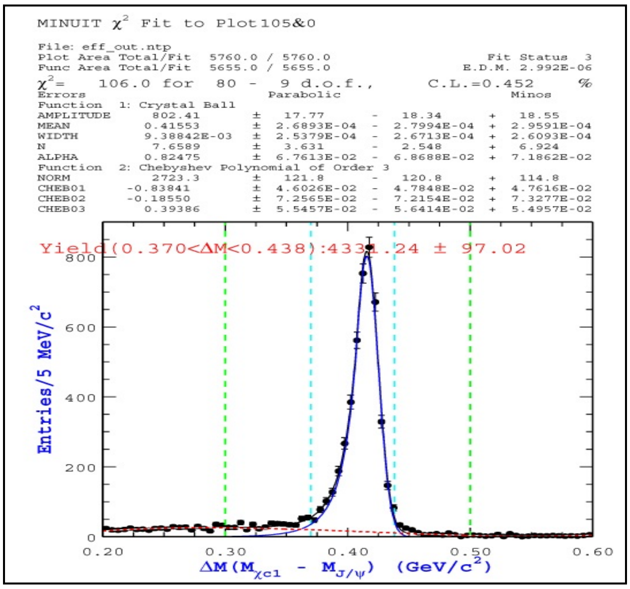


Figure 1: The $M(\chi_{c1}) - M(J/\Psi)$ distributions from Monte Carlo.

8. RESULT AND DISCUSSION

The branching fraction for inclusive χ_{c1} production is calculated as follows:

$$BF = \frac{N_{sig}}{N_{B\bar{B}} \times \varepsilon \times BF(\chi_{c1} \to J/\psi\gamma) \times BF(J/\Psi \to l^+l^-)}, \text{ where}$$

N_{sig} is the observed signal yield, $N_{B\bar{B}}$ are total number of $B\bar{B}$ events in the data sample, ϵ is the reconstruction efficiency. $BF(\chi_{c1} \to J/\psi\gamma)$ and $BF(J/\Psi \to l^+l^-)$ are the daughter branching fractions. The number of observed events are 1576.02 ± 59.36, where signal probability density function is modeled by Crystal Ball function [18] and other combinational backgrounds by Chebyshev polynomial of order 3 as shown in Fig. 2. The daughter Branching fractions published in [19] are used. The resulting branching fraction is (0.29 ± 0.001)% which is consistent with the factorization model.

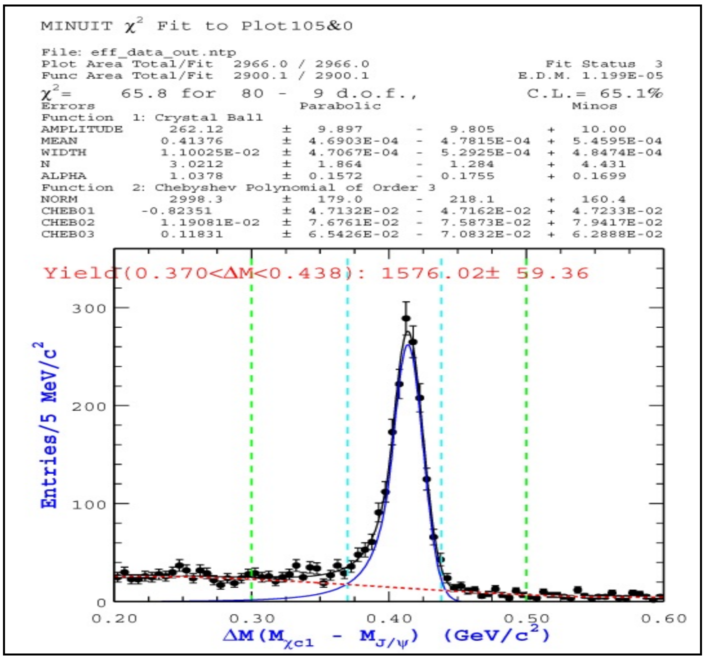


Figure 2: The *M(* χ_{c1} *)–M(J/Ψ)* distributions from experimental data **.**

REFERENCES

[1] T. D. Lee and C. N. Yang, “Question of parity conservation in weak interaction”, *Phys Rev* **104:** 254-58(1956).

[2] C. S. Wu, E. Ambler, R. W. Hayward, D. D. Hoppes and R. P. Hudson, “Experimental test of parity conservation in beta decay”, *Phys Rev* **105:** 1413-15(1957)

[3] J. L. Friedman and V. L. Telegdi, “Nuclear emulsion for parity non conservation in the decay chain $\pi^+ \to \mu^+ \to e^+$ ”, *Phys Rev* **106:** 1290-93(1957)

[4] R. L. Lederman and M. Weinrich, “Observation of the failure of conservation of parity and charge conjugation in meson decays: the magnetic moment of free muon”, *Phys Rev* **105:** 1415-17(1957)

[5] J. H. Christenson, J. W. Cronin, V. L. Fitch and R. Turlay, “Evidence for the 2π Decay of the K_2^0 Meson”, *Phys Rev Lett* **13:** 138-40(1964)

[6] M. Kobayashi and T. Maskawa, “CP Violation in the Renormalizable Theory of Weak Interaction *, Prog Theor Phys* **49:** 652-57(1973)

[7] N. Cabibbo, “Unitary Symmetry and Leptonic Decays”, *Phys Rev Lett* **10:** 531(1963)

[8] Herb *et al, “*Observation of a dimuon resonance at 9.5GeV in 400GeV proton-nucleus collisions”*, Phys Rev Lett* **39:** 252-55(1977)

[9] S. Abachi *et al* DØ Collaboration, “Search for high mass top quark production in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV”, *Phys Rev Lett* **74:** 2422-26(1995)

[10] F. Abe *et al* CDF Collaboration, “Observation of top quark production in $p\bar{p}$ Collisions with the collider detector at Fermilab”, *Phys Rev Lett* **74:** 2626-31. (1995)

[11] K. Abe *et al* Belle Collaboration, “Observation of large CP Violation in the neutral *B* meson system”, *Phys Rev Lett* **87:** 091802(2001)

[12] B. Aubert *et al* BABAR Collaboration, “Observation of CP Violation in the B^0 meson system*”, Phys Rev Lett* **87:** 091801(2001)

[13] S. Kurokawa and E. Kikutani, “Overview of the KEKB Accelerators” *Nucl. Inst. Meth. A* **499**(1): 1-7(2003)

[14] J. J. Aubert *et al, "*Experimental Observation of a Heavy Particle", *J Phys Rev Lett* **33**: 1404-06(1974)

[15] J. E. Augustin *et al*, "Discovery of a Narrow Resonance in e^+e^- Annihilation", *Phys Rev Lett* **33**: 1406-08 (1974)

[16] D. J. Lange, "The EvtGen particle decay simulation package", *Nucl Instrum meth Phys Res Sect A* **462**:152-155(2001)

[17] R. Brun *et al* (1984) Detector Response is simulated with Geant. Geant 3.21 CERN DD/EE/84-1.

[18] T. Skwarnicki, DESY Internal Report, DESY Report No. F31-86-02(1986)

[19] J. Beringer *et al* (Particle Data Group), "Review of Particle Physics", *Phys Rev D* **86**, 010001(2012)

Effect of Tsallis Distribution of Electrons on Ion-Acoustic Waves in $H^+O^-_2$ Plasma

Neha Goyal and Parveen Bala
Department of Mathematics, Statistics & Physics, PAU, Ludhiana
Corresponding Author: goyalneha16190@gmail.com

Abstract: In this research paper, we have studied the properties of ion-acoustic solitons in a plasma consisting of cold positive and negative ions with different concentration of masses and charged states. An investigation has been done by taking a two fluid plasma system consisting of cold positive (H^+) and negative ions (O_2^-) with q-non-extensive velocity distribution of electrons. $H^+O_2^-$ is a plasma system that is found in the D-region of ionosphere. One of the non-Maxwellian distribution, Tsallis distribution known commonly as q-non-extensive distribution has attracted an immense attention of the researchers. Reductive Perturbation Method is used to derive Korteweg-de Vries (KdV) equation, where the nonlinearity and dispersion coefficients are found to be the functions of non-extensive parameter q. The effect of non-extensive distribution of electrons on the dynamics of ion-acoustic solitary waves has been studied. The results of the numerical computations are interpreted in the form of graphs for various parameter regimes.

1. INTRODUCTION

Most of the baryonic matter of the universe is in the form of hot plasma, both as rarefied interstellar medium and as dense stars. Plasma is considered as a different phase or state of matter. It would be seen that we live in the 1% of the universe in which plasma do not occur naturally. Nonlinear wave structures are beautiful and amazing manifestation of nature, arising out of competition between properties like nonlinearity, dispersion and dissipation. To quote a few nonlinear wave structures we have solitons, shock waves, double-layers etc. observed both in space and laboratory but in plasmas ion-acoustic solitons have been focus of most investigations. Equations of plasma dynamics are nonlinear.

Therefore, nonlinearity plays important role in plasma dynamics. A wave packet in which the wavefield is localized in a limited generally propagating spatial region and absent outside the region is called a soliton. The pioneer work of Zabusky and Kruskal [1] on the one-dimensional soliton solution of the Korteweg-de Vries (KdV) equation in plasma physics opened new vistas in the study of nonlinear phenomena in various branches of science. They named a solitary wave with the particle property as soliton. Solitary waves/Solitons form stable entities when effects on nonlinearity and dispersion are balanced. It maintains its shape while travelling at constant speed.

Two ion species having different masses, concentration, charge states and temperature [2-4] are very common in space and laboratory e. g. (Ar+,SF_6), (Ar+,F-), (H+,O_2-), and (H+,H-) plasma systems. Most recent investigations show that particles may not follow Maxwellian distribution due to the formation of space holes. Accordingly, in most space plasmas, particles follow non-Maxwellian distribution [5, 6]. It is worth noting that the electron trapping is observed not only in space plasma but also in laboratory experiments [7, 8]. Further, it had been found that electrons and ion distributions play crucial role in characterizing the physics of nonlinear investigations**.** Particle distribution offer a considerable increase in richness and variety of wave motion that can exist in plasma and further significantly influence the conditions required for the formation of these waves. In recent years, new statistical approach non-extensive statistics or Tsallis statistics [9] has attracted much attention. In Boltzmann-Gibbs statistics, equilibrium functions are Maxwell-Boltzmann ones. But such distribution functions do not describe all possible processes. In general, the Boltzmann-Gibbs formalism fails for systems with long range interactions, memory effects and systems where the relevant phase space has fractal or multifracal structure. For q=1, Maxwell distribution function is obtained where q is measure of non extensivity.

Tsallis extended the standard additivity of the entropies to the nonlinear, non-extensive case where one particular parameter, the entropic index q, characterizes the degree of non extensivity of the considered system (q=1 corresponds to the standard, extensive, BGS statistics). Recently, Tribeche et al [10] have provided a detailed investigation on the large amplitude solitary waves on Tsallis statistical mechanics.

We have investigated the small amplitude nonlinear ion-acoustic waves in a two component plasma system within the same distribution. The aim of the present investigation is to study how the non-extensive electron distributions influence solitary wave/solitons behavior.

2. BASIC EQUATIONS

Two component plasma i.e. $H^{+}O_2^{-}$ consisting of cold ions with non-extensively distributed electrons are considered. The nonlinear behaviour of the ion acoustic waves is described by the following set of normalized fluid equations (Basic Equations):

$$\frac{\partial n_1}{\partial t}+\frac{\partial (n_1 v_1)}{\partial x}=0 \qquad (1)$$

$$\frac{\partial v_1}{\partial t}+v_1\frac{\partial v_1}{\partial x}=-\frac{1}{\delta}\frac{\partial \phi}{\partial x} \qquad (2)$$

$$\frac{\partial n_2}{\partial t}+\frac{\partial (n_2 v_2)}{\partial x}=0 \qquad (3)$$

$$\frac{\partial v_2}{\partial t}+v_2\frac{\partial v_2}{\partial x}=\frac{\epsilon_z}{\delta\eta}\frac{\partial \phi}{\partial x} \qquad (4)$$

$$\frac{\partial^2 \phi}{\partial x^2}=n_e-\frac{n_1}{1-\alpha\epsilon_z}+\frac{\alpha\epsilon_z n_2}{1-\alpha\epsilon_z} \qquad (5)$$

Where $\delta=\frac{\eta+\alpha\varepsilon_z^2}{\eta(1-\alpha\varepsilon_z)}$, $\alpha=\frac{n_2^{(0)}}{n_1^{(0)}}$, $\varepsilon_z=\frac{Z_2}{Z_1}$, $\eta=\frac{m_2}{m_1}$ and ϵ = dispersion parameter. The number density of electron fluid, with non-extensive electrons is given by:-

$$n_e=[1+(q-1)\phi]^{\frac{q+1}{2(q-1)}} \qquad (6)$$

$$n_e=1+c_1\phi^1-c_2\phi^2+c_3\phi^3-\ldots \qquad (7)$$

Where $c_1=\frac{q+1}{2}$, $c_2=\frac{c_1(c_1-2)}{2}$, $c_3=c_2(c_1-\frac{4}{3})$

In the above equations n_1, v_1 and n_2, v_2 are the densities and fluid velocities of positive and negative ion species respectively. $n_1^{(0)}$, $n_2^{(0)}$ are the equilibrium densities of two ion components respectively. Further ϕ is the electrostatic potential, η is the mass ratio of the negative ion species to the positive ion species, α is the equilibrium density ratio of the negative ion to the positive ion species and ε_z is the charge multiplicity ratio of the negative ion to the positive ion species. In equations (1-6) velocities (v_1, v_2), potential (ϕ), time (t) and space co-ordinate (x) variables have been normalized with respect to the ion-acoustic speed C_s, thermal potential $\frac{k_B T_e}{e}$, inverse of ion plasma frequency ω_{pi}^{-1} and Debye length λ_D in the mixture respectively. Ion densities n_1 and n_2 are normalized with their corresponding equilibrium values i.e by unperturbed average number density n_0. In the mixture, the ion-acoustic speed C_s, the ion plasma frequency ω_{pi} and the Debye length λ_D are respectively given by:

$$C_S = \sqrt{\frac{T_e \delta Z_1}{m_1}}, \quad \omega_{pi} = \sqrt{\frac{4\pi n^{(0)} e^2 Z_1 \delta}{m_1}}, \quad \lambda_D = \sqrt{\frac{T_e}{4\pi n^{(0)} e^2}}$$

3. DERIVATION OF KDV EQUATION

To study small but finite amplitude ion-acoustic solitary waves in our multispecies plasma model, we construct a weakly nonlinear theory of the ion-acoustic waves which lead to scaling of the independent variables through the stretched coordinates (ξ) and (τ)

$$\xi = \epsilon^{1/2}[x - \lambda t], \quad \tau = \epsilon^{3/2} t$$

Where ε is a small parameter measuring the weakness of the dispersion and λ is the phase velocity of the wave. Using the above stretched co-ordinates and equations (1)-(6), to study the dynamics of ion–acoustic waves (IAWs), we employ the standard Reductive Perturbation Method (RPM) to get the KdV equation as:

$$\frac{\partial \phi^{(1)}}{\partial \tau} + A\phi^{(1)} \frac{\partial \phi^{(1)}}{\partial \xi} + B\frac{\partial^3 \phi^{(1)}}{\partial \xi^3} = 0 \tag{8}$$

Where $A = \frac{2Q}{P}$, $B = \frac{1}{P}$

Here P and Q are given by:

$$P = \frac{2}{\lambda^3}\,,\ Q = \frac{1-2\lambda^2}{2\lambda^4} + \frac{3}{2}\,\frac{(\eta-\alpha\varepsilon_z^3)}{n^2(1-\alpha\varepsilon_z)\delta^2}\,\frac{1}{\lambda^4}$$

Sagdeev Potential is given by:

$$V(\phi) = [\tfrac{1}{3}Q\phi^3 - \tfrac{1}{2}PU\phi^2] \qquad (9)$$

4. RESULTS AND DISCUSSIONS

From above equation we can see that the Sagdeev potential V (ϕ) depends on the parameter ϕ. Since the solution of equation is characterised by physical entity called solitons, we conclude that lowest order analysis in the reductive perturbation theory accounts for the aspect of nonlinearity giving rise to soliton mode. Soliton solution of KdV equation is given by:

$$\Phi = 3u\mathrm{Sech}^2[\sqrt{\tfrac{u}{2}}(\xi - u\tau\,)] \qquad (10)$$

For the sake of numerical computations we have Considered the three ranges ($-1<q<0$, $0<q<1$, $q>1$) of the non-extensive parameter q. The variation of peak amplitude as a function of Sagdeev potential V (ϕ) for different values of q is shown in figure. Here we have done numerical computation of V (ϕ) v/s ϕ for $H^+O_2^-$ plasma where we have taken the following parameters: $\eta=32$, $\alpha=0.1$, $z_1=z_2=1$.

Results are exhibited in the form of graphs as shown in Fig. 1. Only rarefactive solitons are obtained for all the values of non-extensive parameter q ranging q>1for which the peak amplitude increases with non extensivity.

For the range $0<q<1$, again rarefactive solitons are observed for which peak amplitude increases with q (behavior is similar to to that of q>1). This is clear from the Fig. 2, where the Sagdeev potential has been plotted as a function of ϕ for three different values of q.

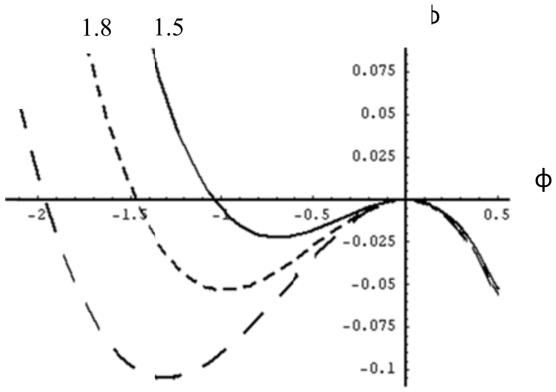


Figure 1: Variation of Sagdeev potential V (ϕ) with ϕ for different values of q with the set of parameters as: η=32, α=0.1, z_1=z_2=1 and three different values of q is 1.5, 1.8, 2.

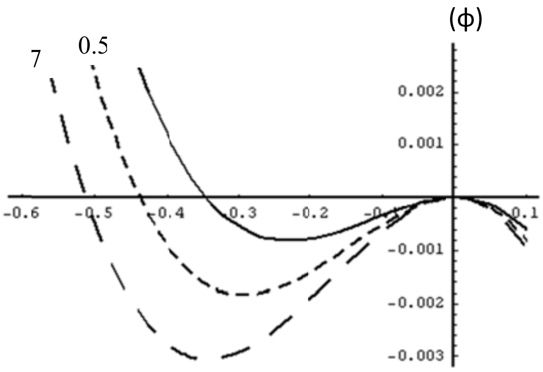


Figure 2: Variation of Sagdeev potential V (ϕ) with ϕ for different values of q with the set of parameters as: η=32, α=0.1, z_1=z_2=1 and three different values of q is 0.2, 0.5, 0.7

However an opposite trend has been observed for the range -1<q<0. For this range of q, a plot of V (ϕ) v/s ϕ has been given in Fig. 3 with other set of parameters as: η=32, α=0.1, z_1=z_2=1 similar to the earlier cases, rarefactive soliton are observed for which the peak amplitude was found to decrease with increase in non extensivity.

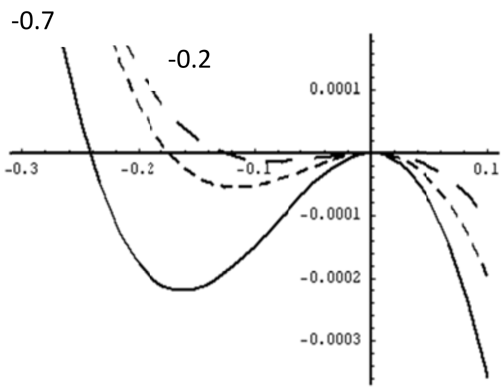


Figure 3: Variation of Sagdeev potential V (ϕ) with ϕ for different values of q with the set of parameters as: η=32, α=0.1, z_1=z_2=1 and three different values of q is -0.2, -0.5, -0.7

5. CONCLUSION

For $H^+O^-_2$ plasma system, only rarefactive solitons are observed for all the ranges of non extensive parameter q. So the non-extensive parameter q is an important parameter to describe the behaviour of soliton. The various graphs may be helpful for understanding ion-acoustic solitary waves occurring in space as well as in laboratory plasma where q-non-extensive electron distribution is observed.

REFERENCES

[1] N.J. Zabusky and M.D. Kruskal, Interactions of solitons in a collisionless plasma and the recurrence of initial states, *Phy.s Rev. Lett.* **15**:240-243 (1965).

[2] M.K. Mishra, R.S. Chhabra and S.R. Sharma, Obliquely propagating ion-acoustic solitons in a multi-component magnetized plasma with negative ions, *J. Plasma Phys.* **52**:409-429 (1994).

[3] R.C. Davidson, *Methods In Nonlinear Plasma Theory*. Academic Press New York and London, (pp 37 (1972).

[4] T.S.Gill, P. Bala, H. Kaur, N. S. Saini, S. Bansal, J. Kaur, Ion acoustic solitons and double layers in a plasma consisting of positive and negative ions with non-thermal electrons, *Eur. Phys. J. D.* **31**:91-100 (2004).

[5] A.A. Mamun, Rarefactive ion-acoustic electrostatic solitarystructures in nonthermal plasmas, *Eur. Phys. J. D.* **11**:143-147 (2000).

[6] A.A. Mamun, Effect of ion temperature on electrostatic solitary structures in non-thermal plasmas, *Phy. Rev. E* **55**:1852-1857 (1997).

[7] K. Saeki, P. Michelsen, H. L. Pecseli and J. J. Rasmussen, Formation and coalescence of electron solitary waves, *Phys. Rev. Lett.* **42**:501-504 (1979). [8] P. Guio, S. Borve, L.K.S. Daldorff, J. P. Lynov, P. Michelsen, H. L. Pecseli, J. J. Rasmussen, K. Saeki and J. Trulsen, Phase space vortices in collisionless plasmas, *Nonlin. Process. Geophys. Rev.* **10**:75-86 (2003).

[8] C Tsallis, Possible generalization of Boltzmann-Gibbs statistics, *J. Stat. Phys.* **52**:479–488 (1988).

[9] M. Tribeche, L. Djebarni and R. Amour, Ion-acoustic solitary waves in a plasma with a q-nonextensive electron velocity distribution, *Phys. Plasmas* **17**:042114 (2010).

Estimation of Moisture Content of Eucalyptus Wood Samples Using Gamma Attenuation Method

Gunjan Thukral and Rajeev Kumar
Department of Mathematics, Statistics & Physics,
Punjab Agricultural University, Ludhiana.
E-mail: rajeevsharma@pau.edu

Abstract: Gamma rays are highly penetrating in nature which can be studied by gamma ray transmission methods. When gamma rays are directed into an object, their energy can be absorbed or scattered and is called attenuation. The transmitted intensity depends mainly on the material's thickness. Wood is a hygroscopic material; it absorbs or releases water depending upon the climate conditions. In the present study, the variation between relative intensity and thickness of Eucalyptus samples at varying moisture levels has been determined along with the moisture contents in them. The moisture levels are varied by keeping the samples in fresh and oven dry conditions for different time intervals. The moisture contents of fifteen samples having thickness of 1 cm each are determined using gamma rays of ^{137}Cs radioactive source and NaI(Tl) scintillation detector. The relative transmission intensities are plotted against the samples thickness and found to be decrease with increase of sample thickness.

1. INTRODUCTION

Gamma radiations are electromagnetic radiations of extremely high frequency or these are the photons emitted as packets of energy, called quanta, which travel at the speed of light. These are highly penetrating in nature and thus are biologically very hazardous. These can be stopped by sufficiently thick layer of the material. In order for a gamma ray to be detected, it must interact with matter; that interaction must be recorded. The gamma radiation interaction with matter takes place by two ways i.e. primary interactions and secondary interactions which further result in a number of processes. Generally, when gamma rays are incident on a sheet of absorbing material, some of the radiation will be absorbed or scattered, which is called attenuation. For the irradiation effect to be thoroughly investigated, initially the determination of the absorption coefficient values is necessary.

Attenuation is the gradual loss in intensity of any kind of flux through a medium. It is an exponential function of the path length through the medium and is generally given by the Beer-Lambert law which says that when a gamma ray passes through matter, the probability for absorption is proportional to the thickness and the attenuation coefficient of the material. The total absorption shows an exponential decrease of intensity with distance from the incident surface:

$$I(x) = I_0 \cdot e^{-\mu x} \qquad (1)$$

where I_0 is the incident intensity of the beam, I is the intensity of the beam after passing through the thickness x(gm/cm^2) of the material, μ is the attenuation coefficient (measured in cm^{-1}).

Attenuation decreases the intensity of an electromagnetic radiation. Attenuation coefficient is a quantity that characterizes how easily a material or medium can be penetrated by a beam of light, sound, particles or other energy or matter. It describes the extent to which the intensity of an energy beam is reduced as it passes through a specific material. These coefficients are studied mainly in terms of linear and mass attenuation coefficients. The linear attenuation coefficient describes the fraction of a beam of gamma rays that is absorbed or scattered per unit thickness of the absorber and is determined from the Beer-Lambert law. The mass attenuation coefficient is a measurement of how strongly a chemical species or a substance absorbs or scatters light at a given wavelength, per unit mass. When this coefficient is to be determined from the Beer-Lambert law, then 'mass thickness' (defined as the mass per unit area) replaces the product of length times density.

Wood is a hard, fibrous structural tissue found in the stems and roots of trees and other woody plants. It is a hygroscopic material which means that it naturally absorbs or desorbs water to balance its moisture content with the surrounding environment. When a tree is felled and sawn into timber, the wood starts to dry and the amount of water contained in the wood depends on the external climate conditions. Moisture gradients in hygroscopic composite materials such as wood are known to affect the internal stresses that cause dimensional changes and eventual development of defects. Estimation of moisture contents in wood has been carried out by various workers using one of the following methods: oven drying including microwave oven drying, electrical resistance method, dielectric method, using a neutron moisture gauge, by nuclear magnetic resonance (NMR) and by measurement of e.m.f. developed in between rotating discs, Negi [1].

Radiation techniques were used to determine MC (moisture content) and density of wood and other materials, Loos [2]-[5]. The principle of these radiation techniques is that penetration of the radiation ray (gamma ray) into materials is dependent on gross density of the material. Most of the time moisture content is measured by the weight of water as percentage of the oven-dry weight of the wood fiber. Water by itself does not harm the wood, but rather, wood with consistently high moisture content enables fungal organisms to grow. The state of bound water in wood having moisture content up to 20% has been determined by the dielectric method in the temperature range 20 to 150^{o}C, Benkova and Ben'-Kova[6].

The mass attenuation coefficients of fifteen Eucalyptus wood samples (thickness 1 cm each) have been determined using the method of gamma ray spectroscopy with the help of a scintillation detector and then the variation of relative intensities with the thickness of the samples has been seen. The moisture content of the samples has been varied by placing them in an electric oven for different intervals of time.

2. MATERIALS AND METHODS

2.1 Wood or Timber

In early days wood or timber was mostly used for construction of shelters/homes. It has a lot of advantages in various fields e.g. it is much stronger than concrete and almost strong as iron, it is better than iron, cement and concrete in thermal insulation, electrical resistance and sound absorption, it is widely used in earthquake prone areas etc.

Different quantities of water are present in all woods irrespective of their condition. This is because wood is a hygroscopic substance. The water present in wood has an important effect on its different properties and variations in this amount causes swelling, shrinkage, alterations in different strength properties of wood, changes in electrical resistance, dielectric and thermal properties etc.

Eucalyptus has been chosen to study its moisture content and mass attenuation coefficient for the present study because of its high moisture absorbing characteristics.

2.2 Moisture Content

Moisture content is the amount of water contained in the wood. It is usually expressed as a percentage of its oven dry weight. The latter denotes the standard condition of dryness of the wood. It is a more or less constant weight of wood that is oven dried between 100-105^{0}C. In the oven-dry condition, all water is removed from the wood, except for the very small quantities which cannot be removed except by further drying to a level where the wood may become thermally degraded due to very high temperatures. In this way, the moisture content (MC) of wood is expressed in percentage with reference to its oven dry weight as-

$$MC = \frac{\text{W}et\text{ weight} - \text{Oven dry weight}}{\text{Oven dry weight}} \times 100$$

Or, in terms of density, moisture content can be determined from the relation:

$$m = \frac{\rho_m - \rho_0}{\rho_0} \times 100$$

where ρ_o is the oven dried density and ρ_m is the density with MC m.

2.3 Interaction of radiation with matter

Interaction of photons with matter gained interest due to their greater penetrating power than the charged particles. The photon attenuation coefficients are needed in solving many problems in radiation and health physics. The attenuation coefficient is a measure of the average no. of interactions between incident photon and matter that occur in a given mass per unit area thickness of the material encountered. The decrease in the intensity of the gamma rays coming from the radioactive source ^{137}Cs due to attenuation is exponential in nature and can be expressed as the Beer-Lambert law given in eq. (1).

Transmission studies of gamma ray photons of energy 662KeV through different wood samples were carried out using a gamma ray spectrometer.

For this a gamma ray source of suitable energy, half life and strength is chosen i.e. ^{137}Cs which has a half life of 30 years and emits gamma ray photons of energy 662KeV.

2.4 Gamma ray spectrometer

Few materials have good properties for detectors. Thallium-activated sodium iodide [NaI(Tl)] and cesium iodide [CsI(Tl)] crystals are commonly used, as well as a wide variety of plastics. CsI(Tl) and plastics have much faster light decay times than NaI(Tl) and are primarily used for timing applications. The high Z of iodine in NaI(Tl) crystals result in high efficiency for gamma-ray detection. Resolution for a 3-inch diameter by 3-inch length crystal is typically about 7% for ^{137}Cs. Besides efficiency, Cs source has many more applications in various fields where it is used, like for cancer treatment, measure and control of flow of liquids in numerous industrial processes, investigate subterranean strata in oil wells, measure soil density at construction sites, ensure the proper fill level for packages of food, drugs and other products because of which its use is preferred over the other available sources.

2.5 Methodology

The wood absorbers were placed close to the detector and gamma ray photon beam was collimated by using lead bricks. The centres of the source, collimator, wooden block and the scintillation head were aligned. The source, absorber and detector geometry was kept the same throughout the experiment resulting in non-varying scattering and air absorption effects. Fifteen Eucalyptus wood samples were used in the present study having thickness of 1 cm each and length and breadth of 8 cms.

Before starting with photon attenuation studies, each block of wood was completely dipped in water for 3-4 days i.e. till its weight stopped increasing. Single channel analyser of the gamma ray spectrometer was set to accept 662KeV photo peak of ^{137}Cs. Zero absorber is correspondent to only air in between the source and detector. Wood absorbers of thickness 1 cm each were placed close to the detector by increasing them in number one by one and counts were recorded for 30 seconds at each absorber thickness, sufficient number of sets were taken such that the statistical error was considered to be below 1%. At oven dry weight and completely wet stages of the absorbers the experiment of gamma ray spectroscopy was performed to determine their relative intensities.

3. RESULTS AND DISCUSSION

The data of relative intensity versus thickness of the wood absorbers were analysed by fitting the data corresponding to linear portion of experimental transmission curve using the equation:

$$Y=ab^x$$

Where Y is the transmitted intensity and x is the absorber thickness (gm/cm^2); a and b are the constants of least square fit. The mass attenuation coefficient is then determined from the slope of measured transmission curve and is given by

$$\mu= - \ln(b)$$

The measured values of mass attenuation coefficients (cm^2/gm) and their moisture levels are given in the table 1.

Table 1. Mass attenuation coefficients and moisture levels of wood samples

Sr. No.	State	Mass attenuation coefficient
1.	Completely wet (106.3%)	0.01847
2.	85.81%	0.02193
3.	70.44%	0.02359
4.	55.64%	0.02529
5.	45.21%	0.02641
6.	34.35%	0.02799

In the present study, taking wood as one component (a composite material) and water as the other, we have tried to study the mass attenuation coefficient of wood at different moisture levels. The parameter which is mainly responsible for the absorption of gamma rays in, materials is the effective atomic number. Effective atomic number of water is 3.33 (according to weighted fraction method) and composition of wood is complex, Bradley [7]. With the increase in the moisture level in wood its effective atomic number as compared to dry wood will go down. We know photon attenuation is directly proportional to the effective atomic number. With decreased effective atomic number, the number of electrons available per unit thickness for photon interaction will decrease. As such transmission of photons through moist wood will increase and attenuation will decrease. Thus the value of mass attenuation coefficient is expected to decrease with the increase in moisture level. The graph of Eucalyptus wood samples at six various moisture levels of our study shows the similar trend, which is shown in Fig. 1.

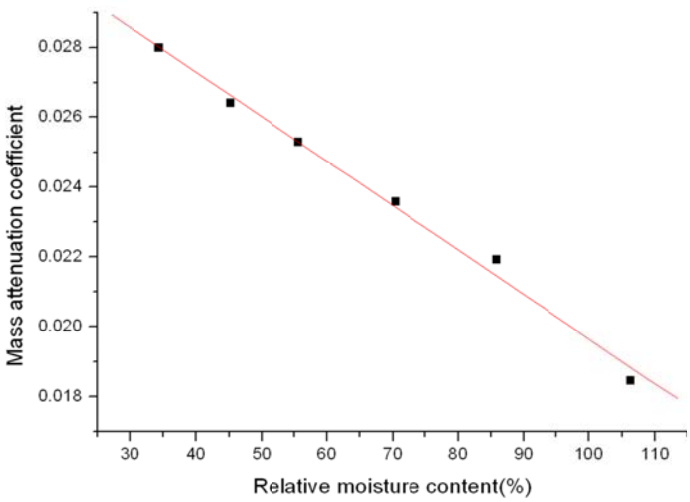


Figure 1. Plot of mass attenuation coefficient (μ) versus relative moisture content for Eucalyptus wood samples. Solid line is the least square fit to measured values of mass attenuation coefficients at different moisture levels.

4. CONCLUSIONS

From the absorption studies of gamma photons of 662KeV energy from ^{137}Cs in Eucalyptus wood samples at different moisture levels, we have made the following conclusions:

1. Transmission of gamma photons in wood samples is exponential in nature.
2. Values of mass attenuation coefficient at varying moisture levels lie in between that of oven dry and completely wet samples. The curve of mass attenuation coefficient versus relative moisture content shows a linear trend.
3. The mass attenuation coefficient is found to decrease with increase in the moisture content, which agrees really well with the theoretical expectations.

References

[1] Negi S S *Wood Science and Technology*, pp 1-106 International Book Distributers, Dehradun, India, 1997.

[2] Loos, W.E. "The relationship between gamma-ray absorption and wood moisture content and density." *Forest Prod. J.*. **11(3)**, 145-149 (1961).

[3] Loos, W.E. "A review of methods for determining moisture content and density of wood by nuclear radiation techniques."*Forest Prod. J.*. **15(3)**, 102-106 (1965).

[4] Gardner, W.H., G.S. Campbell, and C. Callissendorf "Systematic and Random errors in dual gamma energy soil bulk density and water content measurements." *Soil Sci. Soc. Of Am. Proc.*. **36**, 393-398 (1972).

[5] Spolek, G.A. and O.A. Plumb "Capillary pressure in softwoods." *Wood Sci. and Tech.*.**15**, 189-199 (1981).

[6] Benkova. V.E and Ben'-Kova-V.A "The phase state and structural peculiarities of bound water in wood by dielectric data" *IAWA Bulletin,* **11**, 2-117 (1990).

[7] Bradley D.A., Tajuddin A.A, Chewan S and Sabar B. "Photon attenuation studies on tropical hard woods." *Appl Radiat Isot* **42**, 771-73 (1991)

Effect of Magnetic Field on pH of Distilled Water

Kamalpreet Kaur, P.S. Tarsikka and Naresh Sharma
Department of Mathematics, Statistics & Physics,
Punjab Agricultural University, Ludhiana.
E-mail: kamalpreetajnuha@gmail.com

Abstract: The water passes through magnetic field is known as magnetized water. In this work the effect of magnetic field strength on the pH of distilled water was investigated. During the experiment different strengths of magnetic fields from 0.1 T to 0.3 T applied to distilled water and changes in pH of distilled water before and after the application of magnetic field were compared. Measurements were also made on the retention in pH values of distilled water after removal of magnetic field strength. Data collected during the experiment indicated that pH of distilled water increases by magnetic treatment.

1. INTRODUCTION

Water and life are closely linked. Liquid water is required for life to start and for life to continue. Water presence is the fundamental for all life on the planet, because it is nutrient source where chemical reactions happen. According to medical and health sciences there is virtually no function or reaction inside human body that can take place without the presence of water. The water helps the body absorb and assimilate nutrients into the blood stream and internal organs. Water boosts mental performance. As little as 2% dehydration can lead to significant short-term memory loss. The proper hydration helps the body resist the formation of kidney stones, urinary infections and constipation. Water also accelerates the excretion of toxins and wastes from the body. Water is an unusual substance, mostly due to its 3D network of hydrogen bond in the molecule. Its properties allow it to act as a solvent, reactant, a molecule with cohesive properties and as a temperature stabilizer [1]. The water treated by the magnetic field or passes through a magnetic device is called magnetized water [2].The influence of magnetic field on water is to change the dimensions of the clusters, which affects the physical properties of water [3]. When water is exposed to a magnetic field and changes in properties including optics, electromagnetism, thermodynamics and mechanics, for example the changes in the dielectric constant, viscosity, surface tension force, the solidifying and boiling point and electric conductivity, compared with those of pure water [4]. Thus the magnetized water has extensive applications in industry, agriculture and medicine, for instance it may aid digestion and is helpful for eliminating dirt in industrial boilers [5, 6, 7].

The changes with occur in the structure of liquid water under the effect of external magnetic field are important in various applications e.g. water treatment, biological processes and biotechnology. [8] studied the effects of the magnetic field on the hydrogen-bonded structure of water and found that the number of hydrogen bonds increased by 0.34% when the magnetic field strength increased from 1 to 10 T. It is found that the size of a water cluster can be controlled by the application of an external magnetic field. The structure of water is analyzed by calculating the radial distribution function of the water molecules. He concluded that the structure of the water is more stable and the ability of the water molecules to form hydrogen bonds is enhanced when a magnetic field applied, in addition the behaviour of water molecule changes under the influence of the magnetic field. For example the self-diffusion coefficient of the water molecules decreases. The author proposed that the melting point of water increased under magnetic field of 6 T and the reduced entropy of the water. The viscosity of the pure water under the transverse magnetic field of 10 T is less than 10^{-4}.

The plants which were irrigated with magnetic water exhibited a remarkable increase in vegetative growth and biochemical constitutions. Further the results indicated that the number of protein bands got increased in plants treated with magnetized water when compared to untreated control plants. The reason of this effect can be searched in the presence of paramagnetic properties in chloroplast which can cause an acceleration of seeds metabolism [9].

Some of the most beneficial claimed water applications from magnetically treated. The two major benefits of magnetic water treatment (MWT) are scale reduction and improved crop yields with less water. It is found that water bacterial content decreased by 85 and 98.8 % respectively after treatment with chlorine and ozone. Using ozone has some disadvantages found out like the short life-time of its effect and needing powerful treatment for removing high concentration of organic substances and algae. Thus a new biological technique using magnetic field to purify the water is found out [10].

It is also proposed by some researchers that magnetic water is beneficial for kidney ailments, gout, obesity, asthma, fevers, colds, coughs, sore throats and premature aging. [11] Noticed that water can receive signals produced from magnetic forces that have a direct effect on living cells and their vital action. Magnetic water promotes healing of wounds and burns [12].

Passing water through a magnetic field has been claimed to improve chemical, physical and bacteriological quality of water in many different applications. Although the treatment process has been used for decades, it still remains in the realms of pseudoscience. If the claims of treating water with magnets are true, the process offers improvements on many of our applications of water in today's world.

2. MATERIALS AND METHODS

In order to calibrate the variable gap electromagnet, a digital gauss meter is used to note the magnetic field strength at the mid-point between two electromagnets has been measured and results are shown in Table 1 and Fig. 1. Fig. 1 shows the relationship between magnetic field strength against distance. It is seen from the table and figures that when the distance between two electromagnets increases magnetic field strength gradually decreases.

When the distance between two electromagnets is kept constant at 1cm and gradually increase the current has been investigate the relationship between magnetic field strength and the current. We can see from the Table 2 and Fig. 2 that once the current increases magnetic field strength also gradually increases. The Fig. 2 shows the relationship between magnetic field strength against current. The water used in this study was distilled water. The stationary magnetic field strength was generated by adjustable permanent magnets (EM-20). It consist of two pole pieces made from especially annealed soft iron with dimensions, diameter 9.0 cm and length 27.5 cm each. It could produce magnetic field of strength up to 22,000 Gauss at 10 mm gap between two pole pieces. A direct current was supplied to the magnetic coils from a regulated power supply.

Table 1. Magnetic field strength between electromagnet for different distances

Distance (cm)	Magnetic field Strength (T)
1	0.120
2	0.088
3	0.068
4	0.057
5	0.042

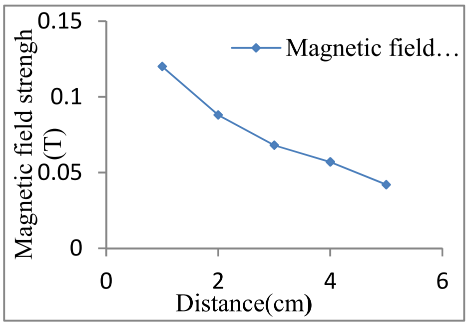


Figure 1. Magnetic field strength for constant current (1A)

Table 2. Magnetic field strength between two electromagnets for different currents at distance of 1cm

Current (A)	Magnetic field strength (T)
1	0.120
2	0.163
3	0.203
4	0.242
5	0.275
6	0.305
7	0.331
8	0.345

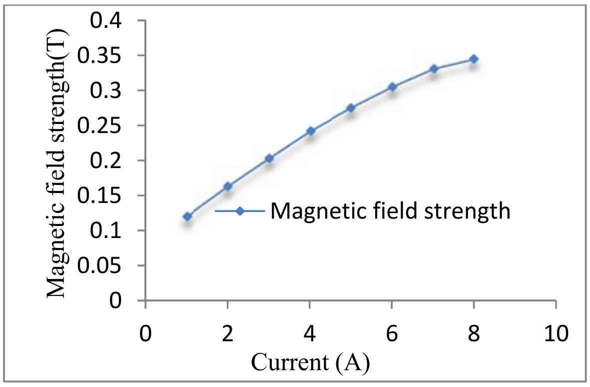


Figure 2. Magnetic field strength for constant distance 1 cm

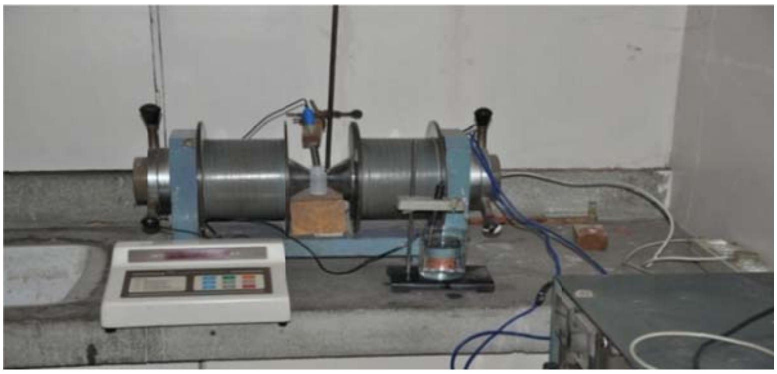


Figure 3. Experimental setup of electromagnets for measurement of pH of distilled water

The magnetic field strength was measured with the hall probe of digital Gauss meter Model DGM-102, supplied by m/s Scientific Equipment, Rookie. pH was determined using a Systronics microprocessor based pH meter Model 361, supplied by M/S Systronics Scientific Electronic Instruments, Naroda, Ahmedabad. It was standardized before use, with the standard Buffer solutions (Buffer 4, 7 and 9). Standardisation of pH meter was done prior to the measurements. For measurement of pH, a beaker containing distilled water was inserted in poles of electromagnets. The difference between the poles of electromagnets was 2.2 cm. The experimental setup for measurement of pH of distilled water is shown in Fig. 3. The pH probe of pH meter were dipped into the sample in such a way that the bulb of pH meter were completely immersed into the sample contained in beaker, at the same depth without touching the bottom and walls of beaker. Thus the pH of distilled water and retention in pH value of distilled water at different magnetic field strengths was determined at different interval of time and observes the results before and after use of application of different magnetic field strengths. Statistical analysis was performed using the tukey's test.

3. RESULTS AND DISCUSSION

Effect of Magnetic Field on pH of Distilled water

For the better growth of crops or to get yield at large scale, pH is one of the most important parameter. Normally for the better growth of crops, pH of soil should be of basic character. The pH parameter is used to find out the whether the water is acidic or basic. The graph shows the experimentally observed values of pH at different magnetic field strengths ranging from 0.1 T to 0.3 T. The maximum and minimum value of pH of distilled water after magnetic treatment reached to 6.53 and 6.89 at 0.1 T and 0.3 T respectively that are shown in Fig. 4.

After the magnetic treatment pH of distilled water increases. It is shown in Fig. 4 that pH of distilled water increases with increase in different magnetic field strengths. The pH of water generally related with number of H^+ ions in water. The changes in the pH of water is due to the magnetization's possible reason for this may be change in the ionization constant of water under the influence of magnetic field resulting in decrease in the concentration of H_3O^+ ions [13]. The effect of magnetic field strength on pH of distilled water was observed that was shown in Fig. 4 indicates, the increase in the pH values of distilled water after magnetic treatment and retention in pH values of distilled water i.e. after removal of magnetic field strength the pH values of magnetized distilled water comes to its original value.

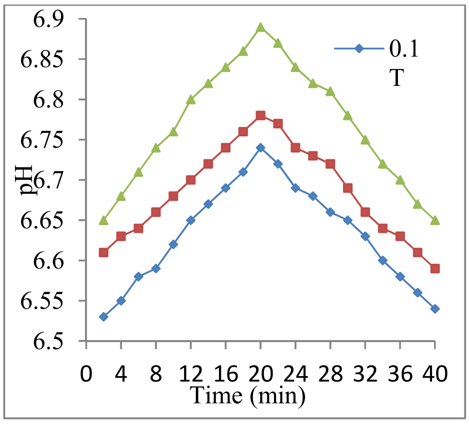


Figure 4. Change in pH of distilled water at different magnetic field strengths

The pH of magnetized distilled water under influence of magnetic field strength very slowly increases with time. In both the cases the pH of distilled water increases with increase in magnetic strengths and also increases with increase in time.

The trend of pH of distilled water under the influence of three different magnetic field strengths was revealed by the Fig. 4.The maximum increase in pH of magnetized distilled water was 6.89 at 0.3 T. The results were found to be significant with Tukey analysis.

4. CONCLUSIONS

The pH changes with magnetic field strength. It was found to vary linearly with increase of both the time as well as magnetic field strength. It rose for all possible combinations of three different magnetic field strengths (0.1 T, 0.2 T, and 0.3 T). The change in pH values obtained from the experiment was in the range of 6.53 and 6.89 where the magnetic field strength ranges from 0.1T to 0.3T. Magnetic field strengths affects pH, but the pH of magnetized distilled water under influence of magnetic field strength very slowly increases with time.

References

[1] Pang X F and Deng B (2008) Investigations of changes in properties of water under the action of a magnetic field. *Sci China Ser G-Phys Mech Astron* 51: 1621-32.

[2] Qados A M S A and Hozayn M (2010) Response of growth, yield, yield component and some chemical constituents of flax for irrigation with magnetized and tap water. *J World Appl Sci* 8:630-34.

[3] Barnov A N, Kiselev V F, Rozanov V V and Soletskii A M (1995) Biophysical properties of magnetized distilled water. *J Aviakosm Ekolog Med* 29:45.

[4] Amiri M C and Dadkhah A A (2006) On reduction in the surface tension of water due to magnetic treatment. *J Colloids Surface A* 278:252-55.

[5] Higashitani K, Okuhara K, Hatade S (1992) Effects of magnetic field on stability of nonmagnetic colloidal particles. *J Colloid interf Sci* 152: 125－31.

[6] Zhu Y B, Yan L S, Cai Z X (1999) Physical and chemical functions of magnetized water. *J Hunan Univ* 26:21-26.

[7] Coey J M D, Cass S (2000) Magnetic water treatment. *J Magn. Magn. Mater* 209: 71-74.

[8] Chang K T and Weng C I (2006) The effect of an external magnetic field on the structure of liquid water using molecular molecular dynamics simulation. *J Appl Phys* 100:0439171-76.

[9] Hozayn M, Abdel-Monem A A and Qados A M S A (2011) Irrigation with magnetized water a novel tool for improving crop production in Egypt. Fifteenth International Water Technology Conference, IWTC-15 (2011) Alexandria, Egypt.

[10] Nieminskie C and Bradford S M (1991) Impact of ozone treatment on selected microbiological parameters. *Ozone Sci Eng Ozseds* 13(2):127-45.

[11] Smirnov J V (2003) The effect of a specially modified electromagnetic field on the molecular structure of liquid water. *Global Quantec Inc* 2: 122-25.

[12] Lake R (1995) Magnetized water is no mystery. *Alive* 148:12-14.

[13] Joshi K M and Kamat P V (1966) The effect of magnetic fields on the pH of water. *J Indian Chem Soc* 43:620.

Ohmic Heating of Mango Juice: Electrical Conductivity and Viscosity

Kanupriya Dawar and P.S.Tarsikka
Department of Mathematics, Statistics & Physics,
Punjab Agricultural University, Ludhiana.
E-mail: kamalpreetajnuha@gmail.com

Abstract: Ohmic heating is a food processing technique. Mango juices having 90% and 80% soluble solids were heated ohmically at two voltage gradients (27 & 22V/cm). Measurements were made from 20-80°C. Electrical conductivity has linear dependence with temperature. Their values were in the range of 6-15 S/cm. Effect of voltage gradient on viscosity was observed.

1. INTRODUCTION

Conventional heating is the common method in the heating of foodstuffs. It consists of heat-transfer mechanisms of conduction, convection and radiation. Classic convective methods for heating process fluids, using plate heat exchangers, are still the most popular methods in the food industry .The internal resistance by conduction results in very heterogeneous treatment and degradation in product quality [1, 2].

Ohmic heating is a highly attractive technique for food processing. It is based on the passage of an alternating electrical current through a food product, which serves as an electrical resistance [3, 4]. Heat is generated instantly inside the food. The amount of heat generated is directly related to the current induced by the voltage gradient in the field and to the electrical conductivity [5, 6]. Ohmic heating is an alternative heating system for pumpable foods. It was first intended to be applied in liquid food processing and later in solid-liquid food mixtures [7, 8].

Ohmic heating yields better products, clearly superior in quality than those processed by conventional heating [9-11]. Its advantages compared to conventional heating also include the more uniform and faster heating, higher yield and higher retention of nutritional value of food [12-15]. This is mainly due to its ability to heat materials rapidly and uniformly leading to a less aggressive thermal treatment.

Data on electrical properties of the liquid foods are especially important in their ohmic processing as a whole product or fluid medium. Several studies were performed on the ohmic heating rates and on the temperature-dependent electrical conductivities of foods. However data on the effects of concentration on electrical conductivity values of liquid foods are limited.

The aim of this study was to give detailed electrical conductivity data for concentrated mango juices to be heated ohmically in the food industry. Effects of concentration based on total soluble solids and applied voltage gradients on ohmic heating rates of mango juice concentrates were studied.

2. MATERIAL AND METHODS

2.1 Experimental set up

Ohmic heating experiments were conducted at a laboratory scale. Ohmic heating system consisting of a power supply and isolating variable transformer. The cell employed was constructed from PVC cylinder of inner diameter 3.5cm and outer diameter 3.7cm. Two stainless steel electrodes were kept at a distance of 10cm resulting in a total sample volume of 94.6ml. The ohmic heating system is shown in figure 1.Temperature was measured with a K-type thermocouple. Uniformity in temperature was checked during the experiment by measuring the temperatures at different locations in the test cell. An Ostwald viscometer was used for the measurement of viscosity.

2.2 Methodology

The mango juices having different concentrations of soluble solids (90 & 80%) were prepared from the concentrate and these were used to investigate the effect of soluble solid concentration on the electrical conductivity and the ohmic heating rates of the juices. For this two voltage gradients (27 & 22 V/cm) were applied for each concentration of the juice. The samples were poured through the thermocouple port; the electronic temperature sensors were inserted and fitted. After the system was sealed, the sample was ohmically heated up to a temperature of 70^0C at 50 Hz frequency, using different voltages to obtain different voltage gradients. Current and temperature data were logged at 5s time interval during heating. Electrical conductivity of samples was calculated from voltage and current data using the following equation:

$$\sigma = \frac{LI}{VA}$$

The time–temperature data were plotted to obtain the ohmic heating curves for mango juice concentrates.

Figure 1. Pictorial representation of ohmic heating system

Electrical conductivity was plotted against the corresponding temperature to obtain the electrical conductivity curves.

3. RESULTS AND DISCUSSIONS

The ohmic heating system developed in the study used effectively to measure electrical conductivity of mango juice. Electrical conductivity values of the juice concentrates were calculated by using the recorded voltage–ampere data during ohmic heating. It was found that the electrical conductivity of the orange juice changes with temperature, the voltage gradient applied and the concentration of the juice. The relationships between temperature and the electrical conductivity for each concentration and voltage gradient applied were linear.

The changes in electrical conductivity of mango juice with temperature during ohmic heating at different concentrations are given in Fig. 2**.** For the same concentration, as the voltage gradient increased, the electrical conductivity values increased at a given temperature. Electrical conductivity increased linearly with temperature, consistent with literature data [4, 16, 17, 18].

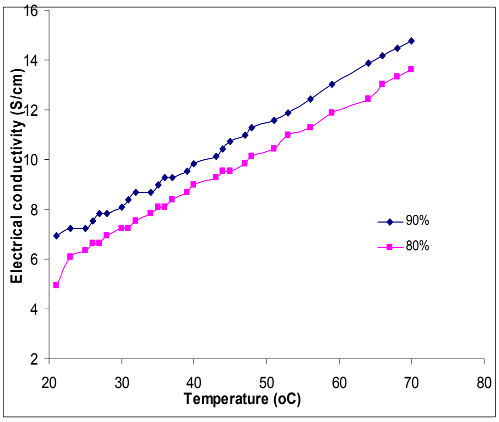


Figure 2. Electrical conductivity curves of mango juice having two different concentrations at 27V/cm.

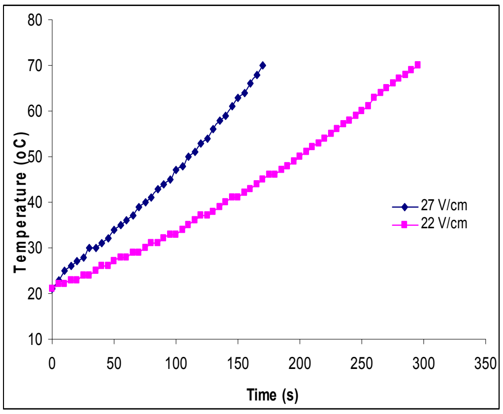


Figure 3. Ohmic heating curves of 90% concentration at different voltage gradient.

Bubbling was observed after 70°C. It was observed that electrical conductivities decreased with temperature rise after bubbling started and the heating was stopped. An increase in the electrical conductivity values with temperature has been explained by reduced drag of the movement of ions [4]. As the voltage gradient increased, time to reach the prescribed temperature decreased as shown in Fig. 3.With the increase in temperature, the current flowing through the sample also increases. The heating time decreased when the voltage gradient was increased [15, 19, 20].

The heating times decreased as a result of higher heating rates, resulting from the higher voltage gradients applied (27 V/cm) at 90 % soluble solids concentration. The same trend was observed at 80% soluble solids concentration. There was no appreciable change in viscosity after ohmic heating at higher voltage gradient.

The heating rate of fluid and particles was found to increase with increasing fluid viscosity [21, 22].

4. CONCLUSIONS

Mango juice was heated on a laboratory scale ohmic heater by applying (27 & 22V/cm) voltage gradient at different concentration (90 & 80 %). The values of electrical conductivity were in the range of 6-15 S/cm. Electrical conductivity of mango juice changes with temperature, voltage gradient applied and concentration during ohmic heating. Electrical conductivity of the solution increases linearly with the increase of concentration as well as temperature. Juice was heated in the range of 20-70° C. bubbling was observed above 70°C. Ohmic heating times are dependent on the voltage gradient used. Heating time increases with the decrease in applied voltage. The rate of change of temperature for 27 V/cm was higher than 22V/cm. No prominent change was observed in the viscosity of mango juice at higher voltage gradient when heated ohmically. Ohmic heating rate of highly viscous liquid was more.

References

[1] I. O. Alibas, B. Akbudak and N. Akbudak , Microwave drying characteristics of spinach, *J Food Eng*. **78**:577-583 (2007).

[2] Z. H. Duan, Li-na Jiang, J. I. Wang , X. Y. Yu and T. Wang , Drying and quality characteristics of tilapia fish fillets dried with hot air-microwave heating,, *Food bioprod process* **89**:472-476 (2011).

[3] A. M. Assiry, M. H. Galiy, M. Alsamee, and A. Sanfudin, Electrical conductivity of seawater during ohmic heating *Desalination* **260**:9-17 (2010).

[4] F. Icier and C. Ilicali , The effects of concentration on electrical conductivity of orange juice concentrate during ohmic heating, *Eur Food Res Technol* **220**: 406-414 (2005).

[5] N. Shirsat, J. G. Lyng , N. P. Brunton and B. McKenna, Ohmic processing: Electrical conductivities of pork cuts, *Meat Sci* **67**:507-14 (2004).

[6] S. Sarang, S.K. Sastry, K. Lynn, Electrical conductivity of fruits and meats during ohmic heating. *J Food Eng*, **87**: 351-356 (2008).

[7] B. P. Lamsal, Investigation of the factor affecting the electrical conductivity of selected fruit juices during ohmic heating, Thesis. Thailand: Asian Institute of Technology, AFE-94-13 (1994).

[8] R. Stéphanie, C. Mathilde, P. P. Laëtitia , P. Jean-Pierre, Design of an ohmic reactor to study the kinetics of thermal reactions in liquid products. *J Food Eng*, **98**: 398-407 (2001).

[9] F. Icier and H. Bozkurt, Ohmic heating of liquid whole egg rheological behavior and fluid dynamics, *Food Bioprocess Tech* **4**:1253-1263 (2011).

[10] H. Allai, L Marchal and E. Vorobiev, Blanching of strawberries by ohmic heating effects on the kinetics of mass transfer during osmotic dehydration, *Food Bioprocess Technol* **3**: 406-414 (2008).

[11] C. Chen, K. Abdelrahim and I. Beckerich, Sensitivity analysis of continuous ohmic heating process for multiphase foods, *J Food Eng* **98**: 257-265 (2010).

[12] J. Stancl and R. Zitny, Milk fouling at direct ohmic heating, *J Food Eng* **99**: 437-444 (2010).

[13] V. B. Vikram, M. N. Ramesh and S. G. Prapulla, Thermal degradation kinetics of nutrients in orange juice heated by electromagnetic and conventional methods. *J Food Eng,* **69**: 31–40 (2005).

[14] H. Nolsoe and I. Undeland, The acid and alkaline solubilisation process for the isolation of muscle proteins: state of the art, *Food Bioprocess Technol* **2**: 1-27 (2009).

[15] F. Marra, M. Zell, J. G. Lyng, D.J. Morgan, D. A. Cronin, Analysis of heat transfer during ohmic processing of a solid food, *J Food Eng*, **91:** 56–63 (2009).

[16] H. Darvishi, A. Hosainpour, F Nargesi, M. H. Khoshtaghza and H. Torang, Ohmic processing temperature dependent electrical conductivities of lemon juice, *Mod Appl Sci* **5**: 210-216 (2011).

[17] M. Amiali, M. O. Ngadi, V. G. S. Raghavan and D. H. Nguyen, Electrical conductivities of liquid egg product and fruit juices exposed to high pulsed electric fields, *Int j Food Prop* **9**:533-540 (2006).

[18] I. Castro, J. A. Teixeira, S. Salengke , S. K. Sastry, A. A. Vicente, *J Food Process Eng* **26**:17–30 (2003).

[19] K. Halden, A. A. P. De Alwis, P. J. Fryer, Changes in the electrical conductivity of foods during ohmic heating,, *Int J Food Sci Technol* **25**: 9-25 (1990).

[20] M. R. Zareifard, H. S. Ramaswamy, M. Trigui, M. Marcotte. Ohmic heating behavior and electrical conductivity of two-phase food systems. *Innovat Food Sci Emerg Technol,* **4**: 45-55 (2003).

[21] W. G. Khalaf and S. K. Sastry, Effect of fluid viscosity on the ohmic heating rate of solid-liquid mixtures, *J Food Eng* **27**: 145-158 (1996).

[22] Z. S. Liu and S. K. C. Chang, Soymilk viscosity as influenced by heating methods and soybean varieties, *J Food Process Preserve* **31**: 320-333 (2007).

Reviews and Posters

Nanotrees and its Applications

Radadiya Riddhi [1], Ghoda Kruti[1] and Radadiya Rashmi [2]
[1]Saurashtra University, Rajkot, [2]Christ College, Saurashtra University, Rajkot
E-mail: riddhi772@gmail.com, ghodakruti007@ymail.com, rashmiradadiya1@gmail.com

Abstract: Nanotechnology is gaining importance rapidly as a most powerful technology. Nanotechnology offers the potential to overcome various serious problems facing mankind over serious decades in many fields. Nanotechnology can address the shortage of fossils fuels such as diesel and gasoline like in the form of *Nanotrees*.

A team of electrical engineers at the University of California are building a forest of tiny nanowire trees in order to cleanly capture solar energy without using fossil fuels and harvest it for hydrogen fuel generation. Hydrogen is considered to be a cleaner fuel compared to fossil fuels because there is no carbon emission, but the hydrogen currently used is not generated cleanly, by harvesting more sun light using the vertical nanotree structure, the team has developed a way to produce more hydrogen fuel efficiently compared to its planar counterparts. Various risks involved in using nanotechnology are also discussed because it is believed that the most disruptive future changes may occur as a result of molecular manufacturing, an advanced form of nanotechnology.

1. INTRODUCTION

Nanotechnology is gaining importance rapidly as a most powerful technology. Nanotechnology offers the potential to overcome various serious problems facing mankind over serious decades in many fields. Nanotechnology can address the shortage of fossils fuels such as diesel and gasoline like in the form of *Nanotrees.*

1.1 What Are Nanotrees?

Nanotrees are made for nanowires which are made from abundant natural materials like silicon and zinc oxide. The trees vertical structure and branches are keys to capturing the maximum amount of solar energy. That's because the vertical structure of trees grabs and adsorbs light while flat surfaces simply reflect it. Adding that it is also similar to retinal photoreceptor cells in the human eye. In images of Earth from space, light reflects off of flat surfaces such as the ocean or deserts, while forests appear darker.

2. WHY NANOTREES?

University of California, San Diego electrical engineers are building a forest of tiny nanowire trees in order to cleanly capture solar energy without using fossil fuels and harvest it for hydrogen fuel generation. Hydrogen fuel is considered a clean fuel because it doesn't generate carbon emissions. However, the conventional method of producing hydrogen gas relies on energy from fossil fuels to separate the atoms from other molecules like water.

By harvesting more sun light using the vertical nanotree structure, there a way to produce more hydrogen fuel efficiently compared to planar counterparts. The vertical branch structure also maximizes hydrogen gas output, said Sun. For example, on the flat wide surface of a pot of boiling water, bubbles must become large to come to the surface. In the nanotree structure, very small gas bubbles of hydrogen can be extracted much faster. “Moreover, with this structure, it is enhanced, by at least 400,000 times, the surface area for chemical reactions”. In the long run, it is aimed for even bigger: artificial photosynthesis. In photosynthesis, as plants absorb sunlight they also collect carbon dioxide (CO2) and water from the atmosphere to create carbohydrates to fuel their own growth. Scientists hope to mimic this process to also capture CO2 from the atmosphere, reducing carbon emissions, and convert it into hydrocarbon fuel.

3. PROCESS OF MAKING NANOTREES

This structure uses a process called photo electrochemical water-splitting to produce hydrogen gas. Water splitting refers to the process of separating water into oxygen and hydrogen in order to extract hydrogen gas to be used as fuel. This process uses clean energy with no green-house gas by product. By comparison, the current conventional way of producing hydrogen relies on electricity from fossil fuels.

The scientists took more than one million nanotrees to form a square centimeter-sized photo electrochemical cell. From here, the nanotree forest is placed in another solution and exposed to sunlight. The vertical silicon structure absorbs the most of the light and then transfers electrons through the zinc oxide branches to the surrounding water. That reaction produces hydrogen gas, which bubbles up through the solution.

A *silicon-based nanowire* that grows zinc oxide branches when placed in a chemical reacting zinc solution. These nano-structures, like the name suggests, are tiny. One of these nanowire trees can reach up to a couple of microns in length. Ten thousand of these suckers could fit on the cross-section of a human hair.

3.1 Nanoscale Silver Filaments

Nanoscale silver filaments are grown in a treelike pattern. Just as a tree's leaves collect sunlight over a broad surface area relative to their trunks, the filaments of *silver nano-trees* would be able to collect solar energy over a broad surface.

3.2 Nanoflowers

A *nanoflower* refers to a compound of certain elements that result in formations which in microscopic view resemble flowers or, in some cases, trees that are called nanobouquets or nanotrees. "Nano Flower,"a 3-D nanostructure grown by controlled nucleation of silicon carbide nanowires on Gallium catalyst particles. As the growth proceeds, individual nanowires 'knit' together to form 3-D structures.

Nanometer scale wires (about one thousandth the diameter of a human hair) of a silicon-carbon material (silicon carbide) are grown from tiny droplets of a liquid metal (Gallium) on a silicon surface, like the chips inside our home computers. The wires grow as a gas containing methane flows over the surface. The gas reacts at the surface of the droplets and condenses to form the wires. By changing the temperature and pressure of the growth process the wires can be controllably fused together in a natural process to form a range of new structures, including these flower-like materials.

3.3 Advantages

With regard to safety from unwanted explosions, hydrogen fuel in automotive vehicles is at least as safe as gasoline. The nanotree forest is 100 times cheaper than current technologies.

3.4 Disadvantage

Studying the alternatives of zinc oxide, this absorbs the sun's ultraviolet light, but has stability issues that affect the lifetime usage of the nanotree structure.

The main difficulties for implementing are slow absorption/desorption kinetics and high reactivity towards air and oxygen, which are also common issues in most lightweight materials.

3.5 Applications

- Water repellant coatings.
- Base for a new type of solar cell.
- Motive powers for cars, boats and airplanes.

4.0 CONCLUSION

There are hopes that in the near future our 'nanotree' structure can eventually be part of an efficient device that functions like a real tree for photosynthesis.

References

[1] http://www.renewable-energy-sources.com/2008/12/03/hydrogen- production- using-photo electrochemical-water-splitting/

[2] http://www.treehugger.com/clean-technology/solar-nanotrees-key-clean-hydrogen-fuel.html

The Binary Star

Komal Patel, Divya Korat and Maulik Patel
Sir P.T. Sarvajanik College of Science, Surat.

1. INTRODUCTION

The Binary Stars

- Discovery
- 1st law (Law of elliptic orbits)
- 2nd law (Law of equal areas)
- 3rd law (Law of harmonics)

Classifications

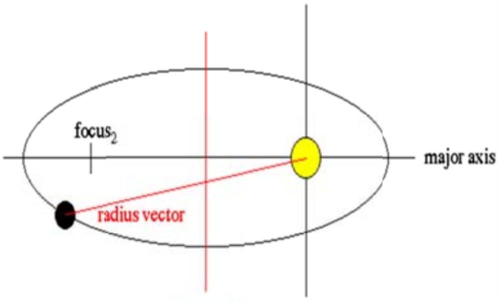
- **Methods of observation:**
  1. visually, by observation
  2. Spectroscopically, by periodic changes in spectral lines
  3. Photometrically, by changes in brightness caused by an eclipse
  4. Astrometrically, by measuring deviation in the position of a star caused by an unseen companion.
- **Configuration of the system**
  1. Detached binaries
  2. Semidetached binary stars
  3. A contact binary
- **Cataclysmic variables and X-ray binaries**
  1. High-mass X-ray binaries
  2. Low-mass X-ray binaries
- **Orbital Period**

2. THE BINARY STARS

- **Discovery:** 85% of the stars in the Milky Way galaxy are not single stars, like the Sun, instead multiple star systems; binaries or triplets.

William Herschel began observing double stars in 1779 and thereafter published catalogues of about 700 double stars. By 1803, he had observed changes in the relative positions of a number of double stars over the course of 25 years, and concluded that they must be binary systems.

If two stars orbit each other at large separations, they evolve independently and are called a *wide pair*. If the two stars are close enough to transfer matter by tidal forces, then they are called a *close or contact pair*.

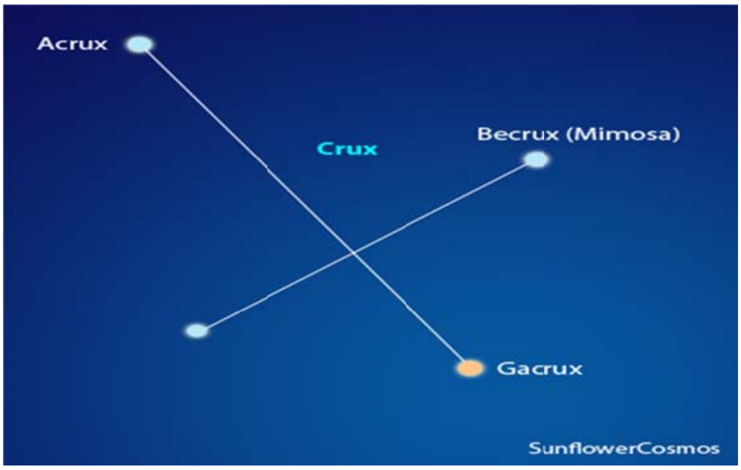


Binary stars obey the three Kepler's Laws of Planetary Motion which are as follows:

- 1st law (Law of elliptic orbits): Each star or a planet moves in an elliptical orbit with the center of mass at one focus.
- 2nd law (Law of equal areas): a line joining one star with the other (called the radius vector) sweeps out equal areas in equal time interval.
- 3rd law (Law of harmonics): The Square of the orbital period of a star or a planet is proportional to the cube of its mean distance from the center of mass.

The term *binary* was first used in this context by Sir William Herschel in 1802: "If, on the contrary, two stars should really be situated very near each other, and at the same time so far insulated as not to be materially affected by the attractions of neighbouring stars, they will then compose a separate system, and remain united by the bond of their own mutual gravitation towards each other. This should be called a real double star; and any two stars that are thus mutually connected, form the binary sidereal system."

By the modern definition, the term *binary star* is generally restricted to pairs of stars which revolve around a common centre of mass. Binary stars which can be resolved with a telescope or interferometric methods are known as *visual binaries*. Since the invention of the telescope, many pairs of double stars have been found. Examples:
Acrux: The bright southern star Acrux, in the Southern Cross, was discovered to be double by Father Fontenay in 1685.



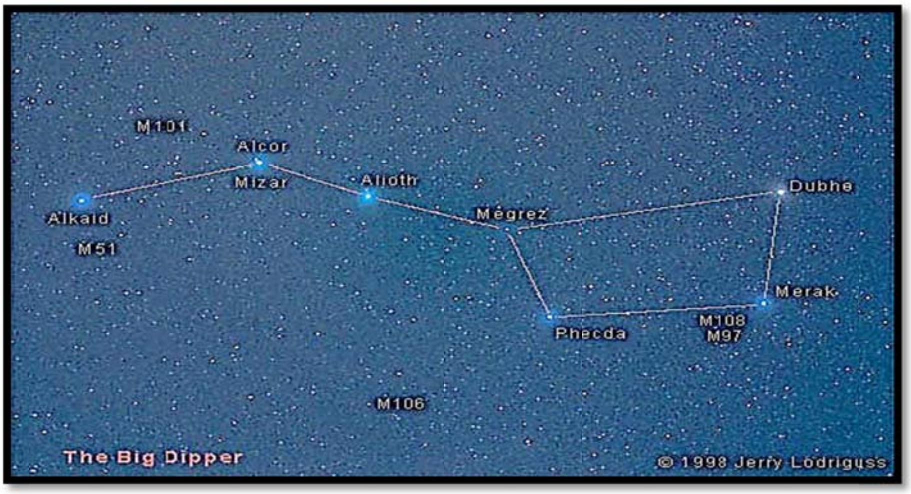
Mizar: in the BigDipper (Ursa Major), was observed to be double by Giovanni Battista Riccioli in 1650 (and probably earlier by Benedetto Castelli and Galileo).

First time, in 1827, Felix Savary, computed the orbit of Xi Ursae Major. Since this time, many more double stars have been catalogued and measured. The Washington Double Star Catalogue, a database of visual double stars compiled by *the United States Naval Observatory,* contains over 1,00,000 pairs of double stars, including optical doubles as well as binary stars. Orbits are known for only a few thousand of these double stars, and most have not been ascertained to be either true binaries or optical double stars.

This can be determined by observing the relative motion of the pairs. If the motion is part of an orbit, or if the stars have similar radial velocities and the difference in their proper motions is small compared to their common proper motion, the pair is probably physical.

Classifications

- Methods of observation
- Configuration of the system
- Cataclysmic variables and X-ray binaries



Methods of observation

Binary stars are classified into four types according to the way in which they are observed:

- visually, by observation;
- Spectroscopically, by periodic changes in spectral lines;
- Photometrically, by changes in brightness caused by an eclipse;
- Astrometrically, by measuring deviation in the position of a star caused by an unseen companion.

Any binary star can belong to several of these classes; for example, several spectroscopic binaries are also eclipsing binaries.

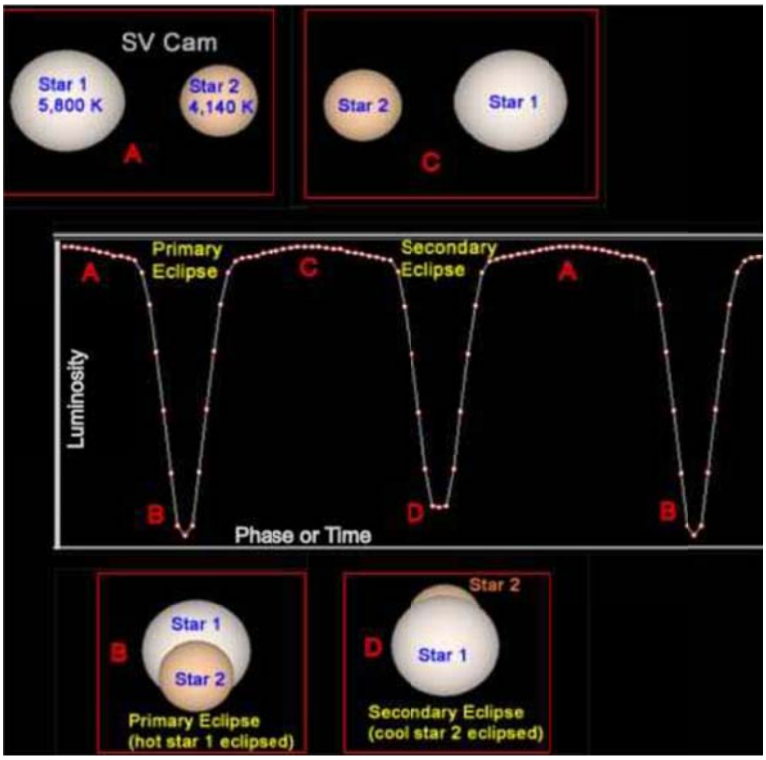
Visual Binary Stars

Two examples: Alpha Centauri A & B. A *visual binary* star is a binary star for which the angular separation between the two components is great enough to permit them to be observed as a double star in a telescope, or even high-power binoculars. The angular resolution of the telescope is an important factor in the detection of visual binaries, and as better angular resolutions are applied to binary star observations increasing number of visual binaries will be detected. The relative brightness of the two stars is also an important factor, as glare from a bright star may make it difficult to detect the presence of a fainter component.

The brighter star of a visual binary is the *primary* star, and the fainter is considered as the *secondary*. In some publications (especially older ones), a faint secondary is called the *comes* (plural*comites*; companion).

The position angle of the secondary with respect to the primary is measured, together with the angular distance between the two stars. The time of observation is also recorded. After a sufficient number of observations are recorded over a period of time, they are plotted in polar coordinates with the primary star at the origin, and the most probable ellipse is drawn through these points such that the Kepler's second law is satisfied. This ellipse is known as the *apparent ellipse*, and is the projection of the actual elliptical orbit of the secondary with respect to the primary on the plane of the sky. From this projected ellipse, the complete elements of the orbit may be computed, where the semi-major axis can only be expressed in angular units unless the stellar parallax, and hence the distance, of the system is known. The observations made relative to the center of mass of the two stars shows their respective elliptical orbits.

In the late 1600's, Italian astronomers noticed that some stars occasionally drop in their brightness up to 1/3 of their peak luminosity. Later measurements showed that these declines were periodic, ranging from hours to days. It is now recognized that these brightness changes are due to the eclipsing of one star by another (as they pass in front of each other).



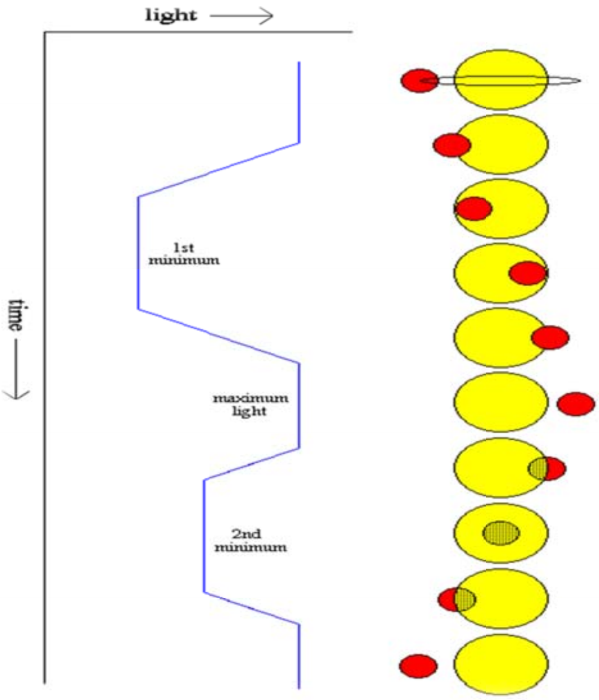
Eclipsing Binaries

Eclipsing binaries are studied by monitoring their light curves (shown below), the changes in brightness with time. When a smaller, dimmer star passes in front of the brighter star, there is a deep minimum. When the dimmer star passes behind the bright star, there is a second, less deep, minimum. Notice the transition zone at the start and the end of each eclipse.

Eclipsing binaries are very rare since the orbits of the stars must be edge-on to our solar system. Notice that an eclipsing binary is the only direct method to measure the radius of a star, both the primary and the secondary from the time for the light curve to reach and rise from minimum.

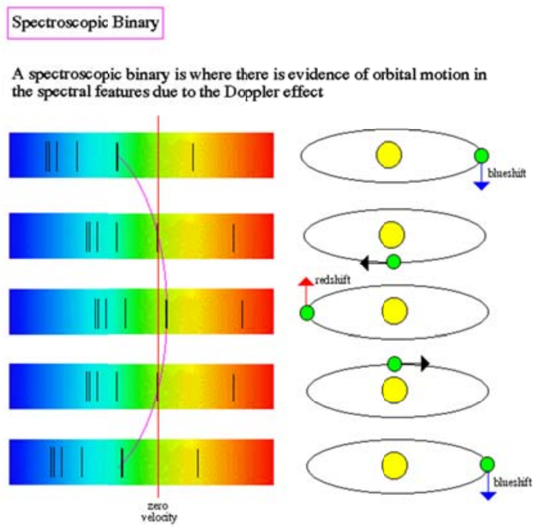
Spectroscopic binaries:

Sometimes, the only evidence of a binary star comes from the Doppler effect on its emitted light. In these cases, the binary consists of a pair of stars where the spectral lines in the light emitted from each star shifts first toward blue, then toward red, as each moves first toward us, and then away from us, during its motion about their common center of mass, with the period of their common orbit.



In these systems, the separation between the stars is usually very small, and the orbital velocity very high. Unless the plane of the orbit happens to be perpendicular to the line of sight, the orbital velocities will have components in the line of sight and the observed radial velocity of the system will vary periodically. Since radial velocity can be measured with a spectrometer by observing the Doppler shift of the stars' spectral lines, the binaries detected in this manner are known as *spectroscopic binaries*. Most of these cannot be resolved as a visual binary, even with telescopes of the highest existing resolving power.

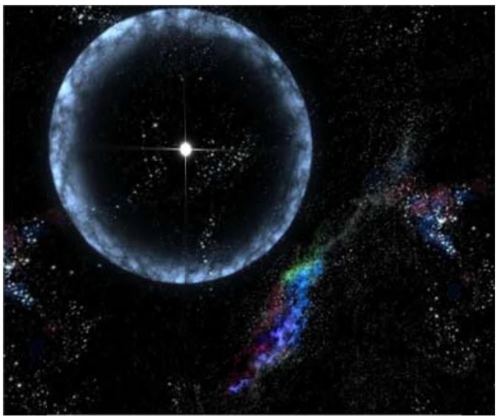
In some spectroscopic binaries, spectral lines from both the stars are visible and the lines are alternately double and single. Such a system is known as a double-lined spectroscopic binary (often denoted "SB2"). In other systems, the spectrum of only one of the stars is seen and the lines in the spectrum shift periodically towards the blue, then towards red and back again. Such stars are known as single-lined spectroscopic binaries ("SB1").



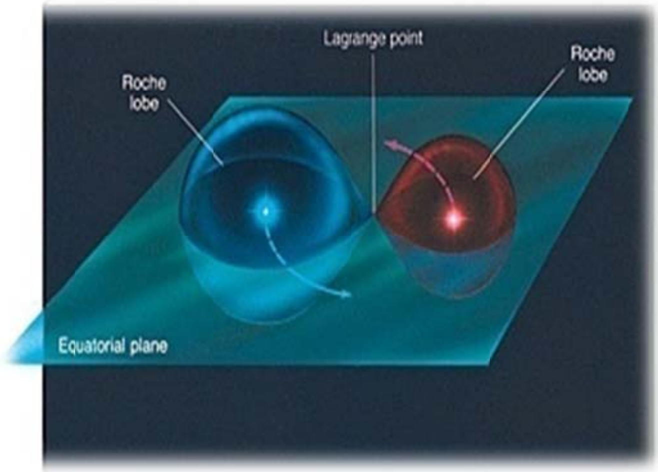
The orbit of a spectroscopic binary is determined by making a long series of observations of the radial velocity of one or both components of the system.

Binary stars that are both visual and spectroscopic are rare, and are a precious source of valuable information when found. Visual binary stars often have large true separations, with periods measured in decades to centuries; consequently, they usually have orbital speeds too small to be measured spectroscopically. Conversely, spectroscopic binary stars move fast in their orbits because they are close together, usually too close to be detected as visual binaries.

Astrometric binaries:



Astronomers have discovered some stars that seemingly orbit around an empty space. *Astrometric binaries* are relatively nearby stars which can be seen to wobble around a point in space, with no visible companion. The same mathematics used for ordinary binaries can be applied to infer the mass of the missing companion. The companion could be very dim, so that it is currently undetectable or masked by the glare of its primary, or it could be an object that emits little or no electromagnetic radiation.



The visible star's position is carefully measured and detected to vary, due to the gravitational influence from its counterpart. The position of the star is repeatedly measured relative to more distant stars, and then checked for periodic shifts in position. Typically this type of measurement can only be performed on nearby stars, such as those within 10 parsecs. Nearby stars often have a relatively high proper motion, so Astrometric binaries will appear to follow a sinusoidal path across the sky.

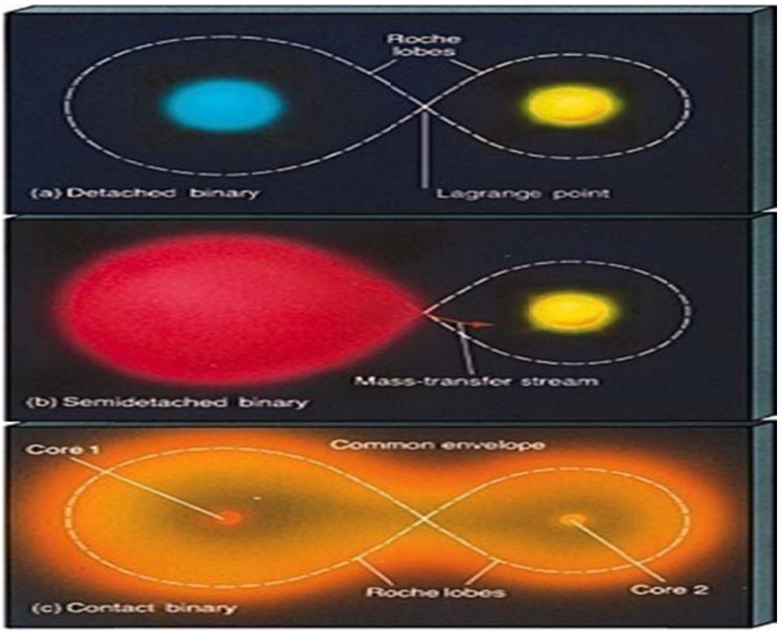
Configuration of the system *:*

Another classification is based on the distance of the stars, relative to their sizes:

Detached binaries are binary stars where each component is within its Roche lobe, i.e. the area where the gravitational pull of the star itself is larger than that of the other component. The stars have no major effect on each other, and essentially evolve separately. Most binaries belong to this class.

Semidetached binary stars are binary stars where one of the components fills the binary star's Roche lobe and the other does not. Gas from the surface of the Roche-lobe-filling component (donor) is transferred to the other, accreting star. The mass transfer dominates the evolution of the system. In many cases, the inflowing gas forms an accretion disc around the accretor.

A *contact binary* is a type of binary star in which both components of the binary fill their Roche lobes. The uppermost part of the stellar atmospheres forms a *common* *envelope* that surrounds both stars. As the friction of the envelope breaks the orbital motion, the stars may eventually merge.



Cataclysmic Variables And X-Ray Binarie:

When a binary system contains a compact object such as a white dwarf, neutron star or black hole, gas from the other (donor) stars can accrete onto the compact object. This releases gravitational potential energy, causing the gas to become hotter and emits radiation. Cataclysmic variable stars, where the compact object is a white dwarf, are examples of such systems.

In X-ray binaries, the compact object can be either a neutron star or a black hole. These binaries are classified as low-mass or high-mass according to the mass of the donor star. High-mass X-ray binaries contain a young, early type, high-mass donor star which transfers mass by its stellar wind, while Low-mass X-ray binaries are semidetached binaries in which gas from a late-type donor star overflows the Roche lobe and falls towards the neutron star or a black hole, eg. high-mass X-ray binary Cygnus X-1.

Orbital Period

Orbital periods can be less than an hour for AM CVn stars, or a few days components of Beta Lyrae, but also hundreds of thousands of years Proxima Centauri around Alpha Centauri AB

Binary star	Orbital period
AM Canum Venaticorum	17.146 minutes
Beta Lyrae AB	12.9075 days
Alpha Centauri AB	79.91 years
Proxima Centauri-AlphaCentauri AB	500000 years or more

References

[1] http://annesastronomynews.com/double-stars-mysterious-connection/binary-star-2-photo/
[2] http://www.daviddarling.info/encyclopedia/R/Roche_lobe.html
[3] http://astronomy.nju.edu.cn/~lixd/GA/AT4/AT420/HTML/AT42006.htm
[4] http://www.ualberta.ca/~pogosyan/teaching/ASTRO_122/lect13/lecture13.html
[5] http://www.space.com/22509-binary-stars.html
[6] An introduction to close binary stars, R.W. Hilditch.

Dead Body Detector

Indrajeet Chauhan
R.C.U. Government College, Uttarkashi
E-mail: kamalpreetajnuha@gmail.com

1. INTRODUCTION

The theme of my idea is to make a "DEAD BODY DETECTOR**".**As the name suggests this device is used to find dead bodies or even alive persons which are buried inside debris applying the use of ultraviolet, infrared (photo sensor) or NRN technology.

The idea for project struck my mind after the flash flood played havoc in KEDARNATH in UTTARAKHAND in which many live were lost and thousands of bodies buried in graves. Flood is a common natural phenomenon in many places and such type of situation occur frequently.

These were the sarcastic scenes that provoked my heart and mind to design and implement something that would , if not prevent, then at least help make things better in this field.

Things became more adverse when the total casualties especially in terms of lost lives. Even after a month total no. of corpse could not be found and this saddening fact makes the base of my idea to create dead body detector which, if not completely, then at least can detect max. Buried bodies, dead or alive.

The one and only motive behind this project is to better the current searching technique of dead body better for good and to ensure maximum safety or at least maximum surety in finding the persons dead or alive respectively.

2. MATERIALS AND METHODS

Dead body detector is a simple yet useful device. This device is a useful tool in finding a person dead or alive buried inside debris, or even concretes.

This device uses a few techniques which are as follow.

a) **NRN Detection:**

NRN or 'Ninhydrin reactive nitrogen' is the first and the most dependable technique. NRN or 'Ninhydrin reactive nitrogen', a compound which is generally found in grave soil. It is easier to detect in vapors state and it is found in that state in air spaces of grave soil.

Methodology: The detector's probe consists of an aluminum coated, porous layer, and open tubular column with a motorized pipette to pull out air samples from the soil at ambient temperatures. This device is the first ever example of tech. that can detect NRN in its vapour state. In order to probe the soil under a concrete slab, a $1/8^{th}$ inch hole is only needed to be drilled through it.

Advantage: The best thing about an NRN detector is that the level of NRN is highest after 5 weeks but it can still be detected after 20 weeks. Hence it supplies a better way to search corpses than traditional techniques.

b) **Hyperspectral Imaging:**

This technique is used to find unmarked graves with special cameras that measures changes in light coming from soil and plants. Hyper spectral imaging collects and processes light from across electromagnetic spectrum including visible light as well as infrared and ultraviolet spectrum. As soon as there is some decay we see a difference in the emitted light.

The reason for the same is as follows:

For the first 5 years or so, a decaying body inhibits plant growth which initially a pretty toxic environment for plants. Plants that grow over such recent graves don't reflect much light in the visible region which scientists can detect through their cameras.

After 5 years however, the plants growing over such places suddenly reflect light instead of absorbing light. Infect the ON GRAVE plants reflect twice as more as light as the OFF GRAVE plants. For human eye, observing such changes is very difficult but can be easily seen on a hyper spectral camera.

The increase in reflected light comes from an increase in chlorophyll, the pigment that plants use to convert light form the sun. After five years a decomposing body becomes fertilizer, supplying the growing plants with much needed nutrients like nitrogen and phosphorus. Bigger plants with bigger, healthier leaves reflect more light.

c) **Dead bodies realize chemicals that stain soil above:**

A decomposing body can fertilize a plant for years. Some graves found by the hyper spectral camera at pearl safari could be so years old. Larger many graves could provide enough nutrients to encourage noticeable plant growth for hundreds of years suspects costopoulous. McGill university teams is currently testing their plant- based hyper spectral images at sides in Canada and Costa Rica. The team also hopes to test their technique at a suspected mass graves site test their technique at a suspected mass graves site in the barren Canadian north.

3. OBSERVATIONS AND RESULTS OF NET TECHNIQUE

The results Of this new technique is far better than the conventional OLD SCHOOL techniques. The reason is that the OlD techniques like

1. METAL DETECTORS: Metal Detectors often used in ground penetrating radar is another technique in finding buried corpse.
2. LARGE SCALE EXCAVATIONS: It involves a large group of search and rescue teams to look out for dead and alive bodies buried under the ground. This can often be dangerous as the team who go looking risk their lives and often ….loose it.
3. CADAVER DOGS: Cadaver dogs are the ones which find buried bodies with the help of smell. This tech is often unreliable as dogs can often be wrong about the smell of two things with similar odour.

May be cheap but are quite unpredictable as they depend on weather and other physical conditions. Their outcome is not dependable and require a lot of manpower and thus are quite hectic. On the other hand, new techniques like NRN and hyperspectral camera s are quite predictable and partially depend on weather and other physical conditions and therefore are more reliable , accurate and less hectic.

The only problem is that these projects require a strong infrastructure to start as they totally depend on scientific methods and analysis. But once started, they can produce far better results than previous techs and can help saving a lot lives than estimated.

METAL DETECTOR

4. DISCUSSION AND BENEFITS OF THE PROJECT

My project named as DEAD BODY DETECTOR as I told earlier is quite useful and Important for the society. The two main advantages of this device is as follows:

1. The main and the most important motive behind this project is to aid rescue operations at the time of calamity. Many people both dead and alive are buried often inside the debris at the time of calamities and since the present search techniques neither adequate nor sufficient, this device will prove as a boon to the current excavation techs.
2. Another important mode in which this device can help the society is by helping police and intelligence in solving the cases regarding missing persons. At times the murderers convict the crimes and hide the dead bodies inside the ground. Solving such a case can be too hard if there is no body as an evidence. Thus a device like this can be an effective tool in this arena since it is capable of finding both dead and alive bodies.

Acknowledgement

I hereby want to thank all the inspiring sources who helped me initiate the project. First of all, I would like to thank Almighty Lord, without whom even a tiniest step would have been impossible. Next, I would like to thank my teachers for their guiding hand and supportive nature, who helped me in every step and guided me whenever I needed help.

In addition to this, I would like to thank my classmates who worked even harder for this project by inspiring me, helping me and correcting me. I have made sincere attempts in every possible way to complete the project and I hope I have been able to complete the projects as per the standards of my college and expectations of my teachers.

References

[1] Mrs. Sumita Shrivastava, HOD Physics Dept.

[2] Mr. G.K Dhingra, Asst. Professor, Botany Dept.

[3] Mrs. Prerna Pokhriyal, Botany Dept.

[4] Mr. Abhishek Kothari, B.Sc. (IInd Year).

Study on the Chemical Doping and Characterization of Radioactive Tellurium Nuclei Produced in Fission Reaction and Comparative Characterization of Different HPGe Detectors

Abhishek Dubey, Sanjeet Singh, and Rajinder Singh
Department of Applied Physics, Indian School of Mines, Dhanbad, Jharkhand- 826004.
Corresponding Author: adubeyips@gmail.com

Abstract: Radioactive tellurium nuclei produced in Fission reaction is important to determine the quadrupole moment and life time of nuclei using gamma ray detector . This poster presentation describes the chemical doping of tellurium acid to tellurium metal matrix which method is used to find the active tellurium from recoiled nuclei which is produced by fission process and characteristic study of various types. of semiconductors and scintillation gamma ray detectors. A comparative study has been performed with 50% HPGe detector. Clover HPGe detector and segmented Ge planar LEPS (Low Energy Photon Spectrometer) detectors using sources ^{152}Eu and ^{132}Ba. We also identified the gamma energy decay of these active nuclei using different gamma energy detector as 50% HPGe and $LaBr_3$ scintillation detector.

1. INTRODUCTION

Tellurium is a semi metallic chemical element in the oxygen group (Group 16) of the periodic table, closely allied with the element selenium in chemical and physical properties. Telluric acid is taken in a tube and is mixed with HCl of strength 6M. A few mg of Hydrazine sulphate is taken and then the mixture is slowly warmed under Argon lamp. Now sodium bisulphate ($NaHSO_3$) is added to the mixture and again warmed under the argon lamp. Te –metal is formed and to separate impurities the method of centrifugation is done. These water soluble impurities are removed by washing the tube 2 or 3 times with water. We pour some acetone in it to keep it far away from oxidation. Since the boiling point (B.P) of acetone is very much lower than that of water. So it is used instead of water, so that there will not be the chance of oxidation.

Again it is dried under the lamp and then heated at very high temperature 330^0c to form Te matrix. Now we will check whether matrix is tellurium or not, we did XRD on Bruker D8 Advance model which showed that matrix produced was indeed tellurium having HCP structure. (Fig. 1)

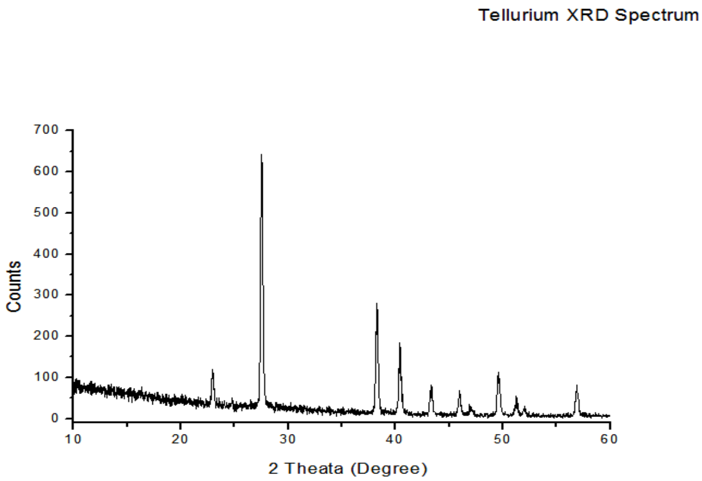


Figure 1: XRD Spectrum of Tellurium metal matrix

<u>Fission process</u>: In Fission process we used K=130 Variable Energy Cyclotron at VECC, Kolkata which produced 40 MeV alpha beam energy and current of beam 200nA.

$$^{238}U\ (^{4}He,\ f)\ ^{131,132}Te\ ,$$

$$E_\alpha = 40\ MeV,\ I_{beam} = 200nA$$

For getting active tellurium, we did a fission reaction using Using UO_2 by bombarding alpha beam when we hit the target. Many nuclides are produced such as Cs, Sn, Pd, U, Pu and Tellurium etc. These nuclides are caught at aluminum foils these Foils are dissolved in HCl solution of strength 6M under warm condition.

After that we did the same procedure as we discussed forming inactive tellurium from the telluric acid. Following the Same method we got Active tellurium (Fig. 2).

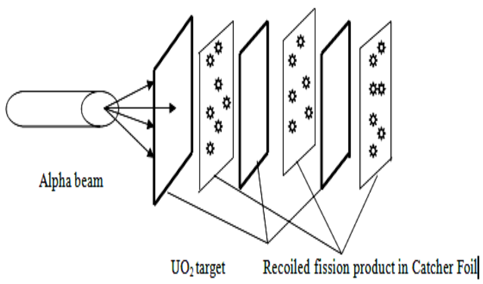


Figure 2: Schematic diagram of Fission process.

Gamma decay analysis- After getting active Tellurium we analyzed the gamma decay energy using 50% HPGe detector (Fig. 3) and $LaBr_3$ scintillation detector at PMT voltages 2500V.

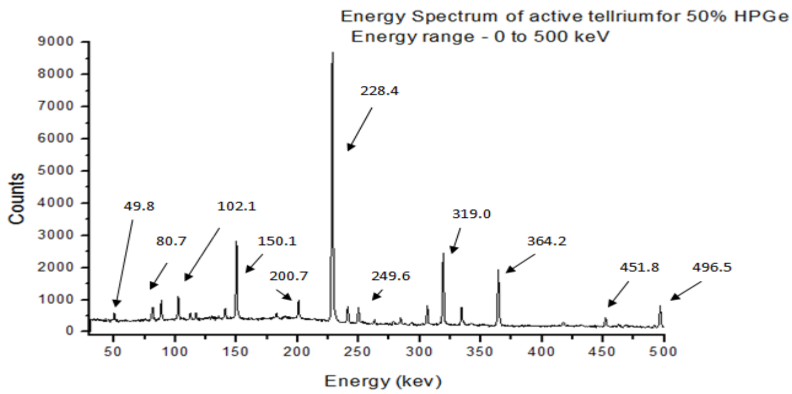


Figure 3: Gamma Energy level decay using 50% HPGe

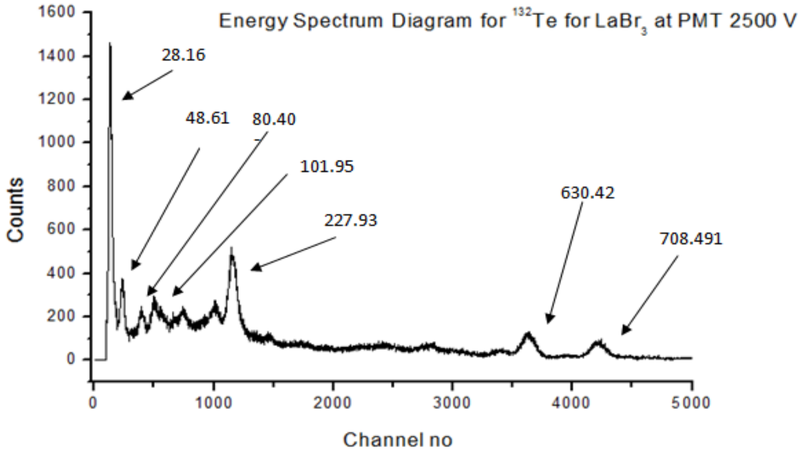


Figure 4: Gamma Energy Decay level of Te using $LaBr_3$ Scintillation detector.

We compared the different HPGe detectors on the basis of Efficiency, Resolution and Response curve. Energy vs Efficiency plot of different HPGe detectors are given below:

Efficiency has been calculated by using the formula given below:

$$\text{Efficiency} = \frac{\text{No. of photons detected by the detector}}{\text{No. of photons emitted by the source}}$$

Fig.5 is showing that the efficiency of the detector is decreasing with increasing energy but for 81.0 keV,it is lower than that of 121.78 kev. This is due to the window effect which increases rapidly for energy below 100 keV.

The results shows that Clover detector, when used in add-back mode gives better peak, thus increases the photo peak efficiency in comparison to 50% HPGe and LEPS. In efficiency curve, we concluded that efficiency of the detector decreases due to summing effect and window effect for low energy gamma ray. Better resolution curve is obtained for 50 % HPGe detector. For Clover detector a poor resolution curve is obtained and we also got the linear response curve for all these detectors.

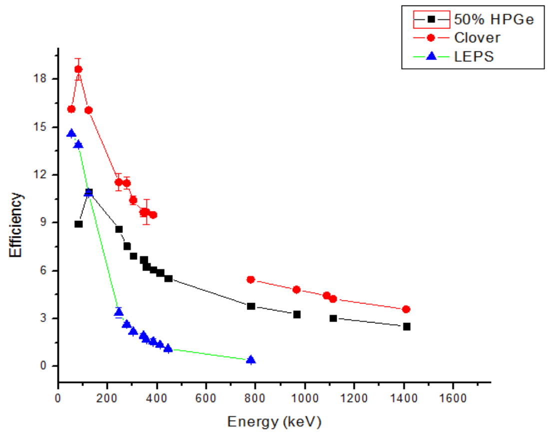


Figure 5: Energy vs. Efficiency plot for different detectors.

Add-back factor is the ratio of add-back efficiency to the added efficiency of the photo peak.

$$F = \frac{\text{add-back effiiciency}}{\text{added efficiency}}$$, where, F is the add-back factor.

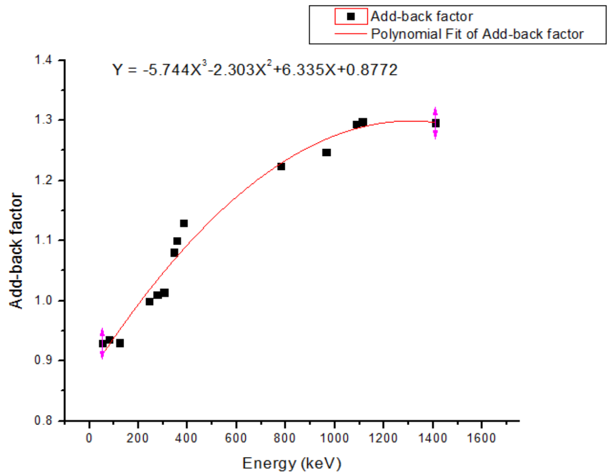


Figure 6: Add-factor Vs. Energy Curve.

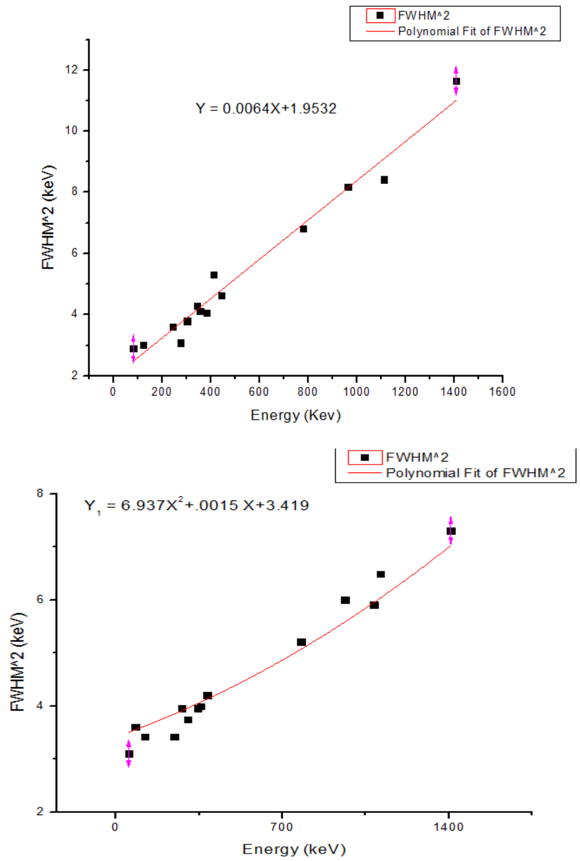


Figure 7: Resolution curve for 50% HPGe detector and Clover detector.

Better resolution curve is obtained for 50 % HPGe detector. For Clover detector a poor resolution curve is obtained.

2. CONCLUSION

We conclude that active tellurium decayed producing the gamma rays of energy 49.8 kev, 80.7keV, 102.1keV, 150.1 keV, 228.4 keV and 364.2 etc. The comparative study of various HPGe detectors shows that Clover detector in add-back mode gives comparatively better efficiency curve than other HPGe detectors. In case of resolution, 50% HPGe proved to be better where as poor resolution curve is obtained with Clover detector.

ACKNOWLEDGEMENT

We wish to acknowledge Dr. (Mrs.) Tumpa Bhattacharjee, Scientific Officer, Variable Energy Cyclotron Centre, Kolkata and Dr. S.K. Das, Head, RCD, VECC, Kolkata and Mr. Debasish Banerjee, Scientific Officer, RCD,VECC, Kolkata and Mr. Arunbha Saha JRF, VECC.

REFERENCES

[1] Glenn F Knoll, Radiation Detection and Measurement, 3rd edition, John Wiley & Sons, Inc.

[2] Investigation of add-back effects in a segmented Clover detector, CPC (HEP & NP), 2010, 34(3): 379-382 Chinese Physics C Vol. 34, No. 3, Mar., 2010.

[3] P.K. Joshi, S. Chattopadhyay, S.Bhattacharya, Study of the characteristics of a clover detector, Nuclear Instruments and methods in Physics Research A 399(1997) 51-56.

[4] www.nndc.bnl.gov

[5] LAMPS(Linux Advanced Multi Parameter system) and Origin Pro-8 software.

Review of Medical Applications of Plasma

Honey Arora, Ramandeep Kaur, and Parveen Bala
Department of Mathematics, Statistics & Physics, PAU, Ludhiana
Corresponding Author: moon.nd.stars@gmail.com

Abstract: Plasma, described as the fourth state of matter, comprises charged species, active molecules and atoms. Plasma based methods offer great potential for developing technologies for realising the healthcare and cleantech revolutions. These technologies could impact a range of healthcare and cleantech sub-sectors. Plasma medicine is an innovative and emerging field combining plasma physics, life sciences and clinical medicine to use physical plasma for therapeutic applications. Initial experiments confirm that plasma can be effective in *in vivo* antiseptics without affecting surrounding tissue and, moreover, stimulating tissue regeneration. Based on sophisticated basic research on plasma-tissue interaction, first therapeutic applications in wound healing, dermatology and dentistry will be opened. These plasma-generated active species are useful for several bio-medical applications such as sterilization of implants and surgical instruments as well as modifying biomaterial surface properties. Sensitive applications of plasma, like subjecting human body or internal organs to plasma treatment for medical purposes, are also possible. In the present poster, some medical applications of plasma are discussed.

1. INTRODUCTION

We are surrounded by plasma, meaning to say that 99% of the universe is in the plasma form. Plasma is a quasi-neutral medium of positive and negative particles which responds strongly to electromagnetic fields. Although these charged particles are unbound, these are not free. When these charges move they generate electrical currents with magnetic fields, and as a result, they are affected by each other's fields that is we can say that they show collective behaviour. We live in 1% of that universe which is not actually plasma. The reason being high temperature conditions required for its quasi-neutral existence.

Plasma medicine is an innovative and emerging field combining plasma physics, life sciences and clinical medicine. Plasma medicine is emerging worldwide as an independent medical field-comparable to the launch of laser technology into medicine years ago. It has been known for a long time that ionized gases have biocidal effects, but only in 1996 successful killing of bacteria with plasma was reported [1]. In contrast to conventional methods which usually require high temperatures or high concentrations of chemical substances such as ethylene oxide, ozone or chlorine, cold plasma can also be used on heat-sensitive and chemically reactive surfaces. Plasma acts rapidly and very effectively and penetrates the smallest openings and hollow spaces. How plasma actually achieves disinfection or sterilization is not yet fully understood. According to current knowledge both physical mechanisms and biological mechanisms appear to be responsible for the inactivation of bacteria [2].

On the basis of their high bactericidal effectiveness plasmas are also used to sterilize medical devices and in packaging food stuffs. Various researches range from investigation of the fundamental physics, study of the optimal, individual plasma composition over the interaction of plasmas with prokaryotic and eukaryotic cells, viruses, spores and fungi, cell structures such as cell membranes, DNA, lipids and proteins up to studies on plant, animal and human tissue and finally on patients. Without damaging surrounding healthy tissue, cold atmospheric-pressure plasmas at room temperature lead to diverse reactions in tissue [3]. Plasma medicine can be subdivided into three main fields:

1. Non-thermal atmospheric-pressure direct plasma for medical therapy
2. Plasma-assisted modification of bio-relevant surfaces
3. Plasma-based bio-decontamination and sterilization

2. ANIMAL AND HUMAN LIVING TISSUE STERILIZATION

The direct plasma treatment implies that living tissue itself is used as one of the electrodes and directly participates in the active plasma discharge processes. Direct application of the high-voltage (10–40 kV) non-thermal plasma discharges in atmospheric air to treat live animals and people requires a high level of safety precautions.

Safety and guaranteed non-damaging regimes are the crucial issues in the plasma medicine. Discharge current should be obviously limited below the values permitted for the treatment of living tissue. Moreover, discharge itself should be homogeneous enough to avoid local damage and discomfort. Creation of special atmospheric discharges effectively solving these problems is an important challenge for plasma medicine. Fridman et al. especially developed for this purpose the floating-electrode DBD (FE-DBD), which operates under the conditions where one of the electrodes is a dielectric protected powered electrode and the second active electrode is a human or animal skin or organ–without human or animal skin or tissue surface present discharge does not ignite [4,5,6,7].

3. NON-THERMAL PLASMA-ASSISTED BLOOD COAGULATION

Blood coagulation is an important issue of medicine, in particular regarding wound treatment. Quasi-thermal plasma has been traditionally used for this application in the form of the so-called cauterization devices: APC, argon beam coagulators, etc [8,9,10]. In these devices, widely used in particular in surgery, plasma is just a source of local high temperature heating, which cauterizes and desiccates the blood. Recent development of the effective non-thermal plasma medical systems permits to achieve effective blood coagulation without any thermal effects.

4. OTHER APPLICATIONS [11]

4.1 Gynaecology

In surgery, where the abdominal cavity was opened, the purulent wound was processed by air plasma in the coagulation regime, and then at later time by the plasma NO-therapy they achieved by remote action through the front abdominal wall and vagina.

4.2 Dentistry

Effectiveness of the plasma NO-therapy has been demonstrated on the chronic gingivitis. After the first session of the therapy, gum bleeding ceased, after 1–2 weeks normalization of tissue and regional blood flow in the tissues of periodontium.

Low-temperature plasmas also make a dissolution or removal of biofilms, often found on catheters, medical implants and teeth, possible. Biofilms are three-dimensional accumulations of microorganisms that adhere to a surface and are enclosed by polymeric substances and can, for example, effectively protect yeasts from attacks out of the environment or the immune system. This markedly increases resistance towards antifungal agents. Lee et al, among others, were able to show that biofilms could be removed in less than 20s and the growth of planktonic bacteria in biofilms could be inhibited within 5s [12].

Other various applications are in the field of Traumatology, Orthopaedics, Phthisiology, Ophthalmology, Dermatology, Gastroenterology etc.

5. CONCLUSION

Thanks to interdisciplinary cooperation in medicine, physics, chemistry, biology and microbiology plasma medicine has developed into an innovative and dynamic field of research in recent years. Even if many questions remain unanswered – especially the mechanism of interaction between plasma and living cells/ tissues and the optimization of plasma composition depending on the desired effect – studies to date illustrate the great potential of plasma medicine. Cold plasmas will surely be available in the near future to an increasing extent both for therapy and prevention of diverse, particularly infectious diseases. There does exist a vision of a breakthrough in medicine comparable to the introduction of antibiotics. The superiority of plasmas in comparison to previous medical standards remains to be clarified, especially in economic terms.

REFERENCES

[1] Laroussi M. Sterilization of Contaminated Matter with an Atmospheric Pressure Plasma. *IEEE Trans Plasma Sci* 1996; 24: 1188–91.

[2] Kong MG, Kroesen J, Morfill G, Nosenko T, Shimizu T, van Dijk J, Zimmermann JL. Plasma medicine: an introductory review. *New J Phys* 2009; 11: 115012.

[3] J Heinlin, G Morfill, M Landthaler, W Stolz, G Isbary, JL Zimmermann, T Shimizu and S Karrer, *J the German Society of Dermatology* DOI: 10.1111/j.1610-0387.2010.07495.x

[4] G Fridman, M Peddinghaus, H Ayan, A Fridman, M Balasubramanian, A Gutsol, A Brooks, G Friedman, *Plasma Chem Plasma Process* 2006, 26: 425.

[5] G Fridman, A Shereshevsky, M Peddinghaus, A Gutsol, V Vasilets, A Brooks, M Balasubramanian, G Friedman, A Fridman, Bio-Medical Applications of Non-Thermal Atmospheric Pressure Plasma, in: 37th AIAA Plasmadynamics and Lasers Conference, 2006, San Francisco, California.

[6] G Fridman, AD Brooks, M Balasubramanian, A Fridman, A Gutsol, VN Vasilets, H Ayan, G Friedman, *Plasma Process Polym* 2006, DOI: 10.1002/ppap. 200600217, in press.

[7] G Fridman, A Shereshevsky, M Jost, A Brooks, A Fridman, A Gutsol, V Vasilets, G Friedman, *Plasma Chem. Plasma Process* 2007, 27, 163.

[8] GG Ginsberg, AN Barkun, JJ Bosco, J S Burdick, GA Isenberg, NL Nakao, BT Petersen, WB Silverman, A Slivka, PB Kelsey, *Gastrointest Endosc* 2002, 55, 807.

[9] JJ Vargo, *Gastrointest. Endosc* 2004, 59: 81.

[10] J Raiser, M Zenker, *J Phys D Appl Phys* 2006, 39, 3520.

[11] G Friedman, A Gutsol, AB Shekhter, VN Vasilets, A Fridman, *Plasma Processes and Polymers,* Applied Plasma Medicine.

[12] Lee MH, Park BJ, Jin SC, Kim D, Han I, Kim J, Hyun SO, Chung KH, Park JC. Removal and sterilization of biofilms and planktonic bacteria by microwave-induced argon plasma at atmospheric pressure. *New J Phys* 2009; 11: 115022.

The History of Optics

Birendra Patel
Surat

INTRODUCTION:

- Importance Of History
- Periods Of Optical History
- Milestones

IMPORTANCE OF HISTORY:

- History is important
- A proper study of historical experiments can give crucial context and understanding
- Many important and enlightening experiments have been "forgotten" by the world of science
- An understanding of such experiments can provide inspiration and a better understanding of the philosophy of science

PERIODS OF OPTICAL HISTORY:

- Prehistory: Initial studies of optics and vision. Aristotle, Ptolemy, Ibn- al-Haitham wrote books of optics between 1011-1021 C.E.
- Particle Nature: Light treated as a stream of particle. Newton published "Optiks" in 1704. Francois Arago studied stellar aberration in 1810.
- Wave Nature: Light treated as a continuous wave. Thomas Young published double slit experiment in 1803. Charls Barkla exhibited X-ray have polarization in 1905.
- Quantum Physics: Light has wave/particle duality. Einstein published photoelectric effect in 1905.
- Modern Physics: Light even weirder than we imagined! Maiman built first laser in 1960. Leonard Mandel showed multi-photon interference in 1963.

MILESTONES:

- **OPTICS & SCIENCE:** The history of optics as a scientific field began in Alexandria, around 300 B.C. At that time, science was flourishing in Greece, and geometry was the hottest scientific topic (like nuclear physics was in the 1970s). One Alexandria's biggest geometry hot-shots were followed by the name of **Euclid.** He was the man who came up with most of the geometry stuff we're taught in school, but he also observed that light travels in straight lines. The first descriptions on the laws of reflection can be found in his work.
- Now let's look at some of those numerous scientific discoveries and innovation in optics over the centuries that have contributed to mankind's illumination, vision, and success:
- **~300 BC: Euclid (Alexandria)**

In his "Optics", he noted that light travels in straight lines and described the law of reflection. He believed that vision involves rays going from the eyes to the object seen and he studied the relationship between the apparent sizes of objects and the angles that they subtend at the eye.

- **PROBABLY BETWEEN 100 B.C. AND 150 A.D. : HERO (HERON) OF ALEXNDRIA**

In his "Catoptrica", Hero showed by geometrical method that the actual path taken by the ray of light reflected from a plane mirror is shorter than any other reflected path that might be drawn between the source and point of observation.

- **~140 AD: Claudius Ptolemy (Alexandria)**

In the twelfth-century, Latin translation from the Arabic that is assigned to Ptolemy, a study of refraction, including atmospheric refraction, was described. It was suggested that the angle of refraction is proportional to the angle of incidence.

- **~965-1020 AD: Ibn-al-Haitham (Also known as Alhazen and Basra)**

In his investigation, he used spherical and parabolic mirrors and was aware of spherical aberration. He also investigated the magnification produced by lenses and atmospheric refraction. His work was translated into Latin and became accessible to later European scholars.

- **~1220: Robert Grosseteste (ENGLAND)**

Magister Scholarum of the University of Oxford and a proponent of the view that theory should be compared with observation, Grosseteste considered that the properties of light have particular significance in natural philosophy and stressed the importance of mathematics and geometry in their study. He believed that colors are related to intensity and that they extend from white to black, while being the purest and lying beyond red with black lying below blue. The rainbow was conjectured to be a consequence of reflection and refraction of sunlight by layers in a 'WATERY CLOUD', but the effect of individual droplets was not considered. He held the view, shared by the earlier Greeks, that vision involves emanations from the eye to the object perceived.

Robert Grosseteste (1175-1253)

- **~1267: ROGER BACON (ENGLAND)**

A follower of Grossteste at Oxford, Bacon extended Grosseteste's work on optics. He considered that the speed of light is finite and that it is propagated through a medium in a manner analogous to the propagation of sound. In his "Opus Maius", Bacon described his studies of the magnification of small objects using convex lenses and suggested that they could find application in the correction of defective eyesight. He attributed the phenomenon of the rainbow to the reflection of sunlight from individual raindrops.

- **~1270: WITELO (SILESIA)**

He completed his perspectiva, which was destined to remain a standard text on optics for several centuries. Amongst other things, Witelo described a method of matching parabolic mirrors from iron and carried out careful observation on refraction. He recognized that the angle of refraction is not proportional to the angle of incidence but was unaware of total internal reflection.

Witelo of Silesia (1230-1275)

- **~1303: BERNARD OF GORDON (FRANCE)**

He was a physician and mentioned the use of spectacles as a way of correcting long-sightedness.

- **~1304~1310: THEODORIC (DIETRICH) OF FREIBERG**

He explained the rainbow as a consequence of refraction and internal reflection within individual raindrops. He gave an explanation for the appearance of a primary and secondary rainbow. But, following earlier notions, he considered color to arise from a combination of darkness and brightness in different proportions.

- **~1590: ZACHARIUS JENSEN (NERTHERLANDS)**

He constructed a compound microscope with a converging objective lens and a diverging eye lens.

- **~1604: JOHANNES KEPLER (GERMANY)**

Johannes Kepler (1571-1630)

In his book, “Ad Vitellionem Paralipomena”, Kepler suggested that the intensity of light from a point source varies inversely with the square of the distance from the source, that light can be propagated over an unlimited distance and that the speed of propagation is infinite. He explained vision as a consequence of the formation of an image on the retina by the lens in the eye and correctly described the causes of long-sightedness and short-sightedness. In his “Dioptric”, Kepler presented an explanation of the principles involved in the convergent lens, microscope and telescopes. In the same treatise, he suggested that a telescope could be constructed using a converging eye lens and described a combination of lenses that later became known as the telephoto lens. He discovered between the angle of incidence and the angle of refraction in 1611.

- **~1608: HANS LIPPERSHEY (NETHERLANDS)**
  He constructed a telescope with a converging objective lens and a diverging eye lens.

Hans Lippershey (1570-1619)

- **~1609: GALILEO GALIEI (ITALY)**

Galileo Galilei (1564-1642)

  He constructed his own version of Lippershey's telescope and started using it for astronomical observation. Using his telescope, Galileo reported several astronomical discoveries including that Jupiter has four moons in 1610.

- **~1618: CHRISTOPHER SCHEINER**
  He constructed a telescope of the type suggested by Kepler with converging objective and eye lenses. This type of telescope has since become known as the 'Astronomical Telescope'. But it is uncertain when the first such instrument was constructed.

- **~1621: WILLEBRORD SNELL (LEIDEN)**
  He discovered the relationship between the angle of incidence and angle of refraction when light passes from one transparent medium to another.

- **~1647: B CAVALIERI**

  He derived a relationship between the radii of curvature of the surfaces of a thin lens and its focal length.

- **~1657: PIERRE DE FERMAT (FRANCE)**
  He enunciated his principle of 'LEAST TIME' according to which, a ray of light follows the path which takes it to its destination in the shortest time. This principle is consistent with Snell's law of refraction.

Pierre de Fermat.

- **~1663: JAMES GREGORY (ENGLAND)**

  He suggested the use of a converging mirror for the objective of a telescope as the cure for aberrations.

James Gregory (1638-1675)

- **~1665: FRANCESCO MARIA GRIMALDI (ITALY)**

  In a book entitled "Physico-mathesis delumine, coloribus et iride" published posthumously, Grimaldi's observations of diffraction when he passed white light through small apertures were described. Grimaldi concluded that light is a fluid that exhibits wave-like motion.

- **~1665: ROBERT HOOKE (ENGLAND)**

  In his treatise "Micrographia", Hooke described his observations with a compound microscope having a converging objective lens and a converging eye lens. In the same work, he described his observations of the colors produced in flakes of mica, soap bubbles and films of oil on water; He recognized that the color produced in mica flakes is related to their thickness and color. Hooke advocated a wave theory for the propagation of light.

- **~1666: ISAAC NEWTON (ENGLAND)**

  He described the splitting up of white light into its component colors when it is passed through a prism. As a solution to the problem of chromatic aberration exhibited by refracting telescopes, Newton constructed the first refracting telescope in 1668. Newton's earlier observations on the dispersion of sunlight as it passed through a prism were reported to the royal society. He concluded that sunlight is composed of light of different colors which are refracted by glass to different extents in 1672. In his "Optiks", Newton put forward his view that light is corpuscular but that the corpuscles are able to excite waves in the ether. His adherence to a corpuscular nature of light was based primarily on the presumption that light travels in straight lines whereas waves can bend into the region of shadow in 1704.

- **~1669: ERASMUS BARTHOLINUS (DENMARK)**
  He discovered double refraction in calcite.

- **~1676: OLAF ROMER (DENMARK)**
  He deduced that the speed of light is finite from detailed observations of the eclipses of the moons of Jupiter from Romer's data.
- **~1678: CHRISTIAAN HUYGENS (NETHERLANDS)**
  In a Communication to the academiedes science in pairs, Huygens propounded his wave theory of light. He considered that light is transmitted through all-pervading ether that is made up of small elastic particles, each of which can act as a secondary source of wavelets. On this basis, Huygens explained many of the known propagation characteristics of light including the double refraction in calcite discovered by Bartholinus.

- ~1727: **JAMES BRADLEY (ENGLAND)**
  Bradley calculated the speed of light from observations of the "aberration" of light from stars, an apparent motion of a star arising from the value of the speed of light in relation to the speed of the earth in its orbit.

James Bradley
(1693-1762)

- **~1733: THOMAS MELVILL (SCOTLAND)**
  He observed that the spectra of flames into which metals or salts have been introduced show bright lines which are characteristic of what has been introduced into the flame.

- **~1801: THOMAS YOUNG (ENGLAND)**
  He provided support to the wave theory by demonstrating the interference of light.

Thomas Young
(1773-1829)

- **~1802: WILLIAM HYDE WOLLASTON (ENGLAND)**


William Hyde Wollaston
August 6, 1766 – December 22, 1828

He discovered that the spectrum of sunlight is crossed by a number of dark lines, but he did not interpret them in accordance with current explanations.

- **~1808: ETIENNE LOUIS MALUS (FRANCE)**


Étienne-Louis Malus (1775-1812)

As a result of observing light reflected from the windows of the Palais Luxembourg in Paris through a calcite crystal as it is rotated, Malus discovered an effect that later led to the conclusion that light can be polarized by reflection.


Joseph von Fraunhofer (1787-1826)

- **~1814: JOSEPH FRAUNHOFER (GERMANY)**

Fraunhoffer rediscovered the dark lines in the solar spectrum noted by Wollaston and determined their position with improved precision.

- **~1815: DAVID BREWSTER (SCOTLAND)**


Sir David Brewster (1781-1868)

He described the polarization of light by reflection.

- **~1816-1817: AUGUSTIN JEAN FRESNEL (FRANCE)**


Augustin Fresnel (1788-1827)

He presented a rigorous treatment to the phenomena of diffraction and interference showing that they can be explained in terms of wave theory of light. As a result of investigations by Fresnel and Dominique Francois Arago on the interference of polarization by Thomas Young, it was concluded that light waves are transverse and not as had been previously thought longitudinal. He also presented the laws which enable the intensity and polarization of reflected and refracted light to be calculated in 1821 AD.

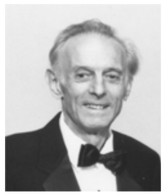
- **~1819: JOSEPH FRAUNHOFER (GERMANY)**
  He described his investigations of the diffraction of light by gratings which were initially made by winding fine wires around parallel screws.


Joseph von Fraunhofer (1787-1826)

- **~1828: WILLIAM NICOL (SCOTLAND)**
  He invented a polarizing prism made from two calcite components. The device became known subsequently as a ‘’Nicol prism’’.

- **~1834: JHON SCOTT RUSSELL (SCOTLAND)**

  He observed a ‘wave of translation’ caused by a boat being drawn along the union canal in Scotland, and noted how it travelled great distances without apparent change of shape. Such waves subsequently became known as ‘solitary waves’ and their study led to the idea of solitons, optical analogues of which have been propagated in optic fibers.



- **~1835: GEORGE AIRY (ENGLAND)**
  He calculated the form of the diffraction pattern produced by a circular aperture.
- **~1845: MICHAEL FARADAY (ENGLAND)**
  He described the rotation of the plane of polarized light that is passed through glass in a magnetic field (the Faraday Effect).


Michael Faraday (1791-1867)

- **~1849: ARMAND HYPOLITE LOUIS FIZEAU (FRANCE)**

  Using a rotating toothed wheel to break up a light beam into a series of pulses, Fizeau made the first non-astronomical determination of the speed of light (in air). He obtained a value of 3,13,300 km/s for the speed of light. He performed an experiment to determine whether the velocity of light in water is affected by flow of the water. He found that it is the change in the velocity of light being about a half of the velocity of the flowing water in 1859.

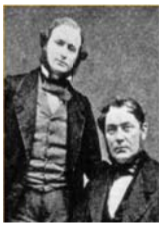
- **~1850: J L FOUCAULT (FRANCE)**

Foucault determined the speed of light in air using a rotating mirror method. He obtained a value of 2,98,000 km/s. In the same year, Foucault used a rotating mirror method to measure the speed of light in stationary water and found that it was less than that in air.

- **~1855: DAVID ALTER (USA)**

He described the spectrum of hydrogen and other gases.

- **~1860: ROBERT WILHELM BUNSEN AND GUSTAV KIRCHOFF**



He observed the emission spectra of alkali metals in flames and also noted the presence of dark lines arising from absorption when observing the spectrum of a bright light source through the flame. The origin of these dark lines was similar to that of dark lines in the solar spectrum observed by Wollaston and Fraunhofer and attributed to the absorption of light by gases in the solar atmosphere that are cooler than those emitting the light.

- **~1865: JAMES CLERK MAXWELL (SCOTLAND)**

From his studies of the equations describing electric and magnetic fields, it was found that the speed of an electromagnetic wave should, within the experimental error, be the same as the speed of light. Maxwell concluded that light is a kind of electromagnetic wave.

- **~1869: JOHN TYNDALL (IRELAND)**

He described experimental studies of the scattering of light from aerosols.

- **~1871: JOHN WILLIAM STRUTT THIRD BARON RAYLEIGH (ENGLAND)**
  He presented a general law which related the intensity of the light scattered from small particles to the wavelength of the light when the dimensions of the particles is much less than the wavelength, he also made a 'ZONE PLATE' which produced focusing of light by Fresnel diffraction.


Lord Rayleigh (John Strutt) (1842-1919)

- **~1873: ERNST ABBE (GERMANY)**
  He presented a detailed theory of image formation in the microscope.


Ernst Abbe (1840-1905)

- **~1874: MARIE ALFRED CORNU (FRANCE)**
  He described a graphical approach (the cornu's spiral) to the solution of diffraction problems.


Marie Alfred Cornu (1841-1102)

- **~1875: JOHN KERR (SCOTLAND)**
  He demonstrated the quadratic electro-optic effect (the Kerr effect) in glass.
- **~1879: JOSEF STEFAN (AUSTRIA)**
  He presented an empirical relationship which asserted that the total radiant energy emitted from a body per unit time is proportional to the fourth power of the absolute temperature of the body.

- **~1879: JOSEPH SWAN (ENGLAND)**
  He demonstrated an electric lamp with a carbon filament.


Joseph Swan (1828-1914)

- **~1879: THOMAS ALVIN EDISION (USA)**
  He developed the electric lamp using cotton as the source of the carbon filament and produced it as a practical device.


Albert Abraham Michelson
(1852-1931)

- **~1882: ALBERT ABRAHAM MICHELSON (USA, B. POLAND)**

  He described Michelson's interferometer. He performed a series of experiments to determine the speed of light using a rotating mirror method with alight path from the observatory at Mount Wilson to a reflector of 22 miles (35 km). He obtained an average value of in 1926.

- **~1885: JOHANN JAKOB BALMER (SWITZERLAND)**

  He presented an empirical formula describing the position of the emission lines in the visible part of the spectrum of hydrogen.

- **~1887: ALBERT A MICHELSON & EDWARD MORLEY (USA)**

  They had their unsuccessful attempts to detect the motion of the earth with respect to the 'LUMINIFEROUS AETHER' by investigating whether the speed of light depends upon the direction in which the light beam moves (The Michelson-Morley experiment).

- **~1887: HEINRICH HERTZ (GERMANY)**

  He accidentally discovered the photoelectric effect.

- **~1890: O WIENER**

  He observed standing waves in light reflected at normal incidence from a silver mirror. Nodes and antinodes in the standing wave were detected photographically and it was concluded that a node exists at the mirror surface. From this it is concluded that, at least as far as photographic effects are concerned, the electric component of the electromagnetic wave has the more important effect.

- **~1891/1892: L MACH AND L ZEHNDER**

  They separately described what has become known as the Mach-Zehnder interferometer which could monitor changes in refractive index and hence density in compressible gas flows. The instrument has subsequently been applied in the field of aerodynamics.

- **~1895: D J KORTEWEG AND G DEVRIES (NETHERLANDS)**

Korteweg and his student Devries, derived a non-linear partial differential equation governing the propagation of waves in shallow water that described the soliton wave described by john Scott Russell. KDV equation has had an important role in the development of the mathematical description of solitons.

- **~1896: WILHELM WIEN (GERMANY)**

He described how the spectral distribution of radiation from a black body varies with the temperature of the body.

- **~1896: PIETER ZEEMAN (NETHERLANDS)**

He had an observation that the spectral lines emitted by an atomic source are broadened when the source is placed in a magnetic field.

- **~1899: LORD RAYLEIGH (ENGLAND)**

Lord Rayleigh (John Strutt) (1842-1919)

He explained the blue color of the sky and the color of the sun during sunset and sunrise as being due to the preferential scattering of blue light by molecules in the earth's atmosphere.

- **~189: MARIE A C FABRY AND JEAN B G G A PEROT (FRANCE)**

They described the Fabry-Perot interferometer which enabled high resolution observation of spectral features.

- **~1900: MAX KARL PLANCK (GERMANY)**

  In his successful explanation of the spectrum of radiation emitted from a hot black body, Planck found it necessary to introduce a universal constant. A consequence is that the energy of an oscillator is the sum of small discrete units, each of which has a value is proportional to the frequency of oscillation.

Note: We have tried to cover the "History of Optics" until the beginning of the twentieth century.

Mars Orbiter Mission

Biswajit Mohanty, Dhrutisundar Parida, Niranjan Prusty, and Priyabrata Swain
Department of Physics, Nayagarh Autonomous College
Nayagarh, Odisha-(India)-752069.
Email: mohantybiswajit80@gmail.com

Abstract: Mars is the second smallest planet of our solar system. It is also called Red Planet because of its red appearance. It is a terrestrial Planet with a thin atmosphere and possesses some features like volcanoes, valleys, deserts and polar ice caps, similar to that of the Earth. The rotational period and seasonal cycles on mars are similar to those of Earth. It has two moons named phobos and Deimos. In 1965 it was speculated after observations by Mariner-4 that the surface of Mars was covered with a lot of water bodies. This fact was supported by the later unmanned missions, whose geological evidence suggested that once Mars had large scale water coverage on its surface. Radar data also proves the presence of large quantities of ice at its poles and mid-latitudes. In 2007 some water containing compounds were collected by rover with Spirit. Our space agency ISRO is now looking forward to two key dates, December 1,2013 when the Mars Orbiter Mission(MOM) space craft leaves the Earth's gravitational field and September-24,2014 when it is captured by the Martian orbit. Till now 51 numbers of such attempts have been made by various countries, out of which only 21 numbers of such mission have succeeded.

1. INTRODUCTION

In our solar system Earth is said to be the sole planet. Hence, utilising his powerful intellect and wisdom, man has started to explore the possibility to build shelter in any other planet. In this quest Mars is considered to be a good option. Amidst a number of criticisms, hopes and aspirations, India has advanced one step forward in the journey to space. Our country's tryst with space science dates back to ancient astronomers and mathematicians like Aryabhatta, Bhaskar, Brahmagupta, Pathanisamanta and many others who have striven a lot to understand and explore apace. Since 1960 India has taken deep interest in the field of space science. After the successful completion of Chandrayaan-1, India became very enthusiastic to start the Mangalayan mission.

With a view to reveal the unknown facts and to study various aspects of the parameters supporting the existence of life on mars, three countries namely USA, Russia and Europe had undertaken such attempts. India will be the fourth country and first in Asia to keep pace with the mission in the name of Mars Orbiter Mission (MOM).

2. MAJOR SECTIONS

2.1 Objectives

It is India's first interplanetary mission, where an orbiter is carried to Mars on being boarded on PSLV-C25, indigenously built by India. This earlier version of the launch vehicle has been improvised to suit the needs of Mars mission. Primary among these changes being that it would successfully carry out a flight which has twice its usual payload. That would be a display of India's ability to conceive, design, develop and execute a complex space mission. On reaching Mars orbit, the focus would shift to the various instruments, that are on board of the orbiter, which would carry out a number of information gathering exercises such as detection of methane, charting of Martian surface, surveying of soil composition, understanding the presence of water and monitoring surface weather phenomenon on the planet. MOM will serve as a technology demonstrator for future space mission. Mangalayaan's journey is a 300 day, 78 crore km journey to orbit Mars and survey its geology and atmosphere. At its closest point it will be 365 kms from the planet surface and at its farthest 80,000 kms. The 1337 kg Mars orbiter satellite will be put into a 250 km ×23,500 km elliptical orbit into its trajectory in about 44 minutes.

2.2 Time Line of the Mission

cAccording to ISRO chief Radhakrishnan, India's attempt in this field is an interplanetary mission which would pass through three phases namely Geo centric, Helio centric and Martian. On 5th November 2013the 44.5 metre PSLV C25 will launch MOM into an initially elliptical Earth parking orbit of 248k.m.×23000k.m.. On 1st December when the spacecraft will be injected, it will leave Earth's orbit into outer space in a trajectory where it will be computed for 280 days ahead of positioning it near Mars. For these days the space craft will float through the inky void towards

Mars. During November 5 to November 30, when the orbiter will move around Earth at a position 250kms away from equator(perigee), its apogee will be raised to 132,000kms from 23,500kms on November 16 firing its motors from ISRO'S telemetry, tracking and command network. On 1st December the motor will be fired at 00.42am (IST), so that the velocity at the orbiter will rise and will start its journey towards Mars. After nine months on September 2014 another firing of motor will reduce the velocity so that the orbiter will precisely capture the martian orbit. The speed of the space craft will be 9.8kms/sec. After launch during 5 orbit raising manoeuvres and trans orbitr injection will be given an additional velocity of 1.55kms/sec. For its nine months journey and reduced to 1.11kms/sec. On 24th September. After reaching Mars orbit, the orbiter will move at that speed for over six months.

2.3 Instruments Present on the Orbiter

MOM satellite has carried five instruments of mass 15kg to study martian surface, atmosphere, mineralogy and many other parameters. Its payload comprises, besides the Tri colour; Mars Colour Camera to image the planet and its two moons, phobos and Diemos, the Lyman Alpha Photometer to measure the abundance of Hydrogen and Deuterium and understand the Planet's water loss process, a Thermal Imaging Spectrometer to map surface composition and mineralogy, the MENCA mass spectrometer to analyse atmospheric composition and the Methane Sensor for Mars to measure traces of potential atmospheric methane down to the ppm level.

2.4 Mission Plan

The mission planning is done in conjugation with three phases:

(a) Geo-centric Phase:

The spacecraft is injected into an Elliptical orbit by the launcher. With six main engines, the spacecraft is gradually manipulated into a hyperbolic trajectory with which it escapes from the Earth's sphere of Influence (SOI). The SOI of earth ends at 918347 km from the surface of the earth beyond which the disturbing force on the orbiter is due to the sun only. One primary concern is how to get the spacecraft to

Mars, on the least amount of fuel. ISRO uses a method of travel called a Hohmann Transfer orbit Or a Minimum Energy Transfer orbit to send a spacecraft from Earth to Mars with the least amount of fuel possible.

(b) Helio-Centric Phase:

The spacecraft leaves Earth in a direction tangential to Earth's orbit and encounters Mars tangentially to its orbit. The flight path is roughly one half of an ellipse around sun. It will intersect the orbit of Mars at the exact moment that Mars is there too. This trajectory becomes possible with certain allowances when the relative position of Earth, Mars and sun form an angle of approximately 44°. Such an arrangement occure periodically at intervals of about 780 days. Minimum energy opportunities for Earth-Mars occur in November 2013, January 2016, may 2018 etc.

(c) Martian Phase

The Spacecraft arrives at the mars sphere of influence (around 573473km from the surface of mars) in a hyperbolic trajectory. At this time the spacecraft reaches the closest approach to Mars, then it is captured into planned orbit around Mars which is called the Mars Orbit Insertion (MOI).

2.5 Programmes so far

Under the name of Mars Orbiter Mission(MOM) India launched its Orbiter from Satish Dhawan Space Centre, Sriharikota on 5th November 2013, exactly at 2.38pm(IST). The rocket on which the orbiter was launched was a polar satellite launching vehicle(PSLV-C25) weighing 320 tonnes and having a height of 44 metres. Rupees 110 crores have been spent in making this. It carried 1340kg Mars Orbiter costing rupees 150 crores. For augmenting the ground support about 90 crore rupees have been spent in this mission. About forty four minutes after lift-off, the solar panels and the main dish shaped antenna of the spacecraft got successfully deployed. Subsequently, the other intended operations to accurately stabilise the spacecraft were also performed successfully.

The first orbit raising of Mars orbiter was performed in the wee hours on Thursday, two days after its successful launch into orbit around the earth. At 1.17 a.m., the first five liquid apogee motor (low) engine of 440 Newton thrust of the space craft was fired for 416 seconds by commanding it from space craft control at ISTRAC. With this the space craft apogee has been raised to 28,825 km while its perigee was at 252km.

The second orbit raising manoeuvre that started at 2.18 am on Friday has been successfully completed. The on board motor of orbiter was fired for 570.6seconds taking it to 40.186km apogee from the Earth level of 28,814km.

2.6 Conclusion

After a journey of 300 days and nearly 700mn km, if all goes well, Mangalayaan will enter the orbit of Mars. It will then try to explore the mineral composition of the red planet.It will try to find methane on the Martian surface. The presence of methane gas is an indicator of biological presence & the biological presence leads to prove about the existence of life.

This is an achievement that the Mangalayaan happens to be the most economical orbiter till date.The Mars Orbiter Mission launched its orbiter from Satish Dhawan space centre, Shriharikota on 5th November 2013, exactly at 2.38 pm. The mission has cost the country ₹450crore. It is the cheapest ticket to the Red planet, & a world Record in the history of mars exploration. Because it carried a low price tag way as compared what NASA, the European space Agency, Japan and china spent on their journey mars. If all goes well the craft will enter the Mars orbit on September 21 of this year. It is the perfect and precise launch and is the first major test in inter-planetary mission.

Hence, the chairman of ISRO, Dr. K. Radhakrishnan and the scientists utilised their scientific intellect, endurance, desire and they provide the opportunities to keep up our nations dignity though India is striving under poverty, hunger, illiteracy, sanitations & so many other burning problems. So friends lets congratulate and appreciate the deeds of our scientists and expect an optimistic result from the mission.

Figure 1. PSLV – C25

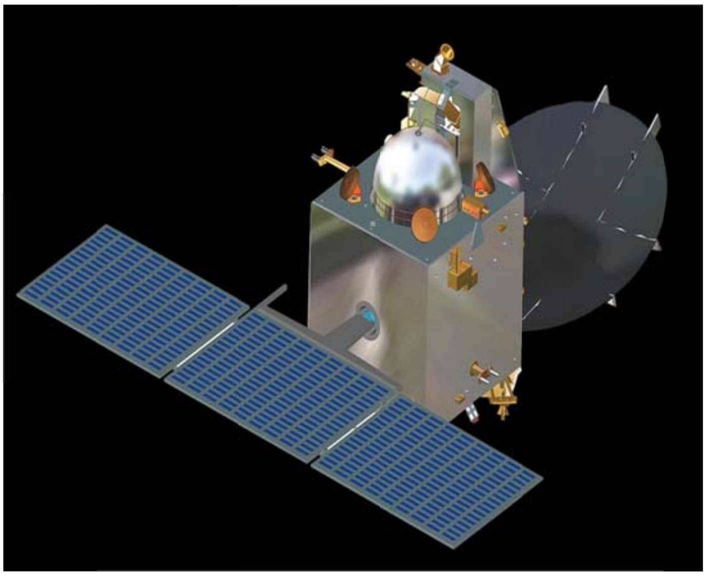


Figure 2. Mars Orbiter

Figure 3. Mars Orbiter Construciton.

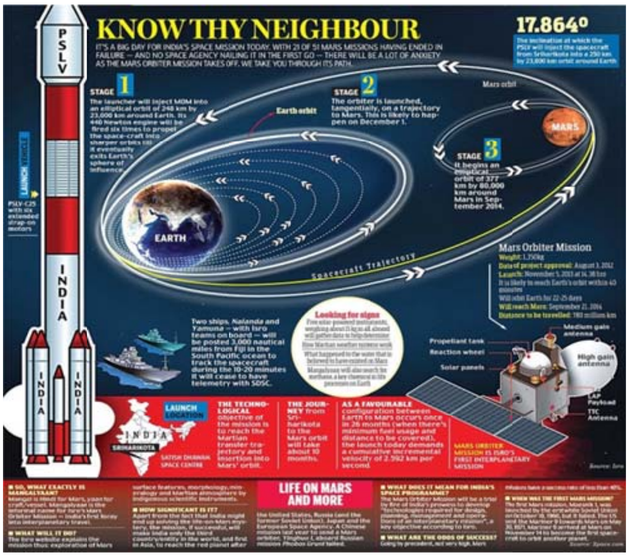


Figure 4. Mission Plan

Acknowledgements

The authors wish to acknowledge Dr. Bipin kumar Pattnaik(P.hd in Physics) for his constant guidance & support in collecting data & preparing manuscript and also to the principal to the Nayagarh Autonomous College for allowing us to attend the symposium.

References

[1] C. George, “ ISRO’s official website-www.isro.org/pslv-c25/mission.aspx”.
[2] P.C.Mohanty, “Mars Orbitor Mission -*Science Horizon*” ,page No.-42-46 (nov-2013).
[3] S.Laxman,“ *Times Of India*”, pg. no-9,Dt-31.10.13

From Natural to Artificial Atoms: Expanding Horizon at Nanoscale

Neha Katoch and Ajay Verma
Department of Physics, Himachal Pradesh University, Shimla 171005.
Email: nehakatoch2@gmail.com, theinvincible001.sufi@gmail.com

Abstract: The advent of Nanoscience as envisioned by nobel laureate Richard P. Feynman proclaiming that "There is Plenty of Room at the Bottom" has pushed frontier in physics forward towards fulfillment of an alchemist dream of creating new elements but without a nucleus. Today we have technologies by which we have moved from the natural atoms to creation of artificial atoms with a novel way of confining electrons in the small space which are not exactly the new elements but confine electrons in the same way as in a natural atom but without the requirement of a charged nucleus. This is leading to the emergence of new possibilities influencing new technologies.

In this poster we present a comparison of the world of artificial atoms with natural atoms and how these so called artificial atoms are bringing new paradigm shifts to very well established technologies from long distance communication to design of quantum computers.

1. INTRODUCTION

Key to making Natural atoms in nature and Artificial atoms in laboratory is confinement of electrons by some means. For all the Natural atoms listed in the periodic table confinement is because of the attractive electrostatic potential between the positively charged nucleus and negatively charged electrons surrounding nucleus.So the question is if by some other means we can confine the electrons of such atoms termed as artificial atoms.

Natural atoms (such as neutral atoms and ions) Artificial atoms (such as superconducting circuits or semiconductor quantum dots or spins in solids) [1]. Semiconductor nanocrystals are called Artificial atoms because of their atom-like discrete electronic structure resulting from quantum confinement [2]. Natural and artificial atoms can be coupled with each other and can also be interfaced with photons for long-distance communications. Quantum dots are fascinating objects,since in some respect they can be regarded as artificial atoms and exhibits discrete and tunable structure in its optical and electrical characteristics. Quantum dots are semiconductor nanocrystals whose exitons are confined in all three dimensions of space. The most attractive property of quantum dot is tunability of electronic energy levels. Among the most successful and rapidly developing ways of realizing Quantum Computation are those using natural atoms and artificial atoms. Contrasting natural and artificial atoms would help highlighting their strengths.

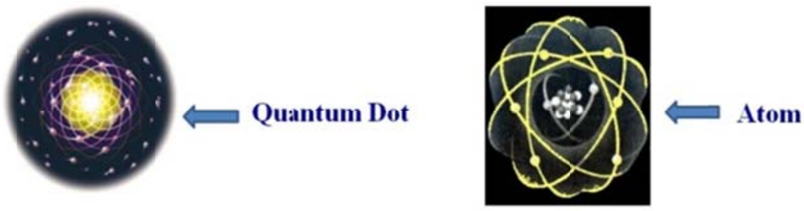


Figure 1: Schematic representation of a typical atom and quantum dot [3].

A Quantum Dot (semiconductor nanocrystals) contains discrete energy, much like an Atom. They are sometimes called "artificial atoms." Artificial atoms can be produced in large numbers and "wired" together on chip. Natural atoms are not wired so they can form almost any 2D or 3D configuration**.**

2. DISCUSSIONS

Classification of artificial atoms [4]

The classification of artificial atoms are shown in Fig. 2. Fig. 2(a) shows s Superatom which is semiconductor heterostructure consisting of a core modulation doped with donors and a surrounding impurity free matrix of greater electron affinity. Fig. 2(b) consists of superantiatom which has a charge distribution similar to a superatom but with the sign reversed. Fig. 2(c) and 2(d) shows inverse superatom and inverse superantiatom respectively. These structures also have bound electrons or holes but the doping is performed in the surrounding matrix.

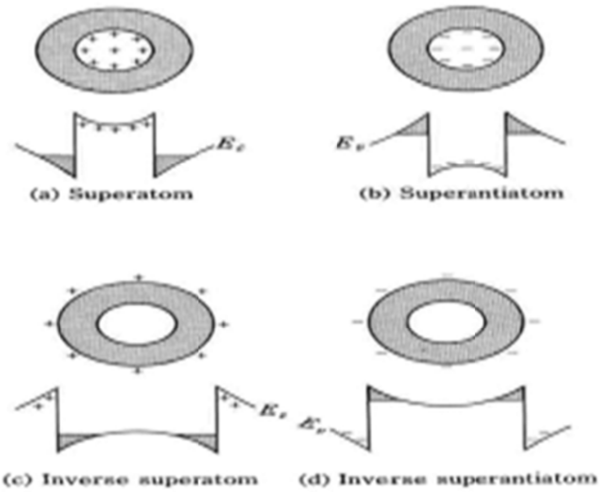


Figure 2. Classification of artificial atoms by structure.

QUANTUM CONFINEMENT [5]

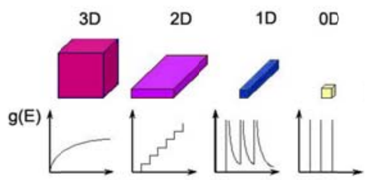


Figure 3: A single isolated quantum dot as an artificial atom. (a) Density of states in one band of a semiconductor as a function of crystals dimension. The energy levels become discrete near the Fermi level for “0D”

3. COMPARISON BETWEEN NATURAL ATOMS AND ARTIFICIAL ATOMS[1]

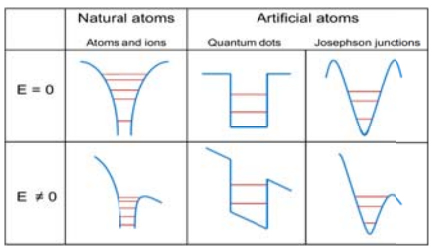


Figure 4: Applied external fields derive coherent quantum oscillations between the specific energy levels which can be used to encode the qubit states. Artificial atoms can be engineered t o have transition frequencies (Microwave and Optical frequencies) while in natural atoms these are fixed.

Table 1: Comparison between natural and artificial atoms [1].

	NATURAL ATOMS		ARTIFICIAL ATOMS	
	Neutral atoms	Trapped ions	Superconducting circuits	Spins in solids
Energy gap	GHz (hyperfine) 10^{14} Hz(Optical)	GHz (hyperfine) 10^{14} Hz(Optical)	1-10 GHz	GHz, 10^{13} Hz
Photon	Optical, MW	Optical, MW	MW	Optical, MW, Infrared
Dimensions	~2 Ang	~2 Ang	~µm	~nm
Distance between qubits	< 1 µm	~5 µm	~µm	~1o nm, ~100 nm
Operating temperature	nK-µK	µk-mK	~mK	Mk – 300 K
Qubit interactions	Collisions, exchange	Coulomb	Capacitive, inductive	Coulomb, exchange, dipolar

4. TOOLS FOR MAKING QUANTUM DOTS

a) Electron Beam Lithography
b) Molecular Beam Epitaxy
c) Microfabrication

5. HYBRID DEVICE [1]

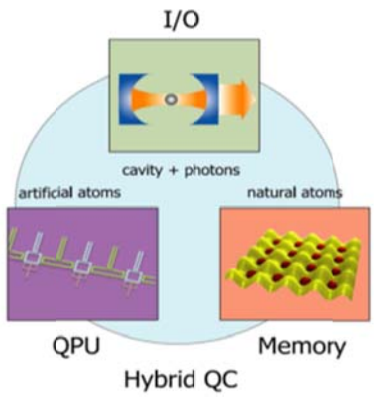


Figure 5: Schematic representation of a hybrid device consisting of natural atoms as quantum memory, artificial atom as "quantum processing unit" (QPU), and an input/output (I/O) photonic interface.

6. QUANTUM COMPUTER [6]

A design which uses the principle of quantum to increase the computational power beyond traditional computers [6].

Table 6. Quantum Computers Vs. Traditional Computers [6]

Quantum Computers	Traditional Computers
a) Computers would store information as either 1, 0, or a quantum superposition of the two states, allows for far greater flexibility.	a) Computers function by storing data in a binary format or bit (1s & 0s).
b) Because of Quantum Parallelism it would be able to perform calculations on a far greater order of magnitude	b) Not possible in case of traditional computer.

8. APPLICATIONS OF ARTIFICIAL ATOMS

a) Nanoelectronics
b) Quantum Computation,Photonic devices: solar cells, Light Emitting Diodes, Photo detectors, LASER
c) Biology: biosensors, imaging.
d) Flat -panel Display, Memory elements.

Acknowledgements

We extend our heartfelt gratitude to Prof. Raman Sharma, Chairperson, Department of Physics for informing us about the student symposium and Prof. P.K.Ahluwalia, Dr. Ashok Kumar, Miss Pooja (Solid State Physics Group) and for numerous discussions.

References

[1] Buluta, S.Ashhab and F. Nori *Rep.Prog.Phys*,74 (2011) 104401.
[2] W.A.Tisdale, Proceedings of the National Academy of Sciences,108(2011) 3
[3] http://oemagazine.com/fromTheMagazine/oct02/images/quantumdotsill.jpg
http://home.arcor.de/cybertaro/kosmologie/atom.jpg
[4] H.Watanabe and T.Inoshita *Optoelectronics* 1(1),1986,3.
[5] Annu.Rev.Phys.Chem.2010.61:369-389.
[6] Physics.about.com/od/quantumphysics/f/quantumcom.htm
[7] C. P. Poole, Jr. Frank J. Owens, “Introduction To Nanotechnology”

About IAPT

A voluntary organization of Physics Teachers (at all levels), Scientists, professionals and other interested in physics (Science) education in the country.

Indian Association of Physics Teachers (IAPT) was established in 1984 by dedicated physics teacher and visionary (Late) Dr. D.P. Khandelwal with active support from likeminded features with the aim of upgrading quality of physics teaching at all level in the country. Since then it has grown into a major organisation with about 6000 members spread over throughout the country and abroad, besides annual members, student members and sustaining members. All IAPT work in voluntary, no remuneration is paid to members for any IAPT activity.

The Association operate through its 20 Regional Councils (RCs) grouped into 5 zones. These is a central Executive Council (EC) which controls and coordinates all its activities. Regional Councils also have a similar structure.

Current Activities of IAPT

Publications

Bulletin – a monthly (32 pages) with the record of uninterrupted publication since 1984. Besides reporting IAPT activities it also carries articles on developments in physics and physics education. Free to the members, it also serves as a vehicle of expression and communication amongst them.

Journal of Physics Education – The IAPT has taken over the publication of this quarterly (previously published by UGC) publication since April 2001 (volume 18). Life members of IAPT can get it at concessional rate. It carries research articles on Physics education

Student Journal of Physics – A quarterly journal carries out articles and research reports by UG/PG students. It also carries invited articles from physicists of repute, now rechristened as *Student Journal of Physics.*

Pragami Trang – This bilingual (Gujarati & Partly English), has been started since 2009 by Gujarat RC.

Horizons of Physics – In a book series brought out for physics teachers and students. Each volume contains about 15 review articles written by experts, taking off from the B.Sc. level and leading to the frontiers of the field.

National Standard Examinations

National Standard Examinations are held at 3 levels with the objectives: to enable the student judge him/herself against a national standard; to present correct perspective of physics; to enhance the students-teacher interaction through discussion on the Q-paper. Members or students are identified, duly honoured and awarded medals and token prizes. These examinations constitute the first step towards participation in International Olympiads in respective subjects. The responsibility of selecting and sending the Indian team to the international Olympiads rests with the Homi Bhabha Centre for Sciences Education (HBCSE) with whom IAPT works in close collaboration.

Evaluation of experimental skills

IAPT started this evaluation with NSEP and NGPE, examinations since 1992, essentially to stress the point that no evaluation of a science student is complete without inclusion of an evaluation of experimental skills.

Extra Low-Cost Book (ELCB) programme

Under this programe life members are offered quality physics books at a considerable discount, under arrangement with publishers. The aim is to help teachers build up their personal libraries.

For Teachers

NCIEP (National Competition for Innovative Experiments in Physics): This programme is being held since 2003, to encourage Physics Teachers to conceive and set up original innovative experiments in Physics. The Competition is held every year at the venue of The Annual Convention. The high quality of entries shows the usefulness of the programme.

National Competition for Computational Physics (started 2011)

Essay Competition: Gujarat RC of IAPT organizes a National Essay Competition for all teachers for the last few years.

Anveshikas (Experimental Physics Centres)

The first such centre was established at SGM Inter College, Indira Nagar, Kanpur in 2001. It provides a base for generating interest in Experimental Physics in young students. upto +2 level through learning by doing. Facilities exist for conducting Teachers Orientation Programmes for encouraging them to undertake class room teaching through demonstrations. A mobile unit gives demonstrations in schools by prior appointment. Each demonstration session is of about 2-3 hour duration. This programme generates interest is students for Physics and clarifies the basic principles. A number of such centres are now coming up in the country.

NANI: It has been decided to establish a National Anvashika Network of India (NANI) of 100 Anveshikas. Already (2011) nearly 15-20 Anveshika's have come into existence others are in the offering.

Centre for Scientific Culture (CSC): The Centre established at Midnapore CoIlege, Midnapore (WB), provides an year round exclusive facility, of working experiments in Physics. It is also engaged in developing laboratory experiments exercises in physics at school level.

Orientation Programmes/Seminars/Workshops for Teachers

These are organised regularly by Regional Councils in both, theoretical and Experimental Physics. A number of such programmes have been carried out with the support from MHRD, Infosys Foundation and other such agencies.

Conventions

A 3-day National Convention is organised every year, since 1984 on some specific theme. Papers are presented by members and lectures are delivered by experts in the field. Presentation of innovations in teaching methods, demonstrations and lab experiments is a regular feature in all conventions. Regional Councils also organise regional conventions at their convenience. Teachers' talent in various aspects of Physics education is identified and rewarded by organizing contests during conventions.

About Department of Physics, Panjab University

The Department of Physics was established in 1947, in Govt. College, Hoshiarpur (Punjab). In August 1958, the department was shifted to the present campus. At that time, the department was headed by Prof. B.M. Anand who had worked with Nobel laureate C.F. Powell. The faculty numbered about a dozen and Prof. Anand soon established a high-energy particle physics group (nuclear emulsion) and optical UV spectroscopy group. The experimental nuclear physics group and mass spectrometry section came into existence soon after.

With Prof. H.S. Hans joining the department in the late sixties, the research activities got a major fillip—cyclotron was installed. Three major research groups in nuclear physics, particle physics and solid-sate physics including both theory and experiments were strengthened and mass spectroscopy laboratory was modernised. Since then the department never looked back. It has UGC Special Assistance Programme (SAP) from 1980 to 1988 and College Science Improvement Programme from 1984 to 1991. With the success of the above programs and of research activities in particle physics, nuclear physics and solid-state physics through national and international collaborations, the department became a major research centre amongst Indian universities.

In 1988, the department was accorded the status of Centre of Advanced Study (CAS) by UGC with three major thrust areas, particle physics, nuclear physics and solid-state physics, which is a unique feature in itself. The department is now in CAS forth phase. At present the department has a strength of 29 faculty members, 47 non-teaching/administrative staff, around 120 research students, 15 M.Phil. students, 10 Post-M.Sc. Course in Accelerator Physics students and about 350 graduate and undergraduate students. Our students clear various entrance examinations, like GRE, BARC, TIFR, DRDO, UGC/CSIR test for research and career in teaching, besides entering professional courses, like M.Tech., MCA, etc. About 30 research projects worth eight crore rupees under national/international collaborations are operating in the department.

Besides imparting quality education to the department students, the faculty also teach specialisation subjects, like nano-technology, nuclear medicine and medical physics to name a few. The department participates in various national and international research initiatives and also hosts various conferences, seminars, meetings etc. of research interest regularly. The department has an 11-inch telescope to encourage/inculcate the scientific temper among public and with particular emphasis on college and school students.

The department houses Indian Association of Physics Teachers (IAPT) office and actively leads in IAPT and Indian Physics Association (IPA) activities.

Acknowledgements

We sincerely acknowledge financial support for the 2nd IAPT National Student Symposium on Physics from the following agencies/individuals:

- Indian Association of Physics Teachers
- Department of Physics, Panjab University, Chandigarh
- Department of Science & Technology, UT Chandigarh
- Punjab State Council for Science & Technology, Chandigarh
- Pyramid Electronics, Parwanoo

National Advisory Committee

- A.K. Grover (V-C, PU Chandigarh): **Patron**
- R. Chidambaram (New Delhi)
- P.N. Ghosh (Kolkata)
- S.D. Mahanti (USA)
- H.S. Mani (Chennai)
- J.V. Narlikar (Pune)
- Satya Prakash (Chandigarh)
- T.V. Ramakrishnan (Bangalore)
- D.P. Roy (Mumbai)
- Milan Sanyal (Kolkata)
- Ashoke Sen (Allahabad)
- Vijay Singh (Mumbai)
- M.S. Sodha (Lucknow)

National Organising Committee

- H.C. Pradhan (Mumbai) – Chairman, NSSP 2014
- L. Satpathy (Bhubaneswar) – Convener, NSSP 2014
- Manjit Kaur (Chandigarh)
- Neelam Gulati Sharma (Chandigarh)
- P.K. Ahluwalia (Shimla)
- S.K. Joshi (Ratlam)
- S.N. Tiwary (Ranchi)
- Gajanan Patil (Sangli)
- A. Anandavadivel (Chennai)
- H.C. Verma (Kanpur)
- Bhupati Chakrabarti (Kolkata)
- U.S. Kushwaha (Chandigarh)
- M.L. Ogalapurkar (Pune)
- B.P. Tyagi (Dehradun)
- K.N. Joshipura (Vallabh Vidyanagar)
- Ravi Bhattacharjee (Delhi)
- A.M. Srivatsava (Bhubaneswar)
- R.P. Malik (Varanasi)
- P.K. Panigrahi (Kolkata)

Local Organising Committee

- C.N. Kumar (Coordinator)
- Kuldeep Kumar (Secretary)
- D. Mehta
- N. Goyal
- B.C. Chaudhary
- P.S. Gill
- M.S. Marwaha
- P.N. Pandit
- Sheojee Singh
- Ranjan Kumar
- Sunita Srivastava
- Bimal Rai

List of Participants

D B Mankad	Christ College Rajkot
Geetanjali Sharma	DAV Indore
Roma Khullar	DAV Indore
Aditi Biswas	HSGU, Sagar
M. Sai Sruthi	MPGC, Vizag
Abinas Pradhan	NIT Rourkela
Siddhant Das	NIT Tirchy
Nisha Tiwari	SAC Jabalpur
Richa Gupta	SAC Jabalpur
Jeral A Singh	SAC Jabalpur
Anjula Tirkey	SAC, Jabalpur
N. Venkata Raveendra	SVU Tirupati
Christopher George	SXC Ahmedabad
Purva Diwanji	SXC Ahmedabad
Sudeep Dighe	SXC Ahmedabad
Bhumika Shah	SXC,Ahmedabad
Manisha Srivatsava	Allahabad

Kruti Ghoda	SU Rajkot
Riddhi Radadiya	SU Rajkot
Rashmi Radadiya	CC Rajkot
Anjali S Nair	KU Kerala
D S Neileena	KU Kerala
Humera Mumtaz	MMU Mulana
Jhalak	MMU Mulana
Neha Soni	MMU Mulana
Neha Soni	MMU Mulana
Biswajit Mohanty	Nayagarh, Odhisa
Dhruti sundar Parida	Nayagarh, Odhisa
Niranjan Prusty	Nayagarh, Odhisa
Priyabrata Swain	Nayagarh, Odhisa
G B Panchal	NSC Surat
H H Chavadiya	NSC Surat
H V Paladiya	NSC Surat
Joshi A Paul	NSC Surat
Hirpara Radhika	NSC Surat
Gunjan Thukral	PAU Ludhiana
Honey Arora	PAU Ludhiana
Kamalpreet Kaur	PAU Ludhiana
Kanupriya Dawar	PAU Ludhiana
Komal Kirandeep Kaur	PAU Ludhiana
Mehak Aggarwal	PAU Ludhiana
Monica	PAU Ludhiana
Naresh Sharma	PAU Ludhiana
Neha Goyal	PAU Ludhiana

Ramandeep Kaur	PAU Ludhiana
Sheenu Juneja	PAU Ludhiana
I Chauhan	RCUPG Uttarkashi
K Divyaben Laljibhai	SPSTC Surat
Patel B Bharatbhai	SPSTC Surat
A Divyakumari Manharsinnh	SPTSC Surat
B. Ajaykumar N Bhai	SPTSC Surat
A Praveen Kumar	SUVCS Tirupati
M.Reddy Prakash	SUVCS Tirupati
Ravi Sharma	BU Bhopal
Varun Khade	BU Bhopal
Nidhi Dhirajlal Bathani	CC Rajkot
M . Bhavik Patel	CC Rajkot
Rahul M.J.	CC Rajkot
Mansi Garg	Delhi University
Shikha Sharma	Delhi University
Swati Chhikara	Delhi University
Tanushree	Delhi University
Vaishali Jain	Delhi University
R.S.Gill	ISM Dhanbad
Sanjeet singh	ISM Dhanbad
Abhishek Dubey	ISM Dhanbhad
Gowthaman. I	JMC Trichy
Surender P	JMC Trichy
Ankur	KUK Kurukshetra
Monika	KUK Kurukshetra
Payal Wadhwa	KUK Kurukshetra
Sanchita	KUK Kurukshetra

Deepak Kumar	KUK Kurukshetra
Anurag Sahu	LBS Sironj MP
Himadri Saini	MSU Baroda
Avik Dasgupta	MSU Baroda
Chandra Sekhar Saraf	MSU Baroda
Vishnu Lohar	MSU Baroda
Barinder Kaur	PAU Ludhiana
Sheenam Saxena	PAU Ludhiana
Sunpreet Kaur	PAU Ludhiana
Rehan Ahmed Ali	RBSC Jalna
S N Nautiyal	RCUPG C Uttarkashi
P.Komalkumari K	SPTCS Surat
P.Maulik Kumar S	SPTCS Surat
Adhish Vinodbhai Raval	SVNIT Surat
Vipin Prajapati	SVNIT Surat
B.Surendra Babu	SVU CAMPUS Tirupati
H.Anil Kumar	SVUCS Tirupati
N Purushottam Reddy	SVUCS Tirupati
P Siddik	SVUS Tirupati
Nirmal Kullu	SXC Ahmedabad
Chamandeep Kaur	SXC Ahmedabad
B. Madhubabu	Tirupati
Ragini Mishra	Univ allahabad
Surendra V Singh	Univ. allahabad
Amanjot Kaur	PU Chandigarh
Anjali Sharma	PU Chandigarh
Kavita	PU Chandigarh
Neha	PU Chandigarh

Ramanpreet Kaur	PU Chandigarh
Richa	PU Chandigarh
Sandeep Kaur	PU Chandigarh
Anshu Gupta	PU Chandigarh
Deepti Rana	PU Chandigarh
Jashan Preet Kaur Batth	PU Chandigarh
Kanika	PU Chandigarh
Simrandeep Kaur	PU Chandigarh
Gurpal Singh Khosa	PU Chandigarh
Paramvir Singh	PU Chandigarh
Varun Sharma	PU Chandigarh
Divya Jyoti	PU Chandigarh
Madhu Dhatwalia	HPU, Shimla
Neha Katoch	HPU, Shimla
Ajey Verma	HPU, Shimla
Shammi Kumar	HPU, Shimla
Sahil Verma	HPU, Shimla
Sanjay Kumar	HPU, Shimla
Abhimanyu	HPU, Shimla
S.N.L.Sirisha	DEI, Agra

For Instruction to Author and

Online Version :

See publication at :

http // www.indapt.org

STUDENT JOURNAL OF PHYSICS

Quarterly Student Journal of Physics will now be available by subscription.

Annual (4 issues)	Rs. 150/-
Single Issue	Rs. 40/-

Payment by crossed bank draft in favour of "Indian Association of Physics Teachers" payable at Chandigarh, may be sent to Dr. C.N. Kumar, Managing Editor, Student Journal of Physics, Deptt. of Physics, Panjab University, Chandigarh - 160014

STUDENT JOURNAL OF PHYSICS

IAPT

Volume 5 **Number 2** **July 2013 – March 2015**

CONTENTS

Published on behalf of Indian Association of Physics Teachers, Karve Road, Kothurd, Pune-411 038, Phone : 020 25455504
Printed by Acharya Associates, BS-2/3, Acharya Vihar, Bhubaneswar – 751 013