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99th Session of the Indian Science Congress

SECTION OF

PHYSICAL SCIENCES

President
Prof. B.N. Jagatap



The Indian Science Congress Association

**PROCEEDINGS
OF THE
NINETY NINTH SESSION OF THE
INDIAN SCIENCE CONGRESS
KIIT University, Bhubaneswar
January 03-07, 2012**

SECTION OF PHYSICAL SCIENCES

President : Professor B.N. Jagatap

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99th Indian Science Congress

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Section of Physical Sciences

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I

PRESIDENTIAL ADDRESS

Sectional President
Prof. B.N. Jagatap

Empowering the Nation with Inclusive Innovations

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Honorable Chairman, Distinguished Delegates, Young Researchers,
Students, Ladies and Gentlemen,

At the outset, let me express my deep sense of gratitude to one and all for electing me unanimously the President of the Physical Science Section of the 99th Indian Science Congress. In a sense, you have bestowed upon me the singular honor of presiding over this very special ‘RathYatra’ of the discipline of Physical Sciences in this temple city of Bhubaneswar. I welcome you all to join me in pulling this ‘Ratha’, the rolling palace of this divine discipline, and make this ‘Yatra’ the most memorable and fruitful one. It is in this historical city of Bhubaneswar that in 216 BC, Emperor Ashok realized the essence of conquest by Dharma in contrast to the conquest by force. It is this land that sent the message of peace and non-violence beyond its frontiers, thereby beginning a new era of enlightenment. We, therefore, have a special responsibility of generating, shaping and spreading new thoughts, while deliberating Physics on this very unique land.

Here in Bhubaneswar, hundreds of temples stand majestically manifesting the stone sculpture of highest artistic pursuit. In the words of Gurudev Rabindranath Tagore – *‘At all places where the eye rests and also at places where the eye does not rest, the busy chisel of the artist has worked incessantly. The abode of God has been enveloped by a variety of figures depicting the good and the evil, the great as well as the insignificant, the daily occurrences of human*

life....' In other words the temple art is of highest echelon because it is all encompassing and all inclusive. This 'inclusiveness' makes this art in stone, magnificent and extraordinarily beautiful. It is a matter of great coincidence that the focal theme of this science congress also revolves round the word 'inclusive', i.e., *Science and Technology for Inclusive Innovations*. We are therefore here to deliberate on the inclusiveness in the pursuit of science and technology, and in particular in research in Physical Sciences. I have, therefore, decided to share with you my own thoughts on this subject. This, I do understand, is a deviation from the usual practice followed in recent times, when my distinguished predecessors, the former Presidents of Physical Sciences Section, had given scholarly Presidential Addresses on technical subjects. While requesting your forgiveness on this straying away from the tradition, I would make an attempt to reflect in my Presidential Address your aspirations of making this country an international hub for innovations in science and technology. At the same time, I do understand my own intellectual limitations to deliberate this very important subject that concerns us all. I have, therefore, used freely in my address the wisdom, experiences and reflections of several wise men and thinkers.

Before I begin the discussion on the topic, I would like to make a special mention to the phrase 'Role of Woman' in the theme of this Science Congress. We all do recognize the important role that women have in the development of science and technology, and to this end I shall quote C.V. Raman – *'I have a feeling that if the women of India take science and interest themselves in the progress and advance of science as well, they will achieve what even men have failed to do. Women have one quality– the quality of devotion. It is one of the most important passports to success in science. Let us therefore not imagine that intellect is a sole prerogative of males only in science'*. We all delegates present here salute this spirit.

Friends, India has relatively a long tradition of research in modern sciences, if we take initiation of microwave research in 1888 by Jagadish Chandra Bose as its beginning. Indian was probably the only place outside Europe and US, where the modern science took its roots in early years. This research tradition produced several renowned scientists, J.C. Bose, S.N. Bose, C.V. Raman, S. Ramanujam, Meghnad Saha, Prafulla Chandra Mahalanobis, Homi Jahangir Bhabha, Vikram Sarabhai, K.S. Krishnan and Shanti Swarup Bhatnagar, who left their indelible mark on international science. Their vision and efforts resulted in building institutes of international repute. The country today boasts of a large number of institutes of higher education, consisting of 42 central universities, 256 state universities, 60 private state universities, 130 institutes deemed to be universities, 5 state and 39 central institutes of national importance, and 31,324 colleges. The enrolment of students in these institutes is close to 13.6 million. These resources make us think that India is on the onset of becoming one of the leading knowledge dependent economies. While all of us want to see this happening, the actual picture that has emerged in recent years is somewhat disappointing.

There are several reports and commentaries on the state of Indian science and education, and I shall refer here to only a few observations:

- The gross enrollment ratio for higher education stands at meager 12% which is much below the world average of 20%.
- The percent of total enrollment in research is meagerly at 0.89%, compared to undergraduate (86.55%), post graduate (11.49%) and diploma/certificate courses (1.15%). Total number of Ph.D.s in science is about 8900 per year.
- None of the Indian educational institutes is in top 100 in the ranking of world universities, whereas 35 universities from Asian region have done better than us.

- India spends only about 1% of its GDP on research compared to 2.7% and 3.4% by the U.S. and Japan. This constitutes only 3.7% of the global R&D expenditure and is static for the past five years. During the same period, China has increased its research expenditure from 13% to 18%. Only 4% of the total R&D expenditure in India is for higher educational institutions, compared to 10% in China, 14% in Japan, 17% in the US and 35% in Canada.
- Per 1000 population, India has 7.8 scientists compared to 21.15 in the U.S, 53.13 in Korea, 139.16 in the Russian Federation and 180.66 in Canada.
- India's share of publications in journals is close to 3% for last 10 years, putting us in the 13th position globally.
- India's research papers were cited on average 3.2 times, putting it in the 119th position out of 149 countries.
- In physics, the story is somewhat similar. The survey conducted for the period 2000-2010 shows that the citation per paper in physics for India is 6.91 against the global average of 8.74.
- India has been able to publish only 100 high-cited papers in science and technology during 1997-2007.
- The bulk of Indian research output is being published in medium to low quality journals. For example, top 25 Indian journals together accounted for 14.18% share in the total cumulative publications output by the country during 1997-07. And top 25 foreign journals account for a smaller share, just 7.08% of the country output for 1997-07.

One may go on and on, the message is loud and clear that we are not doing as well as we are expected to do, and this is in spite of the fact that we have about 120 years of tradition of research in modern sciences, and we boast of stalwarts like J.C. Bose, S.N. Bose, C.V. Raman and H.J. Bhabha. Friends, to my mind the

situation is akin to one other experience in the history of our civilization. At the start of this great civilization, we produced two great epics, Ramayan and Mahabharat, and thereafter we kept on rewriting these epics in different forms in all languages, without making an attempt to produce or acknowledge the third great epic. We need to intensely brood on this. We must attempt to understand the dynamics, both social and scientific, in order to check the so called decline of Indian science. It is here that we see that the concept of 'inclusiveness' makes its appearance again and again.

Rajesh Kocher has made some interesting observations on the state of Indian science in his article 'Rise and decline of modern science in India'. I shall draw here heavily from his observations. He divides the century of Indian pursuit of science in three sequential phases— the first one is the 'nationalistic phase' starting from the work of J.C. Bose, the second one is the 'international phase' beginning with foundation of Tata Institute for Fundamental Research (TIFR) by Homi. J. Bhabha and the third 'globalization phase', which began with the liberalization of Indian economy. Kocher then argues that there is a striking correlation between these three distinct phases and the stages in the diminishing role perceived by middle classes for self in the national scheme of things.

Modern science took off in India at a stage when there existed an enhanced sense of Indian nationalism. It was a stage when succeeding in every activity, say it education, literature, sport and science, was an expression of defiance against the colonial rule, it was a statement of demonstration to the British masters that we are equal if not better in every field of life. In this nationalistic phase, science was perceived as a part of the freedom movement. This provided a role for young educated class to pursue research in modern science. Kocher adds two more points in respect of this nationalistic phase of Indian science, firstly the modern science was young and secondly, the caliber of teachers was exceptionally high. The

nascent stage of modern science was important only in the context of doing world class science with modest equipments. It is in this phase, the Indian science threw up several accomplished scientists, practically all the names those we now take with great reverence.

The international phase of Indian science, as Kocher calls it, began with Bhabha's return to India and then starting of TIFR and thereafter the Atomic Energy Establishment (AEE). This phase can be called as the phase of seeking 'self reliance' in science and technology through limited or large scale foreign collaborations. In this phase, 'nation building' was a recurrent theme, and there was a role for young educated class to join in these efforts. This phase was led by Bhabha, Sarabhai and likes of them, who had a significant overlap with the nationalistic phase of Indian science. The success stories included nuclear science and technology, space science and technology and agriculture. Setting up of Indian Institutes of Technology (IITs), institutes of national importance and several central and state universities, was also accomplished in this phase. While this success stories make us proud today, it must be remembered that in this phase more stress was on the building of infra structure and doing things for the first time in India, and that led to basic research of somewhat less quality compared to that in the nationalistic phase.

Now that we are in the 'globalization phase', we need a newer thought for attracting young people to science and technology. We need to sell new dream which the educated class can identify with. Apparently we have none today. Ideas like 'nationalism' or 'nation building', which attracted younger people to 'careers' in science and technology in the first two phases of Indian science, are no longer effective in the 'globalization' phase. If it is a question of 'career' then there are opportunities abound in the globalized economy, and a career in science and technology in the India is not as attractive. At the same time, the science has

grown much faster in other parts of the world, and it may be attractive for a bright young student to join frontline research in a laboratory abroad than pursuing lower level research in India. It appears that there is a lack of clarity on the role and nature of scientific research in the globalized phase. Is this ambiguity responsible for decline of Indian science in recent years? Let us not blame it on the apathy of the society in general or that of younger generation in particular to scientific research. In the absence of any tangible ideology, we have begun to think what Vishnu Kamath has put in the form of two equations,

Good Science = Good Papers = Modern Equipments = More Funds = A Few Centers of excellence. (1)

Talent Search among 1 Billion Population = Raman/Ramanujam = Good Science. (2)

Let us ask ourselves whether or not these equations constitute our collective thought process on the role and nature of science in current times. Is this thinking going to take us too far, we need to discuss. We need to also discuss the ways we can make a mark on present day science and technology, and convert this country into a real powerhouse of innovations. Key to this is 'inclusiveness' in our approach to science and technology.

In the globalized phase, the scientific research must connect to the society, intellectually as well as economically. Research must be seen as an important instrument of economic growth. Researcher must not think that the research is his sole prerogative, but must include people as an important stake holder in the process of scientific research. At least a part of our research must contribute to growth in GDP. Unfortunately we are slow to develop this mind set in this country to a large extent. Our definition of good science (if it is as given by the

equation (1)) is not inclusive of its important stake holder and therefore unsustainable in the current times. There is no role in it for the society at large, and therefore it will develop fatigue for basic research.

Very recently I read a very interesting article by Vijay Prashad in the magazine Frontline. This article quotes a little known report of 2005 by City group analyst on the problem of inequality in the US. This report pointed out that the US economy suffered a severe structural imbalance. The richest 1% of the household earned as much as the bottom 60% per annum, and they held as much as the bottom 90% of the population. What had been produced by this gap was 'Plutonomy' where economic growth is powered by and largely consumed by the wealthy few. The conclusion is – *'The rich would not only be the engines of the economy, but also its consumers. The rest seem to matter very little'*. In the context of Indian science, are we to follow the same approach, that is, *we scientists are not only the promoters of science but also its beneficiaries. The rest are to matter very little*. It is important for us to realize that it is not enough to tell people that scientific research can benefit them, but it must actually benefit. The beneficiaries of science and technology will then become its promoters, and the science will never die in that society. To quote Kocher– *'Science empowers not its worshipers but its harnessers'*.

While we have not factored this issue consciously in our idea of scientific research, the system appears to be correcting itself, albeit slowly. Take for example, the percentage share of some disciplines in the total research publications in India for the period 1996 to 2010. One finds that the share of Physics and Astronomy has decreased from 9.54% in 1996 to 8.86% in 2010. On the other hand the share of research in Medicine has increased from 11.2% to 15.06%, share of Biochemistry and Genetics has increased from 8.59 to 9.65%, and that of Pharmaceuticals and Pharmacology has increased from 2.03% to

5.71%. This trend is indicative of the participation of scientific research in the process of economic growth. The discipline of Physics is yet to realize this, and therefore there has been a steady decrease in its share and may also be in its practitioners.

Friends, another important issue that we must discuss is the wide spread disparity in the development of science and technology in this country. India still lacks equable distribution of resources as may be seen from the geographical distribution of research output as pointed out by Gupta and Dhawan. Nearly 86% of India's research output comes from top 7 high productivity states, namely Tamil Nadu (16.3%), Maharashtra (14.8%), Delhi (13.49%), Karnataka (12.35%), West Bengal (10.96%), Uttar Pradesh (10.60%) and Andhra Pradesh (7.29%). Kerala, Gujarat, Chandigarh, Madhya Pradesh, Rajasthan, Haryana, Uttarakhand, and Punjab are the eight medium productivity states and they together account for little more than 23% of research output. The rest of the country actually does not count in the field of research. This statistic is also deceptive. Take for example, the state of Maharashtra, where the research output is primarily contributed by Mumbai and Pune, the homes of several institutes of national importance. Science and Technology, thus has continued to remain 'elite' as it was during the first and second phase of Indian science. The globalization has happened outwardly and not inwardly. This is a serious problem. We must realize that *'there is a lot of space at the bottom'* where science and technology can flourish in this country. In this context, I am tempted to quote Kocher – *'If the science is to survive in India, education system must step out and embrace children of illiterate parents'*. We must learn from the experience of our cricket, it flourished and we became the world champions when the game moved away from cities like Mumbai, Delhi, Kolkata, Chennai and Bangalore, and percolated to smaller towns and villages. It

is this inclusive approach that will make the country a power house of innovation, and not a few centers of excellence.

Fifty years ago, a reasonably competent researcher could do good quality research in a modest laboratory with equipments that were either build locally or imported occasionally. Today's cutting edge research needs equipments of high technology. High end physics research today requires high energy accelerators, high power lasers, neutron sources, specialized detectors and high resolution microscopes. While the national institutes and institutes of national importance have access to such high technology equipments, the university system is in general devoid of these facilities. With a meager 4% of the total research expenditure, the universities cannot even think of building requisite research facilities for the contemporary research. The result is mushrooming of inferior quality science, which does not lead us anywhere. Unfortunately in India, these two systems, the national institutes and universities, have remained largely isolated. This isolation has to come to an end, since these systems are interdependent; the national institutes have a stake in improving university education for quality manpower, and the universities have a stake in the national institutes for furthering their research. Unfortunately we lack an integrated approach to resolve this issue. Our national institutes must come forward to involve universities firstly in the development of high technology facilities and secondly in the utilization of these facilities for high end research. The universities must provide adjunct positions to scientists from research laboratories for improved academic interactions. In this context, I may recount here my own experience as an adjunct faculty at the Physics Department of Indian Institute of Technology Bombay. It has led to an excellent interaction between IITB and BARC, and in the past two years, several good students have opted to join research at BARC. The immediate future of Indian science lies in such

collaborations. Consequently, we have planned a special symposium as a part of the programme of the Physical Sciences Section on the topic '*Research Frontiers in Physics—Universities and National Institutes Collaborations for Inclusive Innovations*'.

The word 'collaboration' is a rare commodity in Indian science. We still carry the mind set of individual research, spending phenomenal funds in duplicating facilities. Owning an expensive facility has become a matter of primary consideration than doing world class research work. During a national conference held in 2008, I requested Prof. N.J. Mason of UK to speak about his observations on Indian science. The first observation that he had was – '*I sat through 25 odd invited talks and went through 200 odd posters, and I was surprised to find that there is not a single paper written by authors from two or more institutes. In Europe, the situation is exactly opposite, where we collaborate extensively, we prefer to use existing facilities in a collaborative mode rather than duplicating them.*' Collaborative research is a key word in the globalized science and we simply lack it. Every individual scientist by and large is an island and an institute is a cluster of several such islands. Duplication of efforts and underutilization of facilities are far too common in Indian research. Indian scientists appear to be talking science to each other only briefly during conferences and symposia, and not in their laboratories. We need to change this on an urgent basis.

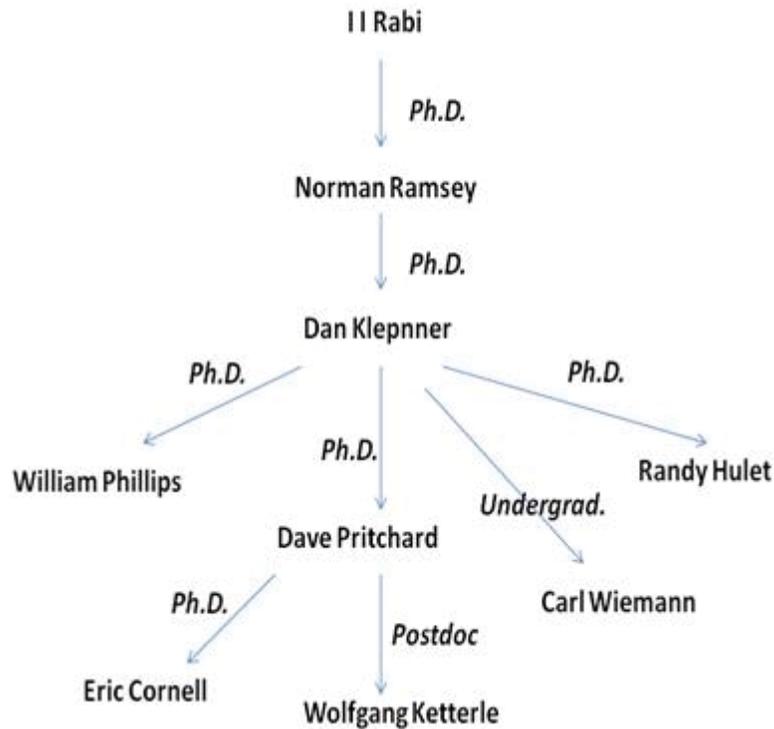
Friends, the development of science and technology is an inclusive phenomenon, and this inclusiveness must be preserved by all of us. Among the various facets of inclusiveness, I would like to touch upon here the inclusiveness relating to the research areas and topics in the contemporary Indian science. In this context, I take the example of Indian research in Physical Sciences. The questions one may ask are- Whether there exist equal opportunities for research in

all relevant branches of Physical Sciences? What are the leading areas of research in India? Whether the Indian research community is sensitive to the advances in potentially technological areas of research? and many more. I shall base my discussion on the detailed survey provided by Gupta and Dhawan. They have compiled a list of major foreign journals publishing Indian research output for the period 1997-2007, which can be used to obtain an idea about the distribution of research interest in Indian science. In the field of Physical sciences, the majority of publications are in the field of Condensed Matter Physics and Material Science with Nuclear and High Energy Physics coming a distant second. Where are then our research contributions in the areas such as Lasers, Optics and Photonics, which are the areas of potential technological applications? While the international research community is making giant strides in these areas, we seem to have a very little presence there. An integrated approach that decides the research priorities in Indian science is must to address these concerns. The very purpose of having a special symposium on 'Advances in Photonics and Metamaterials' in this meeting is to focus our attention on this new emerging area.

In the context of Indian science, there has always been a concern about the general lack of scientists who are willing to ask big questions and address them. The 'big' questions in science inherently involve 'long term' research pursuits. As an example, let us consider the history of research in Bose-Einstein condensation (BEC). From 1924 to 1995, this research led to several important scientific as well as technological advances, which not only culminated into experimental demonstration of BEC, but also changed the course of research in other related fields. Do we really lack of scientists who can ask big questions or is it that we discourage them from doing so? It appears that we have developed such a system of scientific research in this country that it helps those who take 'safe' decisions; it seldom encourages young researchers to take risks and pursue genuine research

problems. The result is that we end up doing ‘incremental’ research, which in the language of Lord Rutherford amounts to ‘stamp collection’.

Unwillingness to ask ‘big’ questions has also led to a general absence of ‘schools of thought’ in Indian science. While in our civilization, we put a great stress on ‘Guru ShishyaParampara’, this concept is nearly absent in Indian science. A scientific thought is not suppose to retire or die with a researcher, but it need be carried over in the next generation with even more vigor. Such research traditions have thrived in Western science at all times. I am tempted here to cite one such tradition, which I have picked up from the Nobel Prize Lecture of W. Ketterle. One may see that the tradition has thrown Nobel Prize winners in every generation.



It is pertinent to ask therefore – Where are our research traditions? Where are our schools of thought? Without strong schools and research traditions we can neither attract bright youngsters to research nor make a significant mark on contemporary science. Existence of several schools of thought was a hall mark of our philosophical development of our society in the early years, this can be very well seen in the writings of Upanishadas. We scientists need to create schools where new thoughts can develop and flourish. Such schools can exist and co-exist provided we have healthy ‘peer’ system in place. The ‘peer’ system in science represents the collective conscious of researchers, where what matters is the scientific truth and not personal views. Western science has developed a strong ‘peer’ system; we however need to walk miles in this direction.

Friends, today the country is ready to invest heavily in science and technology for it is perceived as an investment for a better tomorrow. We scientists are expected to lead the march towards becoming a knowledge centric economy. It is here that we must remember that large research funding does not necessarily ensure success, what we need are enlightened and courageous young researchers. To quote John McCarthy- ‘*An intelligent computer would require 1.8 Einsteins and one-tenth of resources of the Manhattan project to construct*’. Where are these young researchers? We may have the institutes and universities in place, but they do not guarantee the young minds we are looking for. Such researchers are generated in a research atmosphere that is inclusive and which provides optimism for all. In India the thin line between ‘mentoring’ and ‘patronizing’ is very hazy. Mentoring is important for channelizing a young mind and bringing the best of the research output. On the other hand ‘patronizing’ produces two visible classes, the ‘favored’ and the ‘discarded’ ones; the latter being in large numbers bring a general sense of negativism in all our endeavors and scientific research is no exception.

Very recently I was reading an interesting book, ‘The Black Swan’, by Nassim Taleb. A black swan is a phenomenon that occurs rarely and has an extreme impact on our lives. Black swan represents new ideas which change our thinking and our lives. Taleb observes that almost no scientific discovery or technology of note comes from

design and planning, they are just black swans. A small number of black swans explain almost everything in our world around us. Since the black swans are unpredictable, we need to provide them the right atmosphere to flourish and we need to ‘adjust’ to their existence. In Taleb’s words, *‘The strategy is to rely less on top-down planning and focus on maximum tinkering and recognizing the opportunities when they present themselves’*. My dear fellow researchers, the opportunities are abound here today, we need to only change our collective mind set to find several of these black swans in this country.

To conclude I would like to quote C.V. Raman– *‘I would like to tell the young men and women before me not to lose hope and courage. Success can only come to you by courageous devotion to the task lying in front of you and there is nothing worth in this world that can come without the sweat of our brow. I can assert without fear of contradiction that the quality of Indian mind is equal to any Tectonic, Nordic or Anglo-Saxon mind. What we lack is perhaps courage, what we lack is perhaps the driving force which takes one anywhere. We have, I think, developed an inferiority complex. I think what is needed in India today is the destruction of that deadliest spirit. We need a spirit of victory, a spirit that would carry us to our rightful place under the Sun, a spirit which will recognize that we, as inheritors of a proud civilization, are entitled to a rightful place on this planet. If that indomitable spirit were to arise, nothing can hold us from achieving our destiny’*.

Friends, I hope that we all carry this optimism home and spread it in our institutes and universities. Once again I welcome you all to the meeting of the Physical Sciences Section of the 99th Indian Science Congress, and hope that we shall have scholarly and fruitful deliberations.

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II

ABSTRACT OF
PLATINUM JUBILEE LECTURE

**Studies on Substituted BaFe₂As₂ Single Crystals:
Superconducting and Spin Density Wave Ground States**

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The Fe arsenide superconductors have captured the attention of the condensed matter physics community not only for the rich variety of compounds that have been discovered, but also for rich physics they display. The physics of the 122 arsenides have been understood, due to detailed investigations made possible by the availability of single crystals. These studies show that the nature of electronic structure anisotropy plays a role in interplay of spin density wave and superconducting state (SDW/SC) these systems stabilize in. We at the Materials Science Group have synthesized, single crystal specimens of several of these compounds. We demonstrate this interplay by isoelectronic substitution of Ru at the Fe site in BaFe₂As₂ and by application of pressure. The isothermal magnetotransport measurements carried out in the spin-density regime show linear positive magneto resistance indicative of a dominant contribution from bands with linear dispersion saddling the Fermi surface. Apart from measuring the anisotropy of the resistivity in the presence of magnetic field in the SDW state of these compounds, we measure the anisotropy of the upper critical field and critical current density of the compounds in the SC regime. The low anisotropy in the upper-critical field and high critical current density indicate that the compounds are suitable for applications in superconducting magnet technology. The status of current research in the field of the arsenide superconductors will be presented with examples drawn from experiments done in our laboratory.

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III

Abstract of
Young Scientist Award Programme

Self-assembled Nanostructures for Photonics Applications

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Controlling and manipulating the spontaneous emission of light source embedded in nanophotonic structures is a contemporary topic of research due its potential applications in light emitting diodes, low-threshold nano lasers, and solar energy harvesting. Photonic band gap structure is a class of nanophotonic structure characterized with a periodically altered refractive index along three-orthogonal directions. They exhibit a photonic band gap where the photon density of states vanishes for a range of frequencies or enhances at certain other frequencies, irrespective of the directions and polarizations of the light. A holy grail in nanophotonic research is the realization of the 3D photonic band gap which is a challenge due to constraints imposed by the symmetry and refractive index contrast. On the other hand, photonic stop gap, which exhibit only in certain direction is also useful in tailoring the light propagation and emission.

We report experimental demonstration of tunable photonic stop gaps in three-dimensionally ordered photonic crystals in the visible and near-infrared wavelength ranges. Structural analysis shows the (111) plane of the crystal with fewer imperfections. Angle-resolved photonic stop gaps indicate the coupling between the Bragg waves diffracted by different crystals planes. The measured Bragg wave coupling is in good agreement with theoretical calculations. The new diffraction peak arises at the Bragg wave coupling is identified as from the (200) plane of the *fcc* Brillouin zone. In addition, we show a tunable stop gaps in the wavelength region of interest in fiber-optic communication. We also discuss laser induced emission studies on photonic crystals synthesized using dye-doped polystyrene sphere of sub-micron diameters. Emission spectra measured at 23° indicate the suppression of the emission intensity as compared to

a reference photonic crystal, where photonic stop gap has not overlapped with emission frequency. An inhibition of ~51% in emission intensity is observed within the photonic stop gap. Further, with increase in incident pump energy, we observe strong band edge lasing characteristics near the low-frequency photonic band edge.

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IV

Abstract of
SYMPOSIA / INVITED
LECTURES

THE PROCEEDINGS OF THE
NINETY NINETH SESSION OF THE
INDIAN SCIENCE CONGRESS
BHUBANESHWAR, 2012

PART – IV
Abstracts of Symposia / Invited Lectures

SECTION OF
PHYSICAL SCIENCES

President: Professor B.N. Jagatap

1. Challenges of Research in Universities: Role of Inter-University Centres

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India would very soon have the largest number of young persons in the world and the demand for higher education is bound to grow as our economy grows. To address this issue would require expanding the number of Universities and Colleges in India by nearly a factor of three. It is well known that the Universities should not just be the place for transfer of knowledge, but also generate new knowledge. This aspect of knowledge generation in the University sector has been neglected in our country for past several decades and is one of the important factors why we have not been able to attract talented young persons to pursue careers in higher education sector. We would continue to ignore the needs for research in the Universities at our own peril and miss the opportunity to be the educators to the world.

With a large number of Universities to be launched, the task of providing facilities for research to the faculty and students is a daunting task. Ideally every University should have the necessary infrastructure for research in areas that the faculty would like to pursue, but that is very unlikely to happen soon. Till we are able to generate enough resources for a substantial number of universities to have good facilities, the Inter-University Centres can fill in the role of resource centres quite effectively as is evidenced by the example of IUAC, IUCAA and UGC-DAE-CSR, the three research IUCs. The contribution of the IUCs have been recognized by peer groups e.g., the INSA-IASc document (2006) on higher education and research mentions that establishment of the three research IUCs as one of the successful UGC initiatives in the past decade or two to upgrade science education in Universities. Their experiences show that relatively small investments in resources (both human and materials) can result in very large dividends to a large University community.

In this presentation I would discuss the methodologies adopted by the IUCs, specially, those by IUAC in fulfilling its objectives of providing state-of-art research facilities as well as facilitating synergy between many Universities and National laboratories research groups.

2. Synergy between National Labs and Teaching Institutes for Pursuit of Frontiers in Science

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The opportunities for pursuing research in frontier areas of Physics have been steadily growing over the years. A number of world class facilities are developed / being developed in India. Further our access to international facilities has also become a lot easier today compared to what it was nearly 10 years ago. With the 12th five year plan round the corner, the time is ripe to review the status of Mega Science programmes being planned in the country in particular by the national labs with a view to enhance the participation of the teaching institutes in the successful completion and utilization of these world class facilities. The emphasis in this talk will be on the programmes related to Accelerator based Physics research. One of the ambitious programmes undertaken in the recent years has been the use of accelerators in the nuclear energy programme. With large scale utilization of thorium reserves in the country and for sustainable supply of nuclear energy, the Department of Atomic Energy has initiated a programme of the development of Accelerator Driven System (ADS). The ADS consists of three major elements: High energy, high intensity accelerator (1 GeV, 10 mA); A sub-critical core consisting of fissile/fertile material (k value of the order of 0.96); Spallation target of Pb – Bi eutectic. When developed, the ADS will play a crucial role in energy generation, fissile material breeding and transmutation of long lived nuclear waste. The development of ADS involves cutting edge technologies besides multidisciplinary physics capabilities.

This is an area where it will be highly desirable to have the participation of industry and teaching institutes, to collaborate with the national labs.

In order to facilitate participation of the research scholars and faculty from teaching institutes, in these mega science programmes, we have in the country two major funding agencies – DST and BRNS. Sustained efforts are required to generate joint projects involving universities and national labs, using the funding mechanism available through the funding agencies.

In this talk, we will also provide details of a few successful ongoing mega science programmes being pursued under this mechanism as well as other upcoming major projects which will be great interest to the teaching fraternity and research scholars.

3. Overview of Accelerator Programmes at RRCAT

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Raja Ramanna Centre for Advanced Technology, Indore is a premier institute of the Department of Atomic Energy engaged in R&D work in the front-line areas of accelerators, lasers and related advanced technologies and their applications. The Centre is pursuing programmes on high energy electron accelerators to build synchrotron radiation sources and free electron lasers, high energy proton accelerator for spallation neutron source, low and medium energy accelerators for societal applications such as agricultural food irradiation and industrial applications, development of advanced technologies like cryogenics, RF power, magnets, ultra high vacuum, control & instrumentation etc, and collaborative participation in international projects like Novel Accelerator Technologies (CERN, Geneva), Project-X (Fermilab, USA) etc.

The Centre has designed, developed and commissioned two synchrotron radiation sources Indus-1 and Indus-2. Both the sources are national facilities regularly operated in round the clock mode since February 2010. Indus-1 is a 450 MeV, 100 mA storage ring equipped with 5 beamlines providing VUV and soft x-ray radiation to researchers from universities, academic institutions and national laboratories. Indus-2 is a booster-cum-storage ring with design energy of 2.5 GeV to emit hard x-ray radiation. It regularly operates at 2 GeV, 100 mA in round the clock mode with beam life time of ~20 hours at 100 mA current. Six beamlines have already been commissioned and made available to researchers, and several other are in advanced stage of commissioning / development. Efforts are on to enhance the beam energy to 2.5 GeV and increase the stored current with the support of solid state RF amplifiers. It is also planned to add insertion devices based beamlines to the Indus-2 synchrotron radiation source.

Next, a major effort has been launched on the development of superconducting cavities radio frequency (SCRF) cavities required for Department's programs on development of high energy proton accelerator for spallation neutron source and accelerator driven system. A large facility is being set up for SCRF cavity fabrication, processing, assembly and testing. Initial efforts on developing prototype 1.3 GHz single-cell niobium SCRF cavities have shown excellent performance, achieving acceleration gradient exceeding 35 MV/m with a quality factor of 2×10^{10} at 2 K. Other highlights on the technological accomplishments include indigenous development of helium liquefier, high power solid state RF amplifiers as a potential replacement for klystron source, and development of non-evaporable getter coatings to achieve vacuum better than 10^{-11} mbar. R&D activities on low and medium energy accelerators are also being carried out for agricultural food irradiation and industrial applications.

In this talk, an overview of the above accelerator activities will be presented and their role in the outreach programme for universities and other academic institutions will be discussed.

4. Human Resource Development in Accelerator Research

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Particle physics stands at the threshold of a new era of discovery and insight. The Large Hadron Collider, which has just become operational, is expected to answer some of the most fundamental questions that have been intriguing mankind for long, for example, the origin of the mass. One hopes to see some evidence of existence of new particles predicted by supersymmetry, new forces and new dimensions of space. Spurred with the discovery potential of LHC, the scientists are going to demand more. For this LHC may need to be upgraded both in terms of energy and luminosity, and subsequently build a linear electron accelerator (International Linear Collider). Any or all of this would require significant advancement of accelerator science and technology, and we hope India to play an important role in this. Apart from fundamental physics, advancement in accelerator technology would further spur the development of superconducting accelerators for intense ion beams or a fourth generation of light sources (FEL), as well as important practical applications including non-invasive medical diagnostics, cancer therapy, biology, material science and environmental monitoring. In this talk I shall therefore, make a case that such areas of research be introduced in Academic Institutes where interdisciplinary research is possible.

5. World-wide Dark Matter Search Experiments and Possible New Project in India

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One of the biggest current quests in Physics is to discover the nature of the dark matter that dominates the matter content in the Universe. Based on astrophysics and high energy physics, it is believed that dark matter is made up of a Weakly Interacting Massive Particle (WIMP) that has eluded detection so far due to its very nature of being a neutral particle with incredibly low interaction rate with ordinary matter. As many as 30 collaborations across the world are vigorously searching for this illusive particle, using a variety of detector technologies and varieties of project costs (ranging from less \$1 million to \$50 million). My collaboration, Cryogenic Dark Matter Search (CDMS) leads this world wide race in terms of detection sensitivity. I will review varieties of current technologies and their challenges. I will also discuss plans and status of a proposed dark matter experiment effort in India to involving leading Indian research institutions, which if successful, will pave the way for a tremendous mechanism to not only go after scientifically competing results, but also be a vehicle to train new generation of experimentalists in India. A successful collaboration at this stage may lead to a world leading experiment with ton-scale detector mass to be installed in the India-based Neutrino Observatory Lab (INO Lab), which will be a truly multi-national collaboration involving more than two dozen Universities in US and India.

6. The India based Neutrino Observatory: A Laboratory for Studying Rare Processes

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The INO was conceived as an underground laboratory for making measurements on atmospheric neutrinos produced in interactions of high energy cosmic rays with the atmosphere. While the first evidence for atmospheric neutrinos was found by the TIFR-Osaka-Durham collaboration in the Kolar Gold Fields in India, unambiguous evidence for neutrino oscillations was provided by measurements with the 50 kiloton water Cerenkov

detector at Kamioka in Japan. This detector does not distinguish between high energy muon neutrinos (ν_μ) and muon anti-neutrinos ($\bar{\nu}_\mu$). A 50 kiloton iron calorimetric (ICAL) detector was therefore proposed to be set up to be able to distinguish between ν_μ and $\bar{\nu}_\mu$ by tracking and identifying the charged muons produced as a result of interactions with the magnetized iron. Such a measurement has never been done for atmospheric neutrinos. A feature unique to such measurements is the large range of neutrino propagation lengths (upto the diameter of the earth) and energies (about 0.1-100 GeV, though $\sim 1-20$ GeV for ICAL) available. Apart from confirming neutrino oscillations such a detector would also improve significantly the precision on some of the neutrino parameters such as the mass squared difference Δm_{23}^2 . The ICAL detector will also be able to measure the cosmic muon spectrum at very high energies $\sim 1-50$ TeV. If a crucial parameter in the neutrino mass matrix, the mixing angle θ_{13} , is larger than about 7° , ICAL could help resolve the mass hierarchy problem viz. whether $m_3 > m_2 > m_1$ or $m_2 > m_1 > m_3$. At a later stage a neutrino factory beam directed towards INO could, in conjunction with a near detector, identify a possible CP violation in the neutrino sector. The latter issue is of great interest as the CP violation in the quark sector is not enough to understand the matter-antimatter asymmetry in the universe.

The INO will also house other experiments that make use of the low background environment such as searches for neutrinoless double beta decay and dark matter using cryogenic bolometric detectors and a low energy accelerator for making measurements of nuclear reactions of astrophysical interest.

The present status of the India based Neutrino Observatory (INO), a mega science project supported jointly by the Department of Atomic Energy and the Department of Science and Technology, and involving about 25 research institutes, Universities and IITs, will be summarized.

7. Some Interesting Results on Si Nanoclusters Synthesized in Si through a Double Au Implantation

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Ion implantation is a well established tool in Si processing. It provides a possibility of implanting almost any element into any solid matrix thereby generating a desired distribution of implanted species at a depth as determined from the ion energy. Using this technique, Si nanoclusters have been synthesized through excess Si implantation into SiO₂, Si₃N₄ etc. They have been found to produce luminescence over a wide energy band ranging from 1.4 eV to 1.9 eV. In all these cases emission lifetimes have been found to range from *ms* to *μs* with stretched exponential nature. Compared to this we have been able to synthesize Si nanoclusters in a Si matrix using a double Au implantation. In this technique no excess Si is introduced into the system through Si implantation which is known to result in precipitation in the form of nanoclusters. Here a Au implantation at KeV energies to a fluence of $5 \times 10^{15} \text{ cm}^{-2}$ is used to amorphize the top layer of a Si substrate. A subsequent irradiation of this amorphized Si layer with MeV Au ions (to a fluence $\sim 5 \times 10^{15} \text{ cm}^{-2}$) is found to result in production of Si nanoclusters in the amorphized matrix. The Au ions at MeV energy pass through the amorphised Si layer depositing energy primarily around the ion track through electronic excitations in the medium. The nanoclusters formed have been characterized using electron microscopy, photoluminescence and Raman scattering techniques. Unlike the earlier cases the double implanted samples show luminescence in the ultraviolet with lifetimes in *ns* at room temperature. At low temperatures the emission show structures very similar to direct and phonon assisted emissions. The technique has the added advantage of introducing Au nanoparticles in the system which seems to result in an enhancement in the emission intensity through surface plasmon excitations. Results will be presented and discussed.

8. Opportunities and Challenges in Photonics : An Indian Perspective

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Photonics, the science and technology of light-matter interaction is finding ever increasing acceptability in all walks of life spanning across health, information and communication, entertainment, defense, energy and industry etc., and is continually exploring new horizons of application. Control and engineering of the light-matter interaction at wavelength or sub-wavelength scale adds new dimensions to the functionality, thereby, shifting the paradigm to nanophotonics. In this talk, I will broadly review the current trends in nanophotonics with a view to envisage some potential applications which may become accessible in near future and to realize their socio-economic impact, even though, presently, these may be somewhat blur as the field is still in its infancy. Subsequently, I will, briefly, outline the current activity in this area in India so as to place the national status of nanophotonics in the global perspective. This will be concluded with the identification of the challenges, priorities and some pertinent questions facing us.

9. Advances in Metamaterial Research

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Possibility of Metamaterial or Left-handed Material (LHM) having simultaneous negative permittivity and negative permeability was first theoretically proposed by V.G.Veselago in his seminal paper published in 1967. The exotic properties such material

(being artificially structured and not available in nature) can exhibit negative refractive index, reversed Doppler Effect and reversed Cherenkov radiation. However, the practical possibility of realizing tailorable negative permeability (which was most challenging till 1999) was shown to be possible by J.B. Pendry by using Split Ring Resonator (SRR), whose research group also showed earlier that negative permittivity at microwave frequency can be realized using Thin-wire (TW). First experimental demonstration of negative refractive index with two-dimensional (2D) plasmonic metamaterial using SRR-TW structure was done by D.R. Smith et.al in 2000. The transmission line metamaterial was reported by Elephtheriades et.al in 2002 using periodically loaded transmission line (PLTL).

Following these initial developments in metamaterial research there has been exponential growth both in terms of the volume and variety leading to advanced metamaterial research avenues of today. We can now hope of the possibility of 'superlens' overcoming the diffraction limit of conventional optics. 'Sub-wavelength imaging' with evanescent wave amplification caused by surface plasmon polaritons in plasmonic metamaterial, that is gaining enough enthusiasm which might one day make it possible to image individual strands of DNA. 'Cloaking' of objects (may not be of the Harry Potter type as of today) opening up the possibility of making reliable optical memories for new generation computers and showing new avenues for stealth technology. 'Reversed Cherenkov radiation' possible with metamaterial based accelerator might revolutionize future accelerator research, especially in the design of sensitive detectors. Apart from these exotic applications, active and advanced research is going on with new ideas emerging every new morning for the developments of metamaterial based microwave passive components and antennas with improved performance along with size miniaturization. Peoples are even talking of quasi-crystal metamaterial and many more fashionable yet promising terms for meta-material.

Though most of the R&D in metamaterial initially took place in microwave frequency range, advanced developments are taking place these days in terahertz (THz)

and optical range. In fact ultimate fruit of metamaterial research will be most effective only when three-dimensional (3D) optical metamaterial will be a common place reality.

The purpose of this paper will be to make a technical journey through all the relevant developments and recent advances in metamaterial research to stimulate enthusiasm in the mind of young researchers to take-up challenging task to make left-handed material world as strong and as competitive as the right-handed material universe.

10. Biophotonics: Studies at RRCAT

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Biophotonics, the science of the interaction of light (photons) with biological matter, is playing an important role in the pursuit of two major objectives of quality health care; to detect the disease at a very early stage before it becomes difficult to manage and secondly to treat it with high selectivity that is with no or minimal adverse effect on the normal tissue. In the present talk I shall provide an overview of the work being carried out by us in this area. I shall first describe the use of optical techniques like optical coherence tomography (OCT) for minimally invasive, *in-situ* biomedical imaging with resolution down to a few micrometers. Some representative applications of OCT like imaging of microstructures of eye; non-invasive monitoring of the healing of wounds and ethanol-induced developmental abnormalities in Zebrafish embryos will be briefly discussed. Next I shall discuss the advantages of the use of optical spectroscopic techniques for the diagnosis of cancer and describe the results of our recent study carried out at Tata Memorial Hospital, Mumbai for *in vivo* diagnosis of cancer of oral cavity. The use of light for the treatment of cancer with minimal damage to the normal tissue and for

photodynamic inactivation of antibiotic resistant bacteria will also be briefly touched upon. Finally, I shall discuss the use of light to trap single cells or intracellular objects and for transportation, orientation or rotation of these using only light induced forces. The use of these techniques for spectroscopic studies on single cells or measurement of the visco-elastic parameters of single red blood cells and the role these can play in biomedical diagnosis will also be briefly touched upon.

11. Ultra-sensitive Dual-mode Waveguide Interferometers

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Optical interferometers use the interference of light to detect and measure small distances. The smallest displacement that can be resolved by a conventional interferometer is $\lambda/2$, where λ is the wavelength of light used. We proposed and demonstrated a waveguide interferometer that can measure distances as small as $\lambda/130$. Two parallel mirrors with adjustable gap formed the waveguide. An Nd:Yag laser beam (wavelength 1.32 micrometer) from an optical fiber entered the gap at a precise angle. Light travels inside the waveguide as a combination of 'modes' or patterns of light. The incident angle was chosen such that only two modes interfere at the output plane. The interference between these modes and hence the output depends crucially on the guide width. For a guide width of 8 micrometer (roughly, one-tenth the width of human hair), a change in the width by just 10 nanometer (almost eight thousand times smaller than the width of human hair) was enough to flip the 'light at the end of the tunnel' from one side to the other and back.

Recent work of the author has shown that even if light enters the above waveguide at normal incidence along the axis of the waveguide, one can measure distances as small

as $\lambda/40$. This is quite impressive as the setup is much simpler. The only limitation in designing more sensitive waveguide interferometers is the loss of light at the guide walls. However, when the guide walls are replaced by appropriate photonic band gap materials, there will be hardly any such loss. We will show that in that case, one can measure astonishingly small distances of the order of $\lambda/1000$. We believe that these ultra-sensitive waveguide interferometers will find many sensor and switching applications in nano-technology.

12. Electromagnetic Momentum and Energy inside Negative Refractive Indexed Material: A New Look at Concept of Photon

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Keywords : *Negative Indexed Material (NRM), Meta-Material, Group Refractive Index Phase refractive index, Phase Momentum, Wave momentum, Pseudo-Momentum Group and Phase velocity, Mechanical Momentum, Reactive energy, Polariton, Phonon*

Electromagnetic (EM) radiation in dispersion less free space vacuum is represented by a photon, with corpuscular and wave nature. The discussions, for the past century aimed at the nature of photon (rather polariton) inside a media having dispersion in the refraction property, other than free space. Still the debate is continuing regarding Minkowski, Abraham momentum in dispersive media; and to add to this debate the introduction of Veselago's negative refractive indexed media has opened new thoughts to these classical momentum-energy concepts. We call mechanical momentum, wave-momentum (pseudo-momentum), and try to match our 'thought experiments' with intriguing property of this 'photon' (polariton) or pulse carrying EM energy packet, and more so we try to find its property energy, momentum inside a media a positive refractive

media. Well if the media show a negative refractive index behavior, then these queries are profound, and suitable explanations to these classical concepts of corpuscular-wave nature of photon (polariton) inside these media are quest for the scientists dealing with these meta-materials. Here in this deliberation, some of this counterintuitive phenomena of corpuscular-wave nature of photon inside negative indexed material is brought out, with possible 'new definition' of its 'pseudo or wave-momentum', the concept of 'reactive energy' inside negative indexed material, along with possible 'new wave equation'. Also we deliberate and point out several counterintuitive observations regarding propagation of electromagnetic radiation inside the negative refractive indexed material. We will also show that century old Minkowski and Abraham momentums manifests as mechanical momentum and gets transferred to the dispersive media and the transfer of these two type of momentum are same-thus we distinguish these mechanical and 'new-defined possible' wave (pseudo) momentum separately and also try to give Electrical Engineering's Power system's analogy of active and reactive power to the transport mechanism of Energy and Momentum of the EM radiation to Negative Refractive Media.

13. Intrinsically Conducting Elastomers: Towards Electronic and Photonic Applications

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More than three decades after the major breakthrough in the efforts, to develop intrinsic electric conductivity in conjugated polymers, which culminated in the year 2000 Nobel Prize for Shirakawa et al., conducting plastics hold the promise of providing a cost effective and unique alternative material solution for applications ranging from consumer electronics to optoelectronics, solar cells, lighting, memory, and a host of new photonic

applications. It would not be an exaggeration to mention conducting polymers as the materials for the next century. The notion of conjugation as a pre-condition for a polymer to be made intrinsically conducting was challenged when a conjugated polymer like Natural Rubber was doped to increase its electrical conductivity by more than ten orders in magnitude. This discovery by Thakur et al., triggered a spate of investigations on the phenomenon and mechanism of conduction in non-conjugated polymers like Elastomers. The discovery that rubbers could be doped like conjugated polymers raised the hope of finding extremely different micro applications hitherto unknown for Natural Rubber as well as synthetic Rubbers. Investigations point towards the possibility of conducting rubbers, unlike the conjugated polymers having easy processability and cost effectiveness, finding wide applications in organic electronics and photonic applications. It has been found that natural as well as synthetic elastomers doped to form semiconducting polymers possess tremendous potential in a variety of electronic and photonic applications including Photovoltaics, Photonics, Memory devices e. This talk presents a critique of the early and current efforts in developing intrinsic electric conductivity in elastomers in the context of the investigations made by the authors in this direction.

14. High Power Tunable Lasers in Science & Technology

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During the last four decades, tunable lasers have played a pivotal role in advancing our basic understanding of science and in development of advanced technologies. The capability of tunable lasers for selective and efficient interaction with materials at an atomic level has made it possible, on one hand, to push the frontiers of precision measurement of fundamental parameters with higher and higher accuracy, and to

elucidate fundamental processes with increasing discrimination. On the other hand, combined with the inherent capability of lasers to deliver high power density over large distances, it has led to diverse applications in the core sectors of energy, environment, communication, defense, and healthcare.

A majority of these applications are accessible with low power or low pulse-repetition-frequency (up to ~100 Hz) tunable lasers, with CW average powers ranging from ten to few hundred mW, and for pulsed lasers with pulse energies ranging from less than one to several ten microjoules. However, many niche applications of tunable lasers require substantially higher powers of ten to several hundred watts or high pulse-repetition-frequency exceeding several kHz for efficient and effective interaction. One of the major applications, which drove extensive R&D of these tunable lasers is separation of isotopes for use in nuclear energy, with potential spin offs in basic sciences such as for the postulated neutrinoless double beta decay, for producing high purity materials for industry, or in healthcare for facilitating production of medical radioisotopes. Another spin off application of this technology is the laser guide star that requires high average power tunable lasers. Along with related technologies for adaptive optics control, the laser guide star has brought about a revolution in astronomy, and is independently driving R&D in specialized high average power tunable lasers.

Yet another application that is driving the development of advanced, pulsed, solid-state tunable lasers, with moderate power levels but with high pulse-repetition-frequency, is the study of short-lived elements, isotopes and even isomers produced in high energy nuclear reactions using the techniques of resonance ionization spectroscopy. This field of study also includes measurement of long-life rare isotope ratios in samples for chronological and genealogy analysis with promising application for samples of extraterrestrial origin.

The development of high average power, as well as, high pulse-repetition-frequency tunable lasers has historically evolved around liquid dye lasers, where the heat deposited in the gain region can be dissipated rapidly by flow circulation. However, flow fluctuation induced instabilities, photochemical degradation of dye molecules, and use of

large quantity of hazardous circulating liquid have been the main factors thwarting a wider application of dye lasers. Thus, while liquid dye lasers continue to be the backbone in some of these applications, these are being slowly replaced today by solid-state tunable lasers, primarily diode lasers and Titanium: Sapphire lasers, with diverse efforts to overcome limitations on power, repetition frequency, and wavelength range. On the other hand, substantial research is being carried out to suppress dye degradation and improve thermo-optic characteristics of the host media in liquid, as well as, in solid-state dye lasers, to achieve sustained availability and continue to exploit the inherent advantages of the dye as a laser medium. On a different front, widely tunable optical parametric oscillators (OPO) are being developed with novel attempts to reduce the inherently high threshold such that high pulse-repetition-frequency and high average power OPOs, particularly in the visible- near IR wavelength region, can be realized.

In this talk we will briefly review the requirements on tunable lasers, specifically for those applications which need high average powers of several watts or more, or high pulse-repetition-frequency exceeding several kHz, focusing on the subtle features which are important not only for efficient and effective application but also for producing reliable and reproducible data for ultra-trace analytical applications. Next, we will discuss recent multi-disciplinary research activities at BARC on development of these lasers and laser systems, and review the challenges that are being addressed worldwide using novel approaches.

15. High power, Fiber based, Continuous Wave Optical Parametric Sources in the Near- and Mid- Infrared

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The widely available high-power laser sources have critically-small spectral coverage and narrow tunability range. However, many applications in the field of bio-photonics, biomedicine, remote-sensing, trace-gas analysis and spectroscopy require widely tunable single-frequency sources along with high-power. The present talk focuses on the development of new generation of widely-tunable, continuous-wave solid-state light sources based on optical parametric oscillator (OPO) concept in combination with newly emerging fiber laser technology, for applications in bio-photonics, remote-sensing and laser surgery. The presentation will cover physical concepts and experimental requirements that are involved in achieving Watt-level coherent sources in the wavelength windows (near- and mid-infrared) that have largely remained inaccessible by the conventional laser technology.

16. Recent Advances in Infrared Sensors for Thermal Imaging: Non Uniformities Compensation

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Instruments Research & Development Establishment Dehra-dun is actively developing a variety of thermal imagers using Mercury cadmium Telluride(MCT), Indium Antimonide (InSb), Quantum Well Infrared Photo detector(QWIP) and uncooled bolometer infrared focal plane arrays (IRFPA) for such applications as night vision, surveillance, missile guidance, fire detection, robotics and spectral imaging. The other sensor materials under consideration are QDIP (GaAs/InGaAs), Type II Super lattice (InS/InAlAs), A-Si and VOX etc. Advancement in infrared sensor materials and technologies has resulted in improvement in the performance of thermal systems due to increase in number of pixels, smaller pitch and better noise equivalent temperature difference (NETD). Each material has its own advantages and disadvantages with reference to system considerations. For example, MCT has good quantum efficiency

(QE), band gap tunability and possibility of multi color detector, but it suffers from large surface defects and has very sensitive dependence of energy gap on the composition ratio. Similarly, InSb has good QE, good uniformity, possibility of very larger format of arrays but it operates in MWIR only and spectral response shifts to longer wavelength with increase in its operating temperature. QWIP detector offers good uniformity, good thermal stability but suffers from low QE, lower operating temperature and narrow spectral response. Super-lattice (SL) detectors offer tunability, lower dark current, normal incidence and higher uniformity but are still in their infancy.

The performance of thermal imager is strongly affected by several degrading factors and most important of them is sensor photo response non uniformity. Non-uniformity arises due to the fact that each individual detector in the array has a different photo response from its neighboring detector even if the two detectors are illuminated by same radiance. The pixel-to-pixel fluctuations can be attributed to a number of factors such as $1/f$ noise associated with detector and the corresponding readout integrated circuits (ROIC), and the non linear dependence of the detector gain on the photon flux incident on it. All these factors result in spatial and temporal non-uniformities, thereby, degrading the image quality significantly. Furthermore, the spatial non-uniformity fluctuates slowly in time due to changes in FPA temperature, unstable bias voltages and the change in scene irradiance. This temporal drift is manifested in the acquired image in the form of a slowly varying pattern superimposed on the infrared image, which degrades the spatial resolution, radiometric accuracy, and therefore, reduces the temperature resolving capability of the FPA and makes non uniformity correction a much more challenging. A one-time factory calibration will not provide a permanent remedy to the problem. Consequently, the task of any non-uniformity correction technique is to compensate for the spatial non-uniformity and update the compensation as needed to account for the temporal drift in the detector response.

There are mainly two types of non-uniformity correction (NUC) techniques: a) calibration-based, b) scene-based. The most common of these is two-point calibration method using a standard black body. In this method, the normal operation of the thermal

imaging system is interrupted as the camera images a uniformly calibrated target at two distinct and known temperatures. The gain and offset of each detector are then calibrated across the array so that all the detectors produce a radio-metrically accurate and uniform readout at the two reference temperatures. Scene based techniques, on the other hand do not interrupt the operation of infrared system during calibration. These techniques are generally algorithmic in nature and are able to remove both gain and offset non-uniformities. Scene based techniques generally use an image sequence and rely on the motion or change in the actual scene to provide diversity in the scene temperature per detector. This temperature diversity provides a statistical reference point common to all detectors, according to which individual detector response can be normalized.

In this paper, we present different techniques being adopted at IRDE for calibrating the sensor non-uniformities based on both the above mentioned methods. The results and performance evaluation of these methods will be presented.

17. Applications of Cd-Te Quantum Dot Nanoparticles in Bio-Medical Research

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In this work we present preliminary studies of biological effect of a novel QD based nanomaterial system on Escherichia coli (E. coli) bacteria. Presently, we have assessed the rate of E. coli growth as an index of toxicity of hydrogel encapsulated QDs at various concentrations. Growth curves were generated for E. coli growing in 20 mL of

LB media containing hydrogel encapsulated QD nanospheres (400 nm diameter) at relatively higher (0.5 mg/mL) and lower (0.01 mg/mL) concentration of solution. Further investigations are being conducted on cell growth response and to establish the limiting hydrogel concentration for different QD densities.

18. Fractal Growth Study by Simulation

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The concept of fractals was introduced by Mandelbort in 1980. The study of irregular shapes and complex patterns using concept of fractal have become an important tool in various scientific disciplines. Fractal patterns exhibit scale invariance and self similarity. The scientific applications of fractals are enormous. They can be applied to various phenomena existing in physical problems to astrophysics, biology, chemistry and also to the share market fluctuations.

In the present talk I would like to discuss the simulation of fractal growth patterns in electro-deposition (Diffusion limited aggregation) using concept of off lattice walk. The simulation of electro-deposition under increasing electric field conditions with different values of bias are studied and, it is seen that the growth patterns with lower values of bias are less crowded with limited branching. As the electric field is increased (higher value of B), the growth tends to be dense and with more crowding of branches. The box counting technique was implemented to calculate the fractal dimensions of the patterns grown. The results are compared with the experimental observations.

19. Vibrational Spectroscopic Characterisation of Biologically Active Complexes of Zn(II) and Cu(II) with 5-Bromouracil

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After the successful identification of *cis-platin* as antitumor agent a new area of research has been opened up in the field of metal-complexes to search new antitumour agents. Some current hypotheses of carcinogenesis focus on the possible role of transition metal ions, which may act as directly or through metal binding agents. Therefore, during the last couple of years, there has been a considerable interest in the study of interaction of transition metal ions with nucleic acid bases and their derivatives.

Metal complexes play an important role in the biological activity of drugs and several reviews have appeared which indicate that metal complex formation is deeply involved in normal life processes and metal complexes are more potent and less toxic in many cases as compared to the parent compound. Since it is well established now that besides neutral platinum complexes other metal complexes also exhibit antitumor activity, and information regarding the metal complexes of 5-Bromouracil is scanty, therefore, in this study, we describe the synthesis and vibrational spectroscopic characterisation of the complexes of Zn(II) and Cu(II) with 5-Bromouracil.

5-Bromouracil is one of the well known uncommon nucleotide bases and has the ability to bind metals or to bind to tissues via metals. The coordination may occur through two nitrogen atoms of the pyrimidine ring, the two carbonyl oxygens and the bromine of (C5-Br) group. In this study, chemical analyses are used to determine the stoichiometry and vibrational spectroscopy is used to illucidate the vibrational modes and sites of coordination.

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V

Abstract of
ORAL / POSTER PRESENTATION

THE PROCEEDINGS OF THE
NINETY NINETH SESSION OF THE
INDIAN SCIENCE CONGRESS
BHUBANESWAR, 2012

PART – V :
Abstracts of Oral and Poster Presentations

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ORAL

1. A New X-ray Effect: Hypothesis and its Observation

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Keywords: *X-ray scattering, Low atomic number, High dielectric constant*

A new modified X-ray incoherent peak was observed when low-energetic X-rays scattered from low Z -materials with relatively high dielectric constant. In the recent publication (Mallick, Turk J. Phys., 35, 75-114, 2011), the Quantum theory of this new X-ray effect i.e anti-Compton scattering of X-rays (B. Mallick, Proc. Smart Structure and Materials, SPIE Vol.4329, pp.311-318, 2001) confirms the existence the claimed event. Such type of new modified X-ray scattering (angle dependent) was observed, when low-energetic X-rays scattered from crystals, powder, polymer and hydrogenous liquids. . It is expected that this new X-ray effect will be more prominent using high intense x-ray source and materials like bio-fluids or biomaterials (low atomic no. and high dielectric constant, since biofluids are consists of low atomic number elements and possessing high dielectric constant). The present paper describes the details idea, conformation about this new scattering phenomenon.

2. An Ab Initio and DFT Study for Electronic Structure and Spectra of Lamivir and Baraclude Drugs (Anti-heptitis B Infection Treatment)

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Keywords: *Lamivir, Baraclude/Entecavir, Infrared spectrum, Ab-initio Quantum chemical calculations, DFT*

In the treatment of individuals infected with human immunodeficiency virus (HIV), the key case of antiretroviral therapy failing is the emergence of drug-resistance mutations. Conformational flexibility and adaptability are important in the design of nucleoside and non-nucleoside HIV reverse transcriptase inhibitors, NRTIs and NNRTIs, respectively. They have a lot of sites forming inter and intramolecular hydrogen bonds, presenting conformations strongly dependent on the solvent characteristics and experimental conditions. Accurate knowledge of the conformational properties of NRTIs and NNRTIs would be important for the interpretation of drug-target interactions since adaptation to the binding pocket changes due to HIV mutations involves a combination of conformational adjustments, and rotational and translational shifts of the inhibitor within the binding pocket. Improvement of antiretroviral therapy for the human immunodeficiency virus is related to conformational adjustment of drugs to the binding pocket. Consequently, it is important to have information on NRTIs and NNRTIs conformers, and to develop practical procedures for their non-destructive identification, analysis, and process monitoring. In the present work the molecular geometries of Lamivir and Baraclude Drugs have been studied by using ab- initio Quantum Chemical. Density functional calculation at the Becke3LYP (B3LYP) carried out by employing 6-31++G** basis set for inclusion of electron correlation. The molecular structure, dipole moment, energy and vibrational frequencies with IR intensities and thermal properties have been studied. The UV and IR spectra were recorded experimentally. A comparative study of the two molecules has been carried out. Frequency analysis was carried out in all the cases to ensure that the optimized geometries correspond to total energy minima. A tentative assignment of the intense IR vibrational frequencies to different modes has been carried out.

3. Biosensors: Perspective in Human Welfare

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Keywords: *Nanotechnology, Biological fluids*

A biosensor is an analytic tool or a system comprising a biological material is immobilized, the type enzyme, antibodies, organell; transducer and a detector. They are classified depending upon immobilized bio catalytic/enzymetic, affinity, membrane proteins, micro-organism and transducers such as electrochemical, optical, thermal, acoustic, mass transfer etc. They are not only used in direct or indirect measurement of human and animal samples as diagnostics and partly as therapeutics. Nano technology plays an important role in the production, reliability and sensitivity of such sensors. The invention of Nano-bio card in total analysis of blood, urine and other specific biological fluids is a boost in diagnostics leading to patient friendly and emergency saving of life. An early detection of disease could save great injury to vital organs of human. In this regard, construction, specifications, applications and future prospects of bio-sensor will be discussed. Human glucose, cholesterol, CO₂, proteins, enzymes, will be discussed. Our group has attempted to use human fat as a biosensor – a case study of such a sensor will be discussed. Certain physicochemical, optical and thin film properties of fat with adipose tissue will also be presented.

A. ASTROPHYSICS, SOLAR PHYSICS, SPACE PHYSICS

4. Geomagnetic Storms Associated with IV-Radio Bursts and their Relation with Solar and Interplanetary Parameters

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Keywords: *Coronal mass ejections, X-ray solar flares, Radio bursts, Solar wind plasma parameters and Geomagnetic storms.*

We have studied geomagnetic storms ($Dst \leq -75nT$), associated with Type IV radio bursts observed during the period of (1997-2007) with solar and interplanetary parameters. We have observed 33 geomagnetic storms associated with type IV radio bursts, out of which most of the geomagnetic storms (85.00%) are intense or severe geomagnetic storms. All the geomagnetic storms are found to be associated with coronal mass ejections (CMEs). The association rates of halo and partial halo CMEs are 27(81.82%) and 06(18.18%) respectively. All the type IV radio bursts associated geomagnetic storms are found to be associated with X-ray solar flares of different categories. The association rates of geomagnetic storms with different types of flare related CMEs are found 08(24.24)% X class flare related CMEs, 15(45.46%)M class flare related CMEs, 08(24.24)% C class flare related CMEs and 02(6.06)% B class flare related CMEs. Some of the type IV radio bursts associated geomagnetic storms are found to be associated with magnetic clouds 13 (39.39 %). Majority of the geomagnetic storms are found to be related with interplanetary shocks 31 (93.94). We have inferred that geomagnetic storms are closely related to interplanetary magnetic fields. We have determined positive co-relation with correlation coefficient 0.70 between magnitude of geomagnetic storms and maximum value of IMF and 0.77 between magnitude of

geomagnetic storms and magnitude of maximum value of southward component of interplanetary magnetic fields (IMF Bz).

5. Halo CMEs Related Geomagnetic Storms and Their Relation with X-ray Solar Flares, Radio Bursts and Interplanetary Magnetic Field

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Keywords: *Coronal mass ejections, X-ray solar flares, Radio bursts, solar wind plasma parameters and geomagnetic storms*

Geomagnetic Storms ($Dst \leq -75nT$) associated with halo coronal mass ejections observed during the period of 23rd solar cycle (1997-2007) have been studied with X-ray solar flares, radio bursts and interplanetary magnetic field. The observed halo coronal mass ejection associated geomagnetic storms have been divided in three categories, moderate geomagnetic storms, magnitude $Dst \leq -75nT$ to $\geq -100nT$, intense geomagnetic storms, magnitude $Dst \leq -100nT$ to $\geq -200nT$ and severe geomagnetic storms, $Dst \leq -200nT$. It is observed that most of the halo CME related geomagnetic storms are intense or severe geomagnetic storms. The association rates of moderate, intense and severe geomagnetic storms have been found, moderate 18.52%, intense 1348.15% and severe 33.33% respectively. Further it is inferred that all the halo CME related geomagnetic storms are associated with X-ray solar flares of different categories. The association rates of geomagnetic storms with different types of flare are found 09(33.33%) X class flare, 13 (48.15%) M class flare, 03(11.11%) C class flare and 02(7.41%) B class flare. Most of halo CME related geomagnetic storms are found to be related with type IV and type II radio burst 25(92.59%). The association rate of type IV and type II radio burst have been found 15(60%) and 10(40%) respectively. Majority of the halo CME related geomagnetic storms are found to be related with interplanetary shocks 26(96.30%) also. It is also determined that geomagnetic storms are closely related to interplanetary magnetic fields. Positive co-relation have been found between magnitude of geomagnetic storms and magnitude of jump in interplanetary magnetic field with correlation coefficient 0.72

between magnitude of geomagnetic storms and magnitude of interplanetary magnetic field, 0.85 between magnitude of geomagnetic storms and maximum value of southward component of interplanetary magnetic field.

6. Mass Composition of Ultra High Energy Cosmic Rays

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Keywords: *Ultra high energy, Greisen-Zatsepin-Kuz'min*

Cosmic Ray Physics has made enormous progress in recent years and importance is shifted to UHE region due to diverse experimental findings with low statistics, specially around the so called GZK cutoff. We still do not have definitive models for the origin, acceleration and propagation of cosmic rays. The energy region from the first knee to the second knee (1–100 PeV) needs better and more definitive experiments to measure the mass composition of galactic Cosmic Rays. Different experiments do not agree as to the location of the rigidity cutoff and search for local sources remains puzzling. Questions still remain, are the highest energy galactic Cosmic Rays heavy nuclei?; are there Cosmic Rays beyond GZK cutoff, if so what are they ? EAS array detecting UHE giant air showers operating in a hybrid mode, simultaneously measuring optical pulse from the centre of the array. However, the data are subjected to large fluctuation both in particle detection and optical photon detection. Primary energy is estimated through the parameter shower size which is also indirectly measured from a small sample of shower front using array data. Mass composition estimated indirectly relies on simulation model. Further, the Lateral Distribution Function parameter ' δ ' is deduced from data grouped in narrow shower size or energy bins, where individual optical pulse heights are found to scatter around a power law LDF. Data are analysed on the basis of results obtained from CORSIKA simulation of air shower development in the atmosphere using different mass

composition models. The results agree with proton composition at energies above $10^{17.6}$ eV.

7. Solar Source Activities and their Terrestrial Impacts

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Keywords: *SEPs, CMEs, Dst, Global Ap, 11-year Sunspot Cycle.*

The Sun is the primary driver of our space weather. Storms on the Sun, in the form of solar flares/coronal mass ejections, can launch showers of radiation and powerful magnetic fields into interplanetary space. Space weather comes as short-lived storms which can last minutes to hours to days. The Sun also undergoes cycles in its level of activity that span years to decades, causing longer-term variations in space weather. Solar plasma and magnetic field ejected out into interplanetary medium consequently create the perturbation in the geomagnetic field. When these plasmas and fields triggering the earth's atmosphere, peculiar storm time changes on the geomagnetic field can be observed. Storm-time variations are actively follows with solar wind velocity and strength of interplanetary magnetic field. The occurrences of solar source activities vary with 11-year sunspot cycle. So, it is important to investigate association of global geomagnetic activities on long-term basis and its association with different solar transients. In the present work, we have established an association of global A_p , yearly occurrence of solar energetic particle event and flare index of solar activity with annual mean sunspot number for a period 1996-2007, which covers the minimum and maximum phase of solar cycle 23. We have found that the yearly occurred value of flare index varies with 11-year sunspot cycle except at some circumstances. Similarly, the variation of flare index for solar cycle 23 shows close correspondence with 11-year sunspot cycle. It is also found

that association of yearly occurrence of solar energetic particle hasn't shows very significant correlation. Many researchers have shown that global geomagnetic activities are higher during solar maximum and vice versa, but solar cycle 23 shows controversial results and we find higher geomagnetic activities during its declining phase. Various analyses for late-cycle high-activity of solar cycle 23, the general characteristics of past (1-23) solar cycles along with present continued sunspot cycle 24 are discuss in the work. On the variation trend of previous solar cycles, sunspot cycle 24 is much like sunspot cycle 22, peaking around 2011-2012. Solar maximum of sunspot cycle 24 may brings greater risk of havoc on things like GPS signals, power grids, cell phones, airline and military communications.

8. Heliospheric Modulation and Periodicity of Galactic Cosmic Rays at High Cut-off Rigidity During Solar Cycle 23

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Keywords: *Cosmic Rays, Sun: activity- solar terrestrial relationship, periodicity*

Galactic cosmic rays (GCRs) while propagating to and inside the heliosphere, encounter an outward moving solar wind with cyclic magnetic field fluctuation and turbulence, causing convection and diffusion in the heliosphere. GCRs counts from the ground-based neutron monitors show intensity changes, which are anti-correlated with sunspot numbers with a lag of a few months. GCRs experience various types of modulations due to different solar activity indices and influence space weather and terrestrial climate. In this work, I have investigated some aspects of the modulation of GCRs at high cut-off rigidity ($R_c \sim 10$ GV) with some solar and geomagnetic indices for the solar cycle 23 (1996-2008). I have also studied the modulation of GCRS during $A > 0$ (1996-2000) and $A < 0$ (2001- 2008) polarity states and detected that during $A < 0$ phase

the recovery of GCRs are much faster than solar parameters with negative time-lag. The short and mid-term quasi-periodicities of GCRs for this cycle have been identified with wavelet technique. The results are discussed in light of modulation models including drift effects.

9. A Study of the North-South Asymmetry of Sunspot Area during Solar Cycle 24

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Keywords: *Sun, North-South asymmetry, Meridional circulation, Periodicity*

Solar activity indices vary over the Sun's disk, and various activity parameters are not considered to be symmetric between the northern and southern hemispheres of the Sun. The north-south asymmetries of different solar indices provide an important clue to understanding solar dynamo action, especially with regard to non-linear dynamo models. In the present work, I have studied the statistical significance of north-south asymmetry of sunspot areas for the ascending branch of current solar cycle 24. The dominant hemisphere in each year of the cycle 24 has been identified by calculating the probability of hemispheric distribution of sunspot areas. The investigation reveals that during rising phase of cycle 24, northern hemisphere is dominating which is against to the prediction of dynamo based simulations (Jiang et al., 2007, MNRAS, **381**, 1527). The statistically significant intermediate-term periodicities of the north-south asymmetry of sunspot area data have also been investigated using Wavelet techniques. I will discuss the results with the help of helioseimology.

10. Isotopic Abundances of R-process Elements with Particular Reference to Supernova Type II

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Keywords: *Abundance, Supernova, R-Process*

The rapid neutron capture process (r-process) is one of the major nucleosynthesis processes responsible for the synthesis of heavy nuclei beyond iron. Because of the large associated Coulomb barriers these nuclei cannot be produced by fusion processes and a buildup of heavier elements is prevented. As neutrons need not overcome a Coulomb barrier, within an isotopic chain nuclear mass may be built up by successive neutron captures and subsequent β -decay will then allow the nuclear flow to higher Z . Approximately half of the heavy elements with mass number $A > 70$ and all of the actinides in the solar system are believed to have been produced by the r-process. We have studied the r-process in supernova explosion condition (high temperature and density) because the supernova envelopes at a temperature $> 10^9$ K and neutron number density of 10^{24} cm⁻³ are considered to be one of the most potential sites for the r-process. The abundances of elements obtained along the r-process path are compared with the observed data and found to be in good agreement.

**B. ATOMIC & MOLECULAR PHYSICS, SPECTROSCOPY,
CHEMICAL PHYSICS**

**11. Role of Torsional Vibrations in the Electronic Absorption Spectrum of
Acetone**

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***Keywords:** Vacuum ultraviolet, Photoabsorption, Synchrotron radiation, Torsional vibrations, Acetone*

Photoabsorption studies of acetone in the ultraviolet and vacuum ultraviolet regions (1100 – 2800 Å) have been carried out using monochromatised synchrotron radiation from the Photophysics beamline based on Indus-1, a 450 MeV storage ring facility at Raja Ramanna Centre for Advanced Technology, Indore. Several valence and Rydberg transitions are observed accompanied by extensive vibrational structure. Rydberg series corresponding to ns, np and nd excitations converging to the first ionization limit at 9.708 eV (1277 Å) have been identified. Analysis of the observed bands shows strong contributions from the low lying methyl torsional modes with ground state frequencies 124.5 cm⁻¹ and 77.8 cm⁻¹ for the gearing and antigearing modes respectively. Based on this observation, some of the discrepancies in earlier band assignments have been sorted out and revised assignments are proposed. A few bands which were not assigned in earlier works could be assigned. Consideration of the torsional modes has also led to more accurate determination of band origins and quantum defect values. Detailed vibronic analysis of the observed bands with emphasis on the role of hot bands in the electronic absorption spectrum of acetone is reported in this paper.

12. Reduced Potential Curves for the Diatomic Mercury Halides

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Keywords: Potential energy curves, Reduced potential functions for diatomic molecules.

The reduced potential curves (RPC) of the ground electronic states of HgCl, HgBr and HgI are constructed. These curves obey the rules of RPC scheme and also show similarity to respective RKR curves.

13. Comparison of Potential Energy Curves for Ground State of GaCl, GaBr, GaF and GaI Molecules

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Keywords: Potential energy curve, Diatomic molecule, Extended-Rydberg, H-H, Zavitsas Potential.

The diatomic molecules GaCl, GaBr, GaF and GaI, are spectroscopically studied by the many workers. The accurate ground state constant of these molecules, derived from latest Fourier transform spectroscopic analysis are used to construct the RKR curves. The Hulbert-Hirschfelder, extended Rydberg and Zavisstas potential energy functions are used and are compared with their respective RKR curves. The error curves are also studied.

14. Formation and Relative Stability of Neutral Lanthanum Oxide Clusters

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Keywords: *Metal oxide clusters, Stability, Mass spectrometry, Laser photoionization*

Neutral lanthanum metal oxide clusters, La_mO_n ($m = 1-9$, $n = 1-13$), were produced by laser vaporization of lanthanum metal rod in a pulsed supersonic beam of helium doped with molecular oxygen. Clusters were photoionized by UV laser and detected using time-of-flight mass spectrometer (TOFMS). In the mass spectra of La_mO_n clusters, certain specific stoichiometries, $\text{LaO}(\text{La}_2\text{O}_3)_x$ were found to be more prominent. Lanthanum exhibits two oxidation states, +3 and +2, the former being much more stable in the bulk phase. However, in small lanthanum oxide clusters the units having +3 oxidation states $(\text{La}_2\text{O}_3)_x$ are less stable compared to unusual $\text{LaO}(\text{La}_2\text{O}_3)_x$ stoichiometry.

15. Non-Planer Study and Raman Spectra of an Antifungal Agent

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Keywords: *DFT, FT-Raman, NBO, HOMO-LUMO*

Topical antifungal drug tolnaftate has been widely used in the treatment of cutaneous diseases. Present work reports the Raman spectral nalysis supported by DFT computations. The DFT computations were performed at the B3LYP/aug-ccpvtz levels of the theory to get optimized geometry using Gaussian '09 package. IN general, there is a good concordance between the experimental and theoretical spectrum. Naphthalene ring vibrations are found to make a major contribution in the Raman spectra of tolnaftate molecule. The C-C stretching is an important marker band and its wave number is a genuine measure of the degree of conjugation through π -electrons. Activation of the C-C stretching modes of the naphthalene ring provides evidence for the charge transfer interaction between the donor and acceptor groups through π -system, which makes the molecule highly polarized and as a consequence the molecule acts as strong antifungal agent. NBO analysis shows weak C-H...O hydrogen bonding. Lowering of HOMO-LUMO gap shows strong fungicidal activity.

16. DFT Computations and NIR-FT Raman and FTIR Spectral Investigations of Caffeinium Picrate

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Keywords: *FT-IR, FT-Raman, NLO, HOMO-LUMO*

FT-Raman and FT-IR spectra of the nonlinear optical (NLO) molecule caffeinium picrate have been recorded and analyzed. The equilibrium geometry and vibrational wave numbers of caffeinium picrate have been calculated with the help of density functional theoretical (DFT) computations. The C₂₆-O₃₇ bond distance is increased by 0.01906 Å, which is due to the intramolecular charge transfer taking place from the donor to the acceptor group. The caffeinium and picrate ions are connected by N-H...O and C-H...O intramolecular interactions. The N-H...O distance is observed to be less than the Van der Waal's distance and hence the structure shows strong N-H...O hydrogen bonding. The calculated HOMO-LUMO energy gap is found to be -0.13951 a.u.

17. Vibrational spectra and normal coordinate analysis of NLO material 4,4-Dimethyl Benzohenone

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Keywords: *DFT, FT-Raman, FT-IR, NCA*

FT-Raman and IR spectra of the crystallized nonlinear optically active crystal, 4,4-dimethyl benzophenone have been recorded and analyzed. The equilibrium geometry and harmonic vibrational wave numbers of the grown crystal have been investigated with the help of density functional theory method. The assignments of the vibrational spectra have been carried out with the help of normal coordinate analysis following the scaled quantum mechanical force field methodology. The calculated hyperpolarizability value shows the non-linear optical activity of the molecule. The natural bond orbital analysis confirms the occurrence of intramolecular charge transfer interaction.

18. DFT and Vibrational Spectroscopic Approach to the Non-Linear Optical Crystal L-Argininium Perchlorate

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Keywords: FT-IR, FT-Raman, NLO, β values

Good optical quality L-arginine perchlorate (LARPCL) single crystals were grown by slow evaporation technique. Ft-Raman and FT-IR spectra of the nonlinear optical (NLO) molecule LARPCL have been recorded and analyzed. The equilibrium geometry, vibrational wave numbers and the first order hyperpolarizability of LARPCL have been calculated with the help of density functional theoretical (DFT) computations. The downshift in HN_3^+ stretching vibration is due to the strong intramolecular N-H...O hydrogen bonding. The NBO analysis also shows the formation of strong intramolecular N-H...O hydrogen bond. The calculated first order hyperpolarizability of LARPCL is found to be 8.5098×10^{-31} esu, which is 3 times that of urea.

19. A comparative study of biological activity and vibrational wavenumbers of 2'-Deoxyuridine and 5-fluoro-2'-deoxyuridine: DFT approach

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Keywords: *FT-Raman, FTIR, DFT, NBO analysis, Intramolecular charge transfer*

Vibrational analysis of 2'-deoxyuridine and 5-fluoro-2'-deoxyuridine compounds have been performed using FT-Raman and FT-IR spectroscopic techniques. The optimized geometry, various bond features and harmonic vibrational wave numbers have been computed with the help of B3LYP/6-31G(d,p) density functional theory method. The natural bond orbital analysis, Mulliken population analysis on atomic charge and the HOMO-LUMO energy have been calculated to explore the reasons for the change in the biological activity and vibrational wave numbers of these compounds. Potential energy distribution analysis has been used to assign the normal modes of vibration unambiguously.

20. Solvent Dependence of the Vibrational Linewidth and Shift in Liquid Binary Mixtures

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Keywords: *Linewidth, Shift, Resonant energy transfer, Transition dipole, solvent*

The Raman spectra of S=O and C-H stretching vibration of dimethyl sulfoxide were studied in chloroform and chloroform-d solvents. The spectra of the two stretching vibrations were recorded at various mole fractions such as 0.0, 0.1, 0.3, 0.5, 0.7 and 0.9 of solvent concentration of the two solvents. It was found that the peak frequencies of the two stretching vibrations were increased with increase in solvent concentration for both the solvents. The bandwidths of S=O stretching vibration of dimethyl sulfoxide in chloroform solvent were found increase in further dilution, however data pattern were found completely different for chloroform-d solvent. The bandwidths of C-H stretching vibration of dimethyl sulfoxide in both solvents were decreased with the increase in solvent concentration. The increase in peak wavenumber position in further dilution may be due to the formation of hydrogen bond between the S=O of solute and C-H of chloroform. At high dilution, the chloroform molecules diffuse towards the solute molecules, thereby weakening the dipole-dipole interaction of the solute molecules. We are getting similar data pattern in chloroform-d solvent also, as difference in S=O...D-C and S=O...H-C hydrogen bond strength is very less due to small change in reduced mass for the dissociation coordinate.

21. Study of Different Rock Samples using LIBS

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Keywords: LIBS, Rock, Silicon

Modern laser based technique called as Laser Induced Breakdown Spectroscopy (LIBS) came into existence for remote and real time analysis of variety of samples, in any phase (solid, liquid and gas). The different rock samples were. LIBS spectra of the rock samples (Sedimentary, Metamorphic and Igneous rocks) obtained from different places

have been recorded in air in the spectral range from 200 nm to 900 nm. The LIBS spectra of the rocks show presence of various elements like Ca, Mg, Fe, Na, K, Si along with lighter elements C, H,N and O. The intensities of the spectral lines of the elements are different for different rock samples. LIBS spectra of Sedimentary rock sample show highest intensity of the spectral line of the silicon as compared to metamorphic and igneous rocks. Thus the present paper clearly reveals that the LIBS technique may be used for the *in-situ* and rapid identification of the geological samples without sample pretreatment.

22. LIBS Based Study of Soil Contamination due to Industrial Waste

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Keywords: LIBS, Cr, Industrial waste, Soil

The present paper is an attempt to find the heavy/toxic metals in the soil of the field nearby area of leather tanning industries. Jajmau (Kanpur) is the prominent centre of leather tanning industries along the bank of River Ganga. Laser induced breakdown spectroscopy has been utilized to detect and quantify the heavy metals like Cr present in the soil. Soil sample was collected from the different locations nearby industries. The spectral signatures of Cr along with other heavy elements are present in the LIBS spectra of the soil sample. For the quantification of the Cr present in the soil sample calibration curve was drawn for atomic line 267.7 nm. The concentration of Cr was found higher than the limit set by Environmental Protection Agency.

23. Analysis of Cigarette Filter using Laser Induced Breakdown Spectroscopy

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Keywords: LIBS, Cigarette, Filter

The cigarette filter is a type of filter that absorbs a portion of the tobacco smoke, prevents the cigarette end from collapsing, and prevents tobacco from entering the person's mouth. The quality of the cigarette filter can be monitored using laser induced breakdown spectroscopy (LIBS). LIBS spectra of the filter before smoking and after smoking have been recorded in the spectral range of 200-900 nm. The spectral signatures of the different elements like C, Ti, Na, and K etc are present in the filter. The intensity of these elements in the LIBS spectra of the filter after smoking increases as compared to the intensity in the LIBS spectra of filter before smoking. Thus our study demonstrates the feasibility of LIBS for monitoring the quality of filters used in cigarettes.

24. Upconversion Emission Processes in Spherical Ho:Yb:Gd₂O₃ Nanocrystals

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Keywords: GdO Nanocrystal, Rare earth, Upconversion luminescence, Photon-Avalanche.

Intense green upconversion emission in Ho:Yb:Gd₂O₃ spherical nano-particles is reported through hetro-looping enhanced energy transfer process, for the first time.

Different techniques used for structural characterization divulge the formation of spherical Ho:Yb:Gd₂O₃ crystals of diameter ~40-60 nm. Efficient energy transfer from Yb³⁺ → Ho³⁺ ions set spherical nano-crystal to emit in the range of UV-NIR via three NIR photons absorption process. The most intense emission observed in green region [Fig. 1]. Power dependence and the temporal evolution of upconversion intensity suggest occurrence of a process similar to photon-avalanche. The emission enhancement in nano-phosphor sample was explained and the photo-physics involved is correlated with the unique structural properties of the crystallite formed and time resolved spectroscopy.

25. White Light Emission from Rare Earth (Tb, Sm and Dy) Coordinated Complexes in Poly Vinyl Alcohol

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Keywords: *Absorption, Photoluminescence spectroscopy, Energy transfer*

Complexes of Gd,Tb(Sal)₃Phen, Sm,Tb(Sal)₃Phen and Dy(Sal)₃Phen doped in PVA polymer films have been synthesized using solution casting technique. The absorption and photoluminescence spectra of the samples were examined and it is revealed that emissive properties of Tb³⁺ improve when coordinated with Sal. On adding Gd³⁺ to it, the emission intensity of Tb further increased via intramolecular energy transfer. In Sm,Tb(Sal)₃Phen complex, the variation in concentration of Sm³⁺ and Tb³⁺ ions produced emission in blue, green and orange-red regions and can be tuned to produce white light when excited by 355 nm radiation. Self-quenching is seen at higher concentration of Sm³⁺ ions. An efficient energy transfer was seen between Tb³⁺: ⁵D₄ to Sm³⁺: ⁴G_{9/2}. The enhancement in the fluorescence intensity of Sm³⁺ in the codoped polymer sample is due to the intermolecular energy transfer as well as intramolecular

energy transfer. Alongwith, white light emission is also obtained by combining complementary yellow and blue emissions in Dy(Sal)₃Phen PVA sample.

26. Photophysical Properties of Coumarin 343 Laser Dye

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Keywords: Stokes' shift, Excited state, Ground state, Dipole moment, Reorientation time

The ground state (μ_g) and the excited state (μ_e) dipole moments of a Coumarin 343 Laser dyes are estimated in various solvents by Lippert, Backshieve, Kawski-Chamma-Viallet,McRae and Suppan equations by using the variation of Stokes shift with the solvent dielectric constant and refractive index. It was observed that the dipole moment values of excited state (μ_e) were higher than corresponding ground state values (μ_g), indicating a substantial redistribution of the π -electron densities in a more polar excited state than the ground state. The rotational reorientation of Coumarin 343 molecule has also been examined in various solvents. It is observed that the increase in viscosity of the solvent is responsible for the increase in the rotational relaxation time of the probe molecule. Coumarin 343 has an important industrial application like sunscreens, optical brighteners, fluorescence indicators, laser dyes, in enzymology, blood thinners, treating the cancer affected cells, and even as sunburn preventives.

27. Dielectric Study of Ethylene Glycol –N Methyl Acetamide Binary Mixture using Time-Domain Reflectometry

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Keywords: *Time domain reflectometry, Ethylene glycol, N methyl acetamide, Excess parameters, Kirkwood correlation factor, Bruggman factor, Activation energy.*

The dielectric relaxation measurement on binary mixture of ethylene glycol with N methyl acetamide have been carried out for 11 different concentration at 288,298,308 & 318 K using the picoseconds' time domain reflectometry (TDR) over the frequency range 10 MHz to 20 GHz. The mixture exhibit a principle dispersion of Debye relaxation model at microwave frequencies. Bilinear calibration method is used to obtain complex permittivity $\epsilon^*(\omega)$ from complex reflection coefficient $\rho^*(\omega)$ over the frequency range of 10 MHz to 10 GHz from complex permittivity. Dielectric parameters were obtained by fitting in non linear least square fit method to the Havriliak-Nigami expression. The excess permittivity (ϵ^E) has negative value through a system indicates ethylene glycol and N Methyl acetamide interact such that total effective dipoles reduces and form multimers. Excess relaxation time $(1/\tau)^E$ has negative value through a system indicates ethylene glycol and N Methyl acetamide interaction produces a field such that the effective dipoles rotate slowly. Kirkwood correlation factor (g^{eff}) has decreasing trend from pure liquid to mixture indicates dipoles are alien antiparallel which does not cooperate the field activation energy and bruggman factor are also calculated seen systematic variation to study the solute solvent interaction. Deviation from the linearity of various model suggest

molecular association through hydrogen bonding between the –OH Group of alcohol and C=O group of acetamide.

28. Dielectric Properties of Liquid Mixtures of 1-Methyl-2-pyrrolidinone with Alcohols at 303.15 K

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Keywords: *Static dielectric constant, relaxation time, liquid mixtures, time domain reflectrometry.*

Static dielectric constant ϵ_s and relaxation time τ of liquid-liquid solutions of with 1-methyl-2-pyrrolidinone methanol, ethanol, n-propanol, and n-butanol have been measured using picoseconds time domain reflectometry over the frequency range 10 MHz-10 GHz at 303.15K. From experimental values of static dielectric constant and relaxation time, excess static dielectric constant, excess inverse relaxation time, have been calculated. Experimental ϵ_s values gradually increases from corresponding values for alcohols and reaches up to that for pure 1-methyl-2-pyrrolidinone and τ decreases from the corresponding values for alcohols to that for pure 1-methyl-2-pyrrolidinone. Excess static dielectric constant ϵ_s^E values are found to be positive in 1-methyl-2-pyrrolidinone rich region and negative in alcohol rich region, for liquid mixtures containing ethanol, n-propanol, n-butanol, however, in case of methanol solutions entire values are positive. Excess inverse relaxation time $(1/\tau)^E$ values are found to be negative in alcohol-rich region and positive in 1-methyl-2-pyrrolidinone rich region for all liquid mixtures.

29. Analysis of Trace Elements by X-Ray Fluorescence

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Keywords: *Trace analysis, Toxic metals, Environmental pollution.*

Trace element determination in human body is of great importance for prevention and control of several types of diseases. The accumulation of tiny amounts of various elements in the body can be easily detected by analysis of hair. The sample preparations is relatively easy and concentration of trace elements in hair are at least ten times higher than in body fluids. Trace element analyses of hair are of great importance in forensic, medical and environmental sciences. The present research investigation was undertaken to establish the levels of toxic metals among residents of Nakaru district of Kenya arising from environmental pollution.

C. CONDENSED MATTER PHYSICS, THIN FILMS, NANO-SCIENCE

30. Electronic Structure of Intermetallic Ti-Cu

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Keywords: Electron momentum density, Charge transfer, Ti-Cu, X-ray scattering.

In this paper, we report the electronic structure of intermetallic Ti-Cu alloy through the Compton profile measurements. The Am²⁴¹ Compton spectrometer, which uses 59.54 keV gamma-rays, has been used for the measurements. In order to examine the charge transfer in Ti-Cu formation, we have compared the measurement with the superposition of experimental Compton profiles of constituent metals (Ti and Cu). The results suggest transfer of $0.18 \pm 0.05e^-$ from Ti \rightarrow Cu on alloy formation.

31. Electron structure of CaO: Theory and Experiment

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Keywords: Electron momentum density distribution, Charge transfer, DFT.

In this paper, we report the electronic structure of CaO. Both directional as well as spherically averaged Compton profiles are calculated for the compound employing the CRYSTAL code within the framework of density functional theory (DFT). The

anisotropy [100]-[110] is in agreement with the published data. The spherically averaged theoretical values are compared with the measurement made on polycrystalline sample using 59.54 keV gamma-rays from Am²⁴¹ source. Charge transfer in the compound has also been estimated following the ionic model. The present study suggests charge transfer from Ca to O atom.

32. Effect of Impurities on the Hardness of Alkali Halides Single Crystal

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Keywords: *Micro hardness, Alkali halide.*

Micro hardness number of KCl, KBr and KCl-Br grown by Czochralski technique, in the presence of homovalent and aliovalent ions of different ionic radii were measured in the indentation load range from 5 to 80*10⁻³ N. The measured data showed that there is an indentation size effect and classical Meyer's law was used for the characterization of crystal hardness of these crystals. The Meyer's index was also found to be smaller than 2 indicating brittle material characteristic. The P.R.S. model was used for the determination of the load independent micro hardness value. Result can be explained on the basis of interaction between created dislocation and point defect. It was found that hardness of these crystals is depending on the type of impurity.

33. Current-Voltage Characteristics of Ni/(N)Cdse Schottky Junction

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Keywords: Diode ideality factor, Schottky barrier, Thermal evaporation, Cadmium Selenide

The vacuum evaporated CdSe films of thickness 1980 Å has been used to fabricate the Schottky barrier junctions with Ni metal as counter electrode for photovoltaic cells. The CdSe films were doped with Ag metal by coevaporation technique and found to be n-type with doping concentration up to $5.21 \times 10^{14} \text{ cm}^{-3}$. All the junctions of different doping concentrations exhibited rectifying current-voltage (I - V) characteristics. From the current density-voltage (J - V) characteristics, the different junction parameters such as ideality factor (n), barrier height (ϕ), saturation current density (J_0) etc. were studied for Ni/CdSe junction. The Richardson constant evaluated from $\ln(J_0/T^2)$ vs T^{-1} plot was found to be $44 \text{ Am}^{-2}\text{K}^{-2}$. The junctions exhibited very poor photovoltaic effect. Large series resistance, high defect density and presence of interfacial layer are thought to be the main causes for poor photovoltaic conversion efficiency.

34. Influence of Bath Temperature on Chemically Deposited Nanocrystalline CdSe Thin Films

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Keywords: CdSe, Nanocrystalline, XRD, Band gap

Chemical Bath Deposition technique is used to prepare Nanocrystalline CdSe thin films on glass substrates at different bath temperatures. The structural properties, optical and energy band gap were investigated using X-ray diffractometry and optical spectrophotometry method respectively. The XRD analysis reveals that the films are polycrystalline in cubic structure. Optical absorption study shows the presence of direct transition with band gap energy in the range of 2.05 to 1.9 eV. The shift in E_g and the variation of grain size of CdSe crystallite from 1.5 nm to 3.6 nm has been observed when the temperature of the bath varies from 293K to 323K.. These changes are attributed to the quantum size effect in nanocrystalline semi conducting films.

35. Structural Analysis and Magnetic Properties of CoTi Substituted M-Type Calcium Hexaferrites

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Keywords: Ca ferrite, X-ray density, Porosity, Magnetization, Coercivity, Retentivity etc.

Ca hexaferrite samples with chemical composition $\text{CaMe}_x\text{Fe}_{12-2x}\text{O}_{19}$ where ($x = 0$ to 1) and $\text{Me} = \text{CoTi}$ synthesized using proper stoichiometric proportions by solid state reaction at 1040°C for 105 h. The chemical phase analysis has been carried out by X-ray powder diffraction (XRD) method, which confirms the formation of the ferrite structure. It shows hexagonal magnetoplumbite (M) type structure having unit cell dimension 'a' and 'c' varies between 5-6 Å and 21-23 Å. Coercivity (H_c), saturation magnetization (M_s), Retentivity (M_r) and Bohr magneton (η_B) measurements were carried out on a vibrating sample magnetometer (VSM) with an applied field up to 10 KOe. The results were explained in the light of Gorter's spin model. SEM analysis indicates that powders were plate like particles with grain size between 0.29 μm to 0.87 μm .

36. Modes of Vibrations due to Substitutional H^- Ion in Strontium Oxide

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Keywords : Localized Modes, Green Function.

Modes of vibrations due to H^- ion impurity in SrO have been studied by Green's function technique. Vibrations of the defect and its six nearest neighbour ions, having O_h symmetry have been considered. Mass changes at the defect site as well as change in the short-range interaction due to the presence of the defect are taken into account. The results have been compared with experimental values. Nearest neighbour short-range force constant soften by about 30%.

37. Effect of Electric Field on Ferroelectric & Dielectric Properties of PbHPO₄-type Ferroelectrics

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Keywords: *Ferroelectrics, Green Functions, Dielectric constant, Pseudospin, Shift, Width, & Soft mode frequency*

Ferroelectric are certain dielectric substances which exhibit dipole moment even in the absence of external electric field and exhibit hysteresis curve under the action of an alternating voltage. The order-disorder class of ferroelectrics includes crystals with hydrogen bonds in which the motion of the protons is related to the ferroelectric properties as KDP Lead Mono Hydrogen Phosphate (PbHPO₄) and its isomorphs from (PbHAsPO₄, BaHPO₄, CaHPO₄, CaHAsPO₄) the another interesting group of hydrogen bonded ferroelectric crystals similar in same respects to the KH₂PO₄ family. There is interesting property of H-bonded ferroelectric crystal with applying electric field on dielectric constants. This is used extensively in all branches of electrical engineering, where they are employed to increase the efficiency of capacitors. Piezoelectric electric acoustic transducers and pyroelectric infrared detectors are the devices based also on ferroelectrics. The property of hysteresis suggests their use as memory devices for electronic computers. In this paper we theoretically extended two sublattice pseudospin lattice coupled mode model by adding third and fourth-order phonon anharmonic interactions terms as well as external electric field term has been considered for LHP crystal and its isomorphs. With the help of double-time temperature dependent Green's Function method, theoretically, expressions for shift, width, soft mode frequency, dielectric constant and loss tangent are derived. By fitting model values in the theoretical expressions, temperature and electric field dependences of dielectric constant calculated for PbHPO₄ crystal in presence of electric field. The theoretical results compared with

experimental results of Smutny and Fousek [*Ferroelectrics*, 21, 385(1978)] show good agreements.

38. Core Level Shifts in Random CuNi Alloys

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Keywords: *Random alloys, Disorder, Core level shift, Photoemission*

Cu_{1-x}Ni_x alloys (x = 0.0, 0.1, 0.3, 0.5, 0.7, 0.9, 1.0) have been prepared by arc melting method and were investigated using high resolution photoelectron spectroscopy down to 10K. The core levels of Cu and Ni exhibit shifts towards lower binding energy in alloys compared to their metallic counter parts. Cu 2p core levels exhibit a large disorder broadening whereas the width of Ni 2p surprisingly decreases in alloys compared to Ni metal. Usually, chemical shifts (core level shifts) of different components in a binary compound should be in opposite directions following the inter site charge transfer due to bonding. In metallic alloys the electrostatic charge at any site is zero suggesting no chemical shift. But, experimentally a chemical shift of about 1 eV has been observed for several metallic alloys indicating there are other factors like factors (1) core hole relaxation (2) changes in Fermi energy (3) intra atomic charge transfer and (4)

redistribution of charge upon hybridization and bonding apart from inter site charge transfer influencing the chemical shifts. Core relaxation is a final state effect in photoemission and the rest three factors are initial state effects. In these alloys, major contribution to chemical shift is due to changes in Fermi energy.

39. Study of the effect of Jahn-Teller Distortion on the Magneto-resistivity of the Manganite Systems

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Keywords: *Magneto-resistivity, Magnetic and structural transitions.*

We report here a theoretical model to study the magneto-resistivity through the interplay among the magnetic and structural transitions. The model consists of an orbitally doubly degenerate conduction band and a periodic array of local moments of t_{2g} electrons. The band electrons interact with the local t_{2g} electrons via s-f hybridization. The phonons interact with the band electrons through the static and dynamic band Jahn-Teller (JT) interaction. The model Hamiltonian including the above terms is solved for the single particle Green's function and the imaginary part of the self energy gives the electron relaxation time. The Magneto -sensitivity effect is explained near the magnetic and structural transition temperatures. The results will be presented to explain the experimental observations.

40. Temperature Dependence of Second Order Elastic Constants of Alkaline Earth Oxides

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Keywords: EOS; AEO Solids

A simple and straightforward theoretical model is developed to investigate the elastic constants of alkaline earth oxide solids under the effect of temperature. The calculation are performed with the help of high temperature equation of state (EOS) derived from Tallon's method based on thermodynamic analysis. The results obtained for these solids are discussed and compared with experimental data under the effect of high temperature. The results are found to be in good agreement with available experimental results and thus may be helpful in analyzing the other's experimental results.

41. Structural, Dielectric and Impedance Properties of 0.91 Ba(Fe_{0.5}Nb_{0.5})O₃-0.09BaTiO₃ Ceramics

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Keywords: Perovskite, Dielectric spectroscopy, XRD, Relaxation

A polycrystalline ceramics of 0.91 Ba(Fe_{0.5}Nb_{0.5})O₃-0.09BaTiO₃ was synthesized by high temperature solid-state reaction technique. Perovskite based oxide materials with high dielectric constants have several technological applications such as microwave frequency resonators, multilayer capacitors, sensors, detectors, actuators and filters. High

dielectric constants allow smaller capacitive components, thus offering the opportunity to decrease the size of the electronic devices. Dielectric spectroscopy is a powerful and versatile technique to analyze the electrical property of complex perovskite oxides as it distinguishes between intrinsic (bulk) and extrinsic (grain-boundary, surface layer and electrode) contributions. The phase identification of $0.91 \text{ Ba}(\text{Fe}_{0.5}\text{Nb}_{0.5})\text{O}_3\text{-}0.09\text{BaTiO}_3$ was performed using X-ray diffraction technique (XRD). X-ray diffraction analysis of the powders suggests the formation of a single-phase material with monoclinic structure. The microstructure of the ceramics was examined by the scanning electron microscopy (SEM), and shows the polycrystalline nature of the samples with different grain sizes, which are inhomogeneously distributed through the sample surface. Detailed studies of dielectric and impedance properties of the materials in a wide range of frequency (100Hz–1MHz) and temperatures (30-280°C) showed that these properties are strongly temperature and frequency dependent. Relaxation phenomena of non-Debye type have been observed in the above ceramics, as confirmed by the Cole–Cole plots. The details of our results will be discussed in the seminar.

42. Quantum Interpretation of Computing Application of Hydrogen Bonded Ferroelectric and Antiferroelectric Crystals

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Keywords: *Phase transition, Quantum states, Switching*

In this modern age of technology, the revolutionary creation of man is computer which has changed our life very frequently thousand years faster because of its high storage power of data, high accuracy of calculation and fast solution of any problem. Our study is useful to enhance the various parts of computing technology like memory (non-

volatile) and display devices etc. by the application of ferroelectric and antiferroelectric materials, so for better interpretation about application of ferroelectric and antiferroelectric crystals in computing technology we have chosen two crystals in which one of them is ferroelectrics Triglycine Sulphate Crystal (TGS) while another is antiferroelectrics Tin chloride dehydrate crystal. We have tried to explain static and dynamic conditions of crystal lattice in different temperatures and electric fields by the help of quantum mechanics. Thus, for Triglycine Sulphate (TGS) Crystal and Tin chloride dihydrate crystal, we have discussed all physical properties (dielectric, electric, acoustic, photonic, inter-atomic switching mechanism of proton through lattice structures). These properties are any how applicable in computing technology. To solve these all properties of hydrogen bonded ferroelectric and antiferroelectric crystals. We have deal with the vibration and pseudo spin model of ferroelectrics. These two theories of ferroelectrics are mostly based on quantum physics. In this theory we have involved temperature and electric field dependent third and fourth order phonon anharmonic interaction terms for second order phase transition of polarization in renormalized boundary condition of double potential well for better predictions about crystal behaviours. On the bases of these properties of the crystals, we have predicted the possible applications of ferroelectric (triglycine sulphate) crystal antiferroelectric (tin chloride dihydrate) crystal in computing technology.

43. Hydrogen Storage in AB₂ Type Materials

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Keywords: *Reversible hydrogen storage, XRD, TEM*

More than three decades of intensive research on intermetallics for reversible hydrogen storage have not met so far the prime requisites of the high hydrogen storage

capacity, fast kinetics with suitable plateau pressure and temperature. To overcome these problems, one of the mainline efforts is on material tailoring to improve the properties of hydrogen storage materials. One attractive class of metal hydride system, the Zr-based AB₂ system usually shows higher hydrogen storage capacity, rapid kinetics and relatively longer electrochemical charge-discharge cycle life than the well known AB₅ type storage materials. In this paper, we describe and discuss the synthesis, structural-microstructural and hydrogen storage behavior of three AB₂ type storage materials namely (a) ZrFe₂, (b) Zr(Fe_{0.75}V_{0.25})₂ and (c) Zr(Fe_{0.5}V_{0.5})₂. These alloys were synthesized by radio frequency induction melting in argon atmosphere. X-ray diffraction and transmission electron microscope have been employed for structural and microstructural characterizations. The XRD study reveals that the lattice constants and the unit cell volume of ZrFe₂, Zr(Fe_{0.75}V_{0.25})₂, Zr(Fe_{0.5}V_{0.5})₂ alloys, which has C14 type hexagonal Laves phase. The Surface morphology and elemental composition of these alloys were investigated by scanning electron microscope and energy dispersive X-ray analysis. The pressure composition isotherms of these alloys were investigated at room temperature and pressure ranges of 0-100 atmosphere respectively, measured through a fully computerized PCI apparatus. As we increase the concentration of V (substituted for Fe), the total hydrogen storage capacities increased up to 1.45 wt%. This capacity is achieved in Zr(Fe_{0.5}V_{0.5})₂ alloy, while the reversible hydrogen storage capacity decreases due to the formation of a stable hydride phase. It has been found that the lattice constants increase with higher vanadium concentration. This is indicating that the majority of vanadium atoms reside in the B-site. The broader X-ray diffraction peaks observed in Zr(Fe_{0.5}V_{0.5})₂ alloy indicates a higher degree of disorder for alloys with the higher V-content. The yet another interesting feature observed in our present study is that the plateau pressure remains well below 1 atmosphere for all the compositions.

44. In-plane Neél (Domain) Wall Dynamics in Ferromagnet Nanowire Effected by Spin Torque

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Keywords: *Domain Wall, Spin-transfer torque, nanowire, Landau-Lifshitz-Gilbert equation.*

Domain wall (DW) dynamics in ferromagnetic nanowire driven by spin transfer torque is reported in adiabatic approximation. Spin angular momentum carried by spin polarized electrons is transferred to the local moment through the exchange interaction. Thus, the spatial variation of the direction of the spin current inside the DW results in an adiabatic spin-transfer torque on the magnetization. Solving Landau-Lifshitz-Gilbert (LLG) equation, analytically and numerically, along with the adiabatic spin torque in ferromagnetic nanowire, we find that DW motion starts with a maximum velocity at the initial application of the current but the velocity decreases to zero as DW begins to deform during its motion. The system eventually favours a 'closure' structure, the vortex wall, in which the magnetization circulates in the plane about a small perpendicular 'vortex core'. DW displacement and DW distortion in nanowire have been computed and it is concluded that the spin torque is unable to maintain wall movement over a long distance.

45. Effect of Bi Addition on the Optical Properties of Bi/As₂S₃ Bilayer Thin Films

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Keywords: *Thermal evaporation technique, Optical band gap, Photo-diffusion.*

Bilayer thin films of Bi/As₂S₃ were prepared from Bi and As₂S₃ by thermal evaporation technique under high vacuum. Optical constants were calculated by analyzing the transmission spectrum. The optical band gap decreases with the addition of Bi to As₂S₃. The decrease of optical band gap has been explained on the basis of density of states and the increase in disorder in the system. We have irradiated the films by using a laser of 532 nm wavelength to study photo-diffusion of Bi into As₂S₃. The changes were characterised by FTIR and XPS which shows the photo bleaching of the illuminated films.

46. Thickness Dependent Study of Ion Beam Sputtered Fe/t_{si}/Fe Trilayer Films

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Keywords: *Fe/Si films, Silicide formation, Interlayer coupling, MOKE, XPS*

This article describes the systemic investigation of the interface magnetic and electronic properties of ion beam sputtered Fe/Si/Fe trilayer films as a function of thickness. X-ray photoelectron spectroscopy (XPS) measurements show substantial intermixing between the layers during deposition which results in trilayers of complicated structures for different sub-layer thicknesses. The Fe layers in the trilayers were observed to consist of Fe layers doped with Si, ferromagnetic Fe-Si silicide layers and nonmagnetic Fe-Si silicide interface layer, while the Si spacer was found to be Fe-Si compound layers with an additional amorphous Si (α -Si) sublayer for $t_{si} \geq 30$ Å. A strong anti-ferromagnetic (AF) coupling was observed in trilayers with iron silicide spacers, which disappeared if α -Si layers present in the spacers.

47. Single Layered Low Temperature Conductivity Studies of Fe Thin Films

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Keywords: *Thin films, conductivity, Activation energy, Fuchs-Sondheimer theory.*

Using high purity materials (Alfa Aesar) and Under high vacuum conditions, using electron beam gun evaporation method iron films of varied thicknesses and at a different substrate temperature were deposited onto the glass substrates. These films have been investigated for electrical resistivity in the temperature range 80K to 300K. The residual resistance ratio, RRR, and the temperature coefficient of resistance, TCR, were determined and discussed. The power laws for the temperature dependence of resistivity have been established. The thickness dependence of electrical resistivity has been considered in terms of Fuchs-Sondheimer theory and the resistivity of infinitely thick film, ρ_0 , and electron mean free path, l , were determined. The resistivity decreased with increasing substrate temperature and that is attributed to the formation of larger crystallites with increase of substrate temperature. The deposition rate of 2 Å/s is observed to be the optimum rate at which the iron films of minimum resistivity can be produced. It is for the first time that iron films have been investigated in single measuring setup for low temperature resistivity and its dependence on thickness of the film, substrate temperature and rate of deposition.

48. Grain-size Reduction by Fe Doping in ZnO Films

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Keywords: *Zinc oxide, Surface morphology.*

1, 2 and 3 at.% Fe doped ZnO films have been deposited by sol-gel spin coating, their surface morphology and optical transmission are studied. The films are highly transparent in visible and near infrared region. The films are highly transparent showing 80 to 90% transmission value in visible and near infrared region with a sharp cut off at about 300nm. As the amount of Fe is increased, small grains and their clusters are seen to form. With increase in dopant amount, the surface-density of grains reduces. Grain size is also found to decrease with increase in Fe doping.

49. Study of PbS Nano Particles Synthesized using Ethanol Solution

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Keywords: *PbS nano particles, Optical band gap, Ethanol, Wet chemical route, W-H plot, Strain.*

The semiconductor PbS nano particles were synthesized in Ethanol by simple wet chemical route by using colloidal chemistry. The optical characterization was carried out by using the UV Visible spectrophotometer, the optical band gap of 3.09eV indicate that

the PbS nano particles exhibit the significant blue shift with highly enhanced optical band. The structural characterization shows polycrystalline nature of PbS with average particle size of 69.90 nm. The strain obtained by W-H plot is 0.003.

50. Differential Scanning Calorimetry Studies of Conducting Polypyrrole Thin Film

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Keywords: *Polypyrrole, thin film, Differential Scanning Calorimetry (DSC)*

Polypyrrole thin films were prepared by solvent evaporation method. The differential scanning calorimetry (DSC) was carried out at RSIC Chennai. The conducting polypyrrole thin film samples in powder form were used. DSC was carried out on NETZSCH - (model DSC 204), at SAIF, Chennai. The calorimetric investigation of polypyrrole thin films is made in the range of 283 to 673 K at a heating rate of 10 K/min. The differential scanning calorimetric (DSC) curves of present polypyrrole thin films are given. The DSC is useful in identifying the kinetic enthalpy and temperature of onset of reaction, phase transition, glass transition temperature, and melt temperature and solvent evaporation. From the DSC analysis of polypyrrole films, the thermodynamic properties, Glass transition temperature T_g , Change in heat capacity ΔC_p , Crystallization temperature T_c , Crystallization enthalpy ΔH_c and thermal stability ($T_c - T_g$) are calculated. From DSC curve, it is observed that the two to four crystallization

temperatures are obtained, which indicates the crystallization and a small phase formation. The glass transition temperature T_g for these films are lie in the range of 320 to 306 K. The glass transition temperature T_g decreases with increasing wt. % of pyrrole concentration. The decrease in T_g with increase in pyrrole wt. % concentration suggests weak network structure of the pyrrole. The magnitude of ΔC_p is generally indicative of the nature of bonding and is higher for ionic pyrrole thin films and lower for covalent ones. The difference between T_c and T_g decides the thermal stability of the pyrrole thin film..

The endothermic peak in DSC suggests the loss of some modulus residues. Some structural changes that to be occur in sample. Polypyrrole thin films may, however undergo a second order phase transformation at the so-called glass transitions (transformation) temperature T_g . This transition, which corresponds to the accessibility of new configurational energy state or degree of freedom, marks the onset of softening and is accompanied by an increase in the heat capacity and thermal expansion coefficient.

51. XRD and VSM Studies in Ni/Fe Multilayers

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Keywords: *Multilayers, Magnetization, Coercive field and squareness ratio.*

The magnetic multilayers, $[\text{Ni}(100\text{nm})/\text{Fe}(100\text{nm})]_n$; $n = 1, 2, 3$ and 5 were deposited by electron beam evaporation method, under high vacuum at 473 K. The structure, grain sizes and interplanar spacings were determined from the grazing incidence X-ray diffraction (GIXRD) studies. The grain size and interplanar spacing

increased with increasing number of bilayers. The magnetization as a function of field was measured using vibrating sample magnetometer (VSM). The parameters such as coercive field, saturation magnetization, remnant magnetization and squareness ratio were determined from the M-H loops. The coercivity and remnant magnetization were found to be increasing with increasing number of bilayers and this is ascribed to the magnetic hardening of the films with increasing number of bilayers (n).

52. Preparation of Water Repellent, Transparent Silica Films by Sol–Gel Method (Superhydrophobic Coatings)

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Keywords: *Sol–gel process, Superhydrophobic substrates, PMMA, Transparent coatings*

The superhydrophobic surfaces have drawn lot of interest, in both academic and industries because of optically transparent, adherent and self-cleaning behavior. Surface chemical composition and morphology plays an important role in determining the superhydrophobic nature of coating surface. Such concert of non-wettability can be achieved, using surface modifying reagents or co-precursor method in sol–gel process. Attempts have been made to increase the hydrophobicity and optical transparency of methyltrimethoxysilane (MTMS) based silica coatings using polymethylmethacrylate (PMMA) instead of formal routes like surface modification using silylating reagents. The optically transparent, superhydrophobic uniform coatings were obtained by simple dip coating method. The molar ratio of MTMS:MeOH:H₂O was kept constant at 1:5.63:1.58, respectively with 0.5 M NH₄F as a catalyst and the weight percent of PMMA varied from 1 to 14. The hydrophobicity of silica coatings was analyzed by FTIR and contact angle measurements. These substrates exhibited 91% optical transmittance as compared to glass

and water drop contact angle as high as 164° . The micro-structural studies carried out by scanning electron microscopy (SEM).

53. Rashba Polaron in an Asymmetric Single Quantum Well

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Keywords: Rayleigh-Schödinger perturbation theory, Heterostructure

The polaronic corrections to the electron energy and effective mass are calculated taking the Rashba spin-orbit coupling in the compositionally asymmetric quantum well based on heterostructures of the narrow gap semiconductors InGaAs and InAs. The electron interaction with the bulk longitudinal optic phonon is considered in the Frölich form. In the weak coupling limit, the polaron properties are calculated in the Rayleigh-Schödinger perturbation theory. The electron energy shift and the effective mass are enhanced by the Rashba spin-orbit term in the highly asymmetric narrow quantum well. The effect of Rashba term vanishes in the symmetric quantum well. If the quantum well is wide, the effect of spin-orbit interaction term vanishes even if the well is highly asymmetric.

54. Synthesis and Characterization of Silver Oxide and Silver Nanoparticle by Sol-Gel Method

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Keywords: *Nanoparticles, Sol-gel method, SEM, XRD, FWHM, Annealing.*

Nanoparticles of Silver oxide are prepared by Chemical Co-precipitation method i.e. Sol-Gel method. It is prepared by decomposition of silver nitrate solution through Sodium Hydroxide route. The particle size and the nature of the crystal are characterized by X-Ray Diffraction (XRD). The surface morphology of the samples is studied by Scanning Electron Microscope (SEM). The SEM image indicates that the particles are uniformly spread and shape of the particles is semi-spherical in nature. The XRD shows that the peaks are highly intense. It shows that the particles are highly crystalline. The sizes of the particles were calculated by Debye Scherrer formula from the values of Full Width Half Maximum (FWHM), calculated from the peaks. The sizes of silver oxide and silver were obtained to be 25.75 nm and 52 nm respectively. The size of Silver is high because of coalescence of the particle due to annealing effect.

55. D S C Analysis of Low Density Polyethylene /Conducting Natural Rubber Nanoparticles Composites

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Keywords: *Polymer composites, Natural rubber, Nanoparticles, LDPE*

Low-density poly ethylene with varying amount of conducting natural rubber (CNR) nanoparticles composites are prepared by melt mixing. The CNR nanoparticles are prepared by doping the natural rubber solution with antimony pentachloride, a lewis acid using reflux boiling method. The precipitate obtained is filtered and dried under vacuum. The LDPE-based composites are prepared by mixing the CNR nano particles with the ultra fine LDPE powder in various proportions such as 10 phr, 20 phr, 30 phr, 40 phr and 50 phr. The samples are molded into thin films using a micro injection molding machine. The outstanding thermal behaviour of the composites confirmed using DSC analysis. The increased amount of filler in LDPE matrix shows variations in T_g towards the higher temperature region which indicates the effect of CNR nanoparticles in the mobility of molecules in the matrix. Also the equilibrium melting temperature of LDPE depends on the filler particles in the composite. The virgin LDPE shows its melting temperature at 389.42 K, whereas the peak melting temperatures of the LDPE composite is shown to be slightly increasing with the increase of the filler. The melting endotherm also starts at higher temperatures in these composites than that of the virgin LDPE. This is due to the larger crystallite size and narrower size distribution of LDPE in the composites. It is also observed that ΔH value determined by DSC increased with the increase of CNR nanoparticles in the LDPE composites.

56. Noncovalent Functionalization of Carbon Nanotubes

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Keywords: Carbon nanotubes, Functionalization, Preparation, Characterization

Since their discovery, carbon nanotubes (CNTs) have attracted great interest in most areas of science and engineering due to their unique physical and chemical properties, which enable them to be applied for a wide range of applications. One of the major limits to the applications of CNTs is their poor solubility and processibility. Functionalization of CNTs is therefore necessary. In the present work, we report the noncovalent functionalization of CNTs with amino group using L-cysteine. The CNTs were synthesized by chemical vapor deposition of benzene using ferrocene as a catalyst at 850⁰C. The as-prepared amino functionalized CNTs have been characterized by scanning electron microscopy; high resolution transmission electron microscopy and fourier transform infrared spectroscopy. This method ensures good dispersion and stability in water and organic solvents. Due to the presence of the high densities of amino functionalities on the surface of CNTs, various nanoparticles and biological molecules can be attached to CNTs. Details will be presented.

57. Mass-Asymmetric Effect on Wigner Crystallization in the Spin-Polarized Electron-Hole Quantum Bilayers

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Keywords: Quantum Layer, Wigner crystal, Electron-Electron correlation

The phase-transition from the liquid state to the density modulated ground-state is explored in the spin-polarized mass-asymmetric electron-hole quantum bilayers at zero

temperature. To achieve this task, we use the static density susceptibility obtained within the framework of quantum or dynamical version of Singwi, Tosi, Land and Sjölander (qSTLS) approach over a wide range of layer parameters. Interestingly, we notice that the inclusion of mass-asymmetry enhanced the critical density for the onset of Wigner crystallization as compared to the recent results for the spin-polarized mass-symmetric electron-hole quantum bilayers [J. Low Temp. Phys. 158, 515 (2010)].

58. Thermally Stimulated Polarization Currents of Pristine PET/0.8PHB Polymer Liquid Crystals

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Keywords: *Polymer Liquid Crystals, TSPC, PET, PHB, Relaxation*

Thermally stimulated polarization currents (TSPC) of pristine PET/0.8PHB polymer liquid crystals have been investigated at different polarizing fields, 38.5kV/cm, 115.4kV/cm and 153.8kV/cm. The TSPC consists of measuring the currents generated by the buildup of polarization in a solid dielectric sandwiched between two electrodes. In the present investigations, the TSP Currents spectra consists two current peaks one appearing in low temperature and the other in high temperature region. It is observed that the low temperature relaxations are dominated by PET rich phase. The origin of this low temperature peak can be associated with the β' - relaxation process due to fast reacting dipoles of both PET and PHB rich phase.

59. Dielectric Properties and Electrical Conductivity Studies on Some Granites

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Keywords: Dielectric constant, Dielectric loss ($\tan\delta$), AC conductivity, DC conductivity

Some Granite samples are collected from Warangal district of Andhra Pradesh. These Granite samples are powdered to a required size and chemically analyzed using XRF techniques. Dielectric constant (ϵ) and dielectric loss ($\tan\delta$) of granites have been measured in the frequency range 100 Hz to 100KHz and in the temperature range from room temperature to 400⁰ C. AC conductivity was calculated from the data on ϵ and $\tan\delta$. The room temperature dielectric constant measurements are extended to 10 MHz. The room temperature dielectric constant at 10⁶ Hz is 6.4. The DC conductivity as a function of temperature is also measured. The results are discussed in the light of existing data.

60. Synthesis and Characterization of MgF₂/SiO_xN_y Double Layer Antireflection Coating for Photovoltaic Applications

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Keywords: Double layer antireflection coatings, MgF₂/SiO_xN_y materials, EB-PVD technique.

The use of MgF₂/SiO_xN_y couple for double layer antireflection (DLAR) coatings (SiO_xN_y=bottom layer) and its deposition by using electron-beam physical vapor deposition (EB-PVD) technique on Si substrates is reported in this paper. The films are characterized by XPS, UV-Visible spectroscopy, Ellipsometry, Energy dispersive spectroscopy (EDS) and Tally step measurement. The minimum reflectivity $R = 1.72\%$ with bandwidth $\sim 50\text{nm}$ (thickness $\sim 79\text{ nm}$ and reflective index ~ 1.88) is obtained for the single layer antireflection (SLAR) coating of SiO_xN_y on Si. This satisfies the conditions of near quarter wavelength of SLAR coating. These reflectivity and bandwidth values are found to be improved to $\sim 1.43\%$ and $\sim 100\text{ nm}$ (at $R \sim 15 \times 10^{-3}$) respectively for the best DLAR coating of MgF₂/SiO_xN_y on Si substrate. The results obtained for above couple on Si substrates are found to be comparable with data given for the reported DLAR coatings.

D. ELECTRODYNAMICS, PLASMA PHYSICS

61. Two Plasmon Decay of Self- Trapped Laser Radiation in Relativistic Plasma

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Keywords: Ponderomotive force, Langmuir modes, parametric instability

Currently there is much interest in the interaction of high intensity ultra-short-laser pulses with plasmas. When a laser beam is focused into plasma, self-focusing and self channeling can occur as result of relativistic modification of electron mass in the laser field and reduction of electron density on the focal region due to expulsion of electrons by laser ponderomotive force. The paper presents the localization of Langmuir modes in self – generated plasma channel. The channel supports localized Langmuir eigenmodes of the plasma which could be driven unstable parametrically by the laser pump. Since the Langmuir waves do not suffer convective losses across the plasma channel, the threshold for the onset of a parametric instability is of the same order of magnitude as that obtained in homogeneous plasma with a uniform pump. Above the threshold, the instability grows on a time scale somewhat longer than the one in uniform plasma. The growth rate increases with the azimuthal mode number.

62. Arbitrary Amplitude Solitary Waves in Dusty Plasma Consisting of Nonthermal Electrons

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Keywords: Dusty plasma, Solitary waves, Sagdeev potential, Nonthermal electrons

Dust-ion-acoustic solitary waves have been theoretically studied in an unmagnetized noncollisional plasma consisting of warm positive ions, negatively charged dust particles and nonthermal electrons using pseudo-potential method. The profiles of the Sagdeev potential are drawn taking different values of the plasma parameters. The conditions for the existence of solitary waves in the dusty plasma in presence of nonthermal electrons are obtained. The solutions of the first-order and next higher-order solitary waves in the dusty plasma are obtained from the nonlinear equation derived from the Sagdeev potential. The variation of amplitudes of the solitary waves is shown graphically for different values of dust density and nonthermal parameter of electrons.

63. Behaviour of External Magnetic Field with Different Radii of Electron and Intrinsic Properties of Electron

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Keywords: Electron radii, Electron model, α -quantization.

Several models of electron are proposed for last one century depending on the properties of electron. Different electromagnetic phenomena are also developed for different radii. For different radii, the behaviour of charged spinning sphere (electron) is

one interesting topic and is being discussed here under non-uniform magnetic field. It also reveals the nature of how the external magnetic field can get affected for the different electron radii and lead to the results which include the intrinsic properties of electron in a special manner. Also these results are α -quantized.

64. Magnetic Self Energy and Helical Motion of Charge Invoking Spinning Sphere Model of Electron

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Keywords: *Electron radii, α -quantization*

Magnetic self-energy calculated with the help of relativistic spinning sphere (RSS) model of electron leads us to helical motion of charge. Also this includes a modified RSS model of electron. Helical motion of electron described here connects the RSS and the dynamical spinning sphere (DSS) model of electron.

65. Conducting Polypyrrole Intercated Elastomeric Composite by Plasma Polymerisation Technique

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Keywords: *Plasma polymerisation, Elastomeric composites, Styrene butadiene rubber, Corrosion.*

Recently, plasma polymerization has emerged as an interesting new approach for synthesising thin polymer films. It is a 'dry' technique that doesn't require the use of

solvents. From an ecological and economical point of view, the absence of solvents and solvent waste offers a lot of advantages, a time-tested technique for polymerizing polymers and coating them into substrates. The advantages of plasma polymerization based coating technique are the ease of coating and film uniformity and controllability of the film thickness.

The aim of this work is to synthesise homogeneous conducting polymer composite films of Styrene butadiene rubber (SBR) and polypyrrole (PPy) by plasma polymerisation. The composite films are prepared using a dc plasma polymerisation set up. The optical and morphological properties of the composite films investigated using UV-Visible and AFM studies indicate an effective formation of the composite. The optical band gap energy calculated from the absorption spectra is found to be in the semiconductor range. Since the plasma polymerized organic thin film is known to be highly crosslinked without pinholes and have good adhesivity, it can be a good barrier for the corrosion of metals. The corrosion protective properties of the synthesised composites in 3.5 % NaCl are studied using polarisation measurements. From the polarisation measurements it is found that plasma polymerised SBR/PPy composites provides better barrier protection in saline media.

66. Theoretical Study of Ion Cloud Shape, Ordering and Phase Transition of Non-Neutral Plasma in the Penning Trap

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Keywords: *Non-neutral plasma, Penning trap, Coulomb crystal, Quadrupole Potential*

Plasma constituted of particles of the same charge i.e., non-neutral plasma, also known as one-component plasma (OCP), provides some unique research opportunities

that are not possible with neutral plasmas. Trapped ions provide a good and low-temperature realization of a strongly coupled OCP in the laboratory. In this context, Penning traps, which use static fields for confinement, provide an ideal experimental platform. We discuss here the shape of ion cloud at different trapping potentials and the periodicity of strongly coupled Ca^+ ions in the Penning Trap. A Monte Carlo simulation for a three dimension system is carried out at different trapping potentials and with different number of ions. The ion cloud shape transition from prolate to oblate has been investigated. For a pure oblate ion cloud the ground state configuration is seen to follow planer (2-D) distributions. For a 3-D system, a Mendeleev-type of shell structure for varying number of ions has been obtained.

67. A New Pseudo Magnetic Levitation System

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Keywords: *Ferromagnetic Object, Permanent Ring Magnet, Pseudo Magnetic Levitation, Stable Magnetic Levitation System.*

This paper gives an innovative technique to create a stable pseudo magnetic levitation of ferromagnetic objects. This new Pseudo levitation system remains stable for any position/rotation of system in space and can work in absence of gravitational force so that it can be used for space applications and measurement of various forces. A permanent ring magnet, a solid soft iron cylinder, two soft iron circular disks and a soft iron pin having length less than the outer radius of ring magnet are used to create this system. The physics involved in this levitation is analyzed by permanent bar magnets and magnetic compasses for different possible configuration at room temperature. Possible applications, properties and functional experiment studies are presented.

E. NUCLEAR PHYSICS, PARTICLE PHYSICS, ACCELERATOR PHYSICS

68. Study of Disintegration Caused by 4.5 A GeV Carbon Nuclei in Nuclear Emulsion

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Keywords: Nuclear emulsion, Normalized multiplicity moments, Leading particle multiplicity etc.

Attempt has been made to investigate the characteristics of relativistic charged particles produced in 4.5 A GeV ¹²C-emulsion interactions. The results reveal that normalized multiplicity moments do not depend on the nature and energy of the projectile. Moreover, it is observed that this parameter also does not depend on the atomic mass of the target nucleus. Finally, the value of the leading particle multiplicity is found to depend strongly on the mass of the projectile.

69. Shear Driven Electrostatic Ion-Cyclotron Instability in Auroral Acceleration Region

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Keywords: Electrostatic Ion-Cyclotron Instability (EICI), loss-cone distribution function, velocity-shear

Effect of ion beam velocity and transverse d.c. electric field is studied on the Electrostatic Ion-Cyclotron Instability using the loss-cone distribution function. Using the parameters appropriate to upward current auroral region it is found that the parallel-velocity-shear due to the ion beam velocity and transverse electric field gives rise to shear-driven EICI by the inverse-Landau damping of the wave. The loss-cone distribution index further enhances the growth rate of the wave by extracting energy from the resonant ions. The results give an explanation for the FAST satellite observation of energetic EIC waves in the regions of velocity shear.

70. Study of Totally Disintegrated Ag Br Nuclei in the Centre of Mass System

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Keywords: *Catastrophic destruction, Centre of mass, Nuclear emulsion, etc.*

Study of the catastrophic destruction of Ag Br nuclei caused by 4.5 A GeV/c Silicon nuclei in nuclear emulsion has been carried out. It is observed that the probability of total break up of Ag Br nuclei of nuclear emulsion increases with the total available energy in the centre of mass system. Results reveal that the probability of total disintegrations also depends on the mass of the projectile. Finally, the results are also compared with the results obtained in high energy hadron-nucleus and nucleus-nucleus collisions.

71. Neutrino Masses and Mixing in a Three Generation $SU(2)_L \times SU(2)_R \times U(1)_{B-L} \times SU(2)_H$ Gauge Model

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Keywords: *Neutrino mass, Mixing angles, Horizontal symmetry, Neutrino oscillation*

We consider an extended gauge model based on $SU(2)_L \times SU(2)_R \times U(1)_{B-L} \times SU(2)_H$ gauge groups and it is shown that Fritzsche type mass matrices can be obtained in the lepton sectors with minimal Higgs fields. We could relate the mass eigenvalues of the charged leptons and of the neutrinos to the mixing angles. A normal hierarchy among the neutrino masses has been observed in the model. The values of atmospheric mixing angle and the mixing element V_{3e} have been suggested in the model. Furthermore, neutrino oscillation and leptonic CP violation are found to be strongly favoured in the model.

72. Exclusive Non-Leptonic $B_c \rightarrow VV$ Decays

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Keywords: *Nonleptonic decay, Factorization approximation, CKM matrix, Branching ratios, CP odd fraction*

The exclusive non-leptonic $B_c \rightarrow VV$ decays are studied within the factorization approximation in the framework of the relativistic independent quark model based on a confining potential in the scalar vector harmonic form. The predicted branching ratios are obtained in a wide range from tiny values of $o(10^{-6})$ for $\beta_c \rightarrow D^* D_{(s)}^*$ decay modes to as large as 22.4% for $B_c \rightarrow B_s^* \rho$ in general agreement with other quark model predictions. We obtain $b \rightarrow c, u$ induced transitions in predominantly longitudinal mode and $\bar{c} \rightarrow \bar{s}, \bar{d}$ induced transitions in slightly higher transverse mode. The CP odd fractions for different decay modes are also predicted. The predicted value for color flavored ones such as $\beta_c \rightarrow D^* D^*$, $D^* D_{(s)}^*$ indicate a significant CP violation in this sector.

73. Non-Leptonic $B_c \rightarrow PP, PV, VP$ Decays

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Keywords: *Nonleptonic decay, Factorization approximation, CKM matrix, Branching ratios.*

We study exclusive non-leptonic $B_c \rightarrow PP, PV, VP$ decays within factorization approximation in the framework of the relativistic quark model based on a confining potential in the scalar harmonic form. The weak form factor realized as overlap integral of meson wave functions obtainable in the model are calculated in the allowed kinematic range. The branching ratios for $b \rightarrow c, u$ and $\bar{c} \rightarrow \bar{s}, \bar{d}$ induced modes are predicted in general agreement with other quark model predictions. The dominant contributions are found from the CKM favored $\bar{c} \rightarrow \bar{s}, \bar{d}$ modes of which the most promising modes are

$B_c^- \rightarrow \overline{B_s^0} \pi^-$, $B_c^- \rightarrow \overline{B_s^0} \rho^-$ and $B_c^- \rightarrow \overline{B_s^0} \pi^-$ with the predicted branching ratios of 11.8%, 9.6% and 8.5% respectively, which might be detected at LHC in near future.

74. Implications of the Spatial String-Tension Parameter on QCD Thermodynamics

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Keywords: Spatial string tension, Wilson loops

In this contribution, we have investigated the influence of the spatial string-tension parameter on various distinctive features associated with QCD thermodynamics. The behavioural implications of this parameter are explored under different QCD phases. Several contributory insinuations of the Wilson loops at high temperature aid in probing deconfinement. Also, we have studied the effective spatial string-tension in quenched $SU(N_c)$ QCD under the gluon chain model when temperatures are considered below T_c . The spatial string-tension is also visualized within a five dimensional AdS/QCD framework. The temperature dependence of string-tension is very soft below T_c and sharp above T_c .

F. OPTICS, PHOTONICS, METAMATERIALS

75. Making an Optical Vortex and its Copies using a Single Spatial Light Modulator

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Keywords: *Optical vortex; Topological charge; Information processing*

Light beams with phase singularities and helical wavefronts are characterized by an integer number called topological charge. These beams are known as optical vortices. We have devised a method for making an optical vortex and its copies with the same topological charge by using a single spatial light modulator (SLM) [Phys. Lett. A 375, 3634 (2011)]. Appropriate diffractive optical elements are transferred to the SLM for generating a vortex and its copies. The nature of the topological charges was investigated with the interferometric technique. Experimental results are verified with theoretical analysis. We anticipate that these results may find applications ranging from optical manipulation to quantum information.

76. Quantum Teleportation with Two-Mode Squeezed Light

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Keywords: *Quantum Teleportation, Entangled States, Fidelity, Displacement Gain factor, Squeezed States*

We propose a scheme for quantum teleportation of a single-mode squeezed coherent state using entangled *two*-mode squeezed vacuum. We establish the analytic expression of gain dependent fidelity in terms of the squeezing parameter r and quantum channel parameter p . We observe that the fidelity does not respond well for the higher value of squeezing parameter r with the increase of the entangled quantum channel parameter p . It establishes that the optimization of the gain dependence of the fidelity is suitable for small squeezing of the entangled resource. The dependence of the optimum gain for teleporting a squeezed state upon the EPR entanglement is also calculated. We find that the fidelity increases with the increase of EPR parameter, while it decreases with the increase of the squeezing parameter of the signal. We find infinite squeezing is required for the generation of ideal and perfect entanglement as resource. We establish that the coherent state ($r = 0$) is the best quantum signal for quantum teleportation once the quantum channel is built. We observe that the nonclassicality of fidelity decreases in the higher value of squeezing parameter r than the lower one but once the better EPR pair entangled quantum channel parameter is built then the fidelity increases to achieve ideal condition to be teleported unknown coherent state. It confirms that the nonclassical properties of an unknown state to be teleported can be preserved in the teleportation. These results may pave the way for designing teleporting systems with nonclassical states to improve the quality of the teleported quantum state and may be expected for fabrication of future teleporting devices.

77. Electromagnetically Induced Transparency and Absorption in a 4 Level N Type Atomic System

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Keywords: *Coherent spectroscopy, N type system, EIT, EIA*

Coherent pump-probe spectroscopy in a 4 level system in N-configuration, which presents a combination of Λ and V systems, has received considerable attention recently. In this paper we investigate the role of driving field on the coherent dynamics of N type system coherently coupled by three external fields, i.e., strong pump and coupling fields and a weak probe field. Here strong control and driving fields form a Λ and a V system respectively with the weak probe field. We analyze the system in the framework of master equation to obtain steady state coherences and populations. The destructive interference leading to electromagnetically induced transparency in a Λ system can be switched to constructive interference by driving the third transition in the N scheme. We observe that when the strengths of the two strong fields are comparable then there is no population trapping in the medium leading to electromagnetically induced absorption. If the driving field is weaker compared to the control field, then the population trapping in the dark state renders the medium transparent to the probe. The dependence of field detunings on the probe absorption spectrum is also studied. The effect of finite bandwidths of the three fields on the two and three photon resonances is also discussed.

78. The Nature of Vacuum Fluctuation in Quantum Theory to some Non-Physics Cases

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Keywords: *Quantum optics, vacuum fluctuation, spontaneous emission, Laser cavity*

There are several problems in quantum optics where spontaneous emission or vacuum fluctuations play an important role. However there are some classical examples and also some non physical cases can be found which are quite analogues to zero point

fluctuation or vacuum fluctuation. In the present work we investigate such cases for the sake of analogy only. Examples are triode oscillator, tetrode oscillators, heartbeat; build up of longitudinal growth of biological samples. Another example is the growth of dimensionless intensity in a Laser cavity. It may however be noted that the vacuum fluctuation is the outcome of a fully quantized theory of radiation. And there is no actual analogy that exists.

79. Self-Reconstruction Property of Optical Ring Lattice Beams

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Keywords: *Laguerre-Gaussian beam, Self-reconstruction, Optical ring lattice*

We generate optical ring lattice structures, experimentally. It is produced by computer generated hologram consisting of the superposition of two coaxial Laguerre-Gaussian (LG) modes with common waist position and waist parameter. We have observed that these structures show the self-reconstruction property even though they are not diffraction-free. The reconstruction property of ring lattice could be explained by plotting the transverse energy flow at different z-planes. The experimental results are verified by the numerical simulations.

80. Many-Body Theory of Dark Current in Quantum Well Based Infrared Photodetector

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Keywords: *Photodetectors, Quantum Well, Dark current*

Taking into account the electron scattering with confined plasmon-phonon coupled modes in a many-body formalism, the dark currents in a quantum well structure have been calculated. The non-parabolicity of the conduction band, finite temperature, and applied bias have been included in the calculation of scattering rates. Good agreement with the experiments has been obtained by including the non-parabolicity of conduction band in the theory.

81. Revealing the Order of a Vortex through its Intensity Record

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Keywords: *Optical vortex, Fourier Transform, Laguerre polynomials*

Optical vortices are beams with phase singularities. Around the point of phase singularity, there is a phase change of $2\pi l$, where l is the order of vortex. We show that the intensity distribution of a vortex contains information of its order. Specifically, the number of dark rings in the Fourier transform of the intensity is found to be equal to the order of the vortex. Based on this property and the orthogonality of Laguerre polynomials, we demonstrate a technique for determining the order. It shows how complementary space can find the information that is not available in other domain.

82. Short Pulse Amplification in A Nd:Glass Chain using the Chirped-Pulse-Amplification Concept

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Keywords: High Power, Ultra short pulse, CPA technique, Nd:glass, stretcher, compressor

High power ultra short laser pulses are currently used in a variety of studies that involve high field interactions with matter. The chirped pulse amplification (CPA) concept is almost a quantum jump in the techniques of high peak power generation in laser chains. The total system involves temporally stretching an ultra short pulse, amplifying it and then temporally recompressing the pulse. In this paper we detail the generation and characterization of such a pulse using Nd:glass as the active medium in amplifiers. The beginning is with a 100MHz train of 200fs pulses, that is supported by a 7nm FWHM spectral bandwidth and a central wavelength at 1056nm. A single pulse of 70pJ energy and 200 fs pulse width is selected from this train and stretched to a 119ps pulse. This stretched pulse is amplified to about 40mJ and then compressed to a 1.5ps pulse having a spectral bandwidth of 3.8nm FWHM. Pulse width expansion and compression is achieved by means of conjugate grating pairs. Positive dispersion is created in the stretcher and negative dispersion is created in the compressor. A real – time autocorrelator set up measures the stretched as well as the compressed pulse.

83. Effect of Iodine Doping On Polyamide Nylon 6 Films

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Keywords: Polyamide Nylon 6, phase change, X-ray diffraction, optical properties

The Polyamide-Nylon 6 is widely used in the textile industry, for engineering and technological purposes in the pure and doped form because of its good mechanical properties and high thermal resistance. Nylon 6 has the $[-\text{NH}(\text{CH}_2)_5(\text{CO})-]$ repeating group and is characterized by the presence of secondary amide groups NHCO in the polymer skeleton and the hydrogen bonds formed between neighbouring chains strongly affects the mechanical properties. In the present study pure and iodine doped nylon 6 films are prepared. The structure analysis of the films is carried out by X-ray diffraction (XRD) studies. The changes observed in the X-ray diffractograms are related to variations in the crystalline α and γ forms of the polyamide during the iodine sorption process. The XRD results indicate that pristine nylon-6 films crystallize in α form and nylon 6-iodine complex films exists in the γ form. A new peak formed in the UV-visible absorption spectrum of the complex film corresponds to the $\pi \rightarrow \pi^*$ transitions of the lone pair electron in the carbonyl group, resulting in the conjugation of the polymer. The absorption band has extended to the near infrared region and the intensity of the peaks has increased, which shows that iodine molecule has formed strong charge transfer complexes with the polymer. Optical properties like absorption edge, direct band gap, and indirect band gap are estimated for pure and doped films from the absorption spectra. It is found that the energy gap and band edge values shifted to lower energies on doping with iodine. The reduction in the band gap due to iodine doping indicates the incorporation of iodine into the polymer chain and, thereby, extending the density of states more into the visible and near IR region of the electromagnetic spectrum.

84. Effect of Temperature on the Performance of Organic Light Emitting Diodes

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Keywords: OLED, PLED, Impedance spectroscopy, Dual carrier device

Research in organic displays has opened a new era in the history of display technology since it form flexible and portable display devices catering today's versatile requirements. At the same time, it brings many new challenges in terms of efficiency, vulnerability to moisture and temperature. The way the device responds to different temperature ambience attracts attention of researchers since its applications at cryogenic temperature are yet to be explored. This paper explains our experimental work on the fabrication and characterization of organic light emitting diodes under temperatures from 100K to 300K.

We have fabricated polymer based and small molecule based organic light emitting diodes by spin coating and vacuum evaporation techniques. By using an integrated set up of cryostat, temperature controller and PC with LabVIEW software set up, the electrical characterizations were carried out. Impedance spectroscopic studies were also made on the devices in this temperature range. The qualitative difference between the device behaviors when subjected to a small excitation of 100mV peak to peak with no superimposing DC voltages at different temperature is discussed. It is observed that as temperature goes down, 'turn on' of the device will be delayed and more bias voltage is required.

85. Synthesis of Thermoresponsive Nanogels by Laser Irradiation

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Keywords: *Nanogels, DLS, PVME, Laser irradiation*

Now a days temperature-sensitive hydrogels have gained considerable attention due to their abilities to swell or/and deswell as a result of changes in temperature of the surrounding fluid. Hydrogels serves a broad range of applications including biomaterials, matrices for drug delivery systems and scaffolds for tissue engineering. The rapid progress in this field correlated with increasing demands for more effective medical treatment keep these systems in the list of “materials of 21st century”. In most literatures, chemical cross-linker, initiator, and surfactant (usually Sodium dodecyl Sulphate) are always employed in polymerization system to prepare micro- or nanogels particles. But here we employed a totally cross-linker and initiator free polymerization technique. Thermo responsive nanogels are synthesized by UV laser irradiation method. 1% aqueous polyvinyl methyl ether (PVME) solution is exposed to excimer laser beam of wavelength 248nm. Resultant gel is characterized by Dynamic Light Scattering (DLS) measurements and UV-VIS spectroscopy.

DLS result confirms the presence of nanogels having a particle size of 15 nm. UV VIS spectrum at different temperatures clearly indicates that lower critical solution temperature (LCST) is at around 36⁰C. The phase transition temperature is again confirmed by cloud point measurement. It is observed that the particle size of prepared gel decreases with increase in irradiation time.

86. Preparation of Conducting Composite Film with Natural Rubber and Pedot: Pss for Application in Optoelectronic Devices

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Keywords: PEDOT: PSS, Natural Rubber, Composite

Among the numerous electrically conductive polymers have been studied and developed over the past few years, Poly (3,4-ethylenedioxythiophene): poly(styrene sulfonate) (PEDOT:PSS) has appeared to be one of the successful material. Recently (PEDOT:PSS) is being widely employed in organic photo-voltaic devices and OLEDs as hole transporting layer, because of its suitable work function and acceptable transparency in visible light range. A transparent conducting composite film prepared with PEDOT: PSS and doped natural rubber (NR) is an excellent material can be used for application in optoelectronic devices.

The doping of NR with iodine is carried out by dissolving polyisoprene in vacuum distilled toluene at a fixed ratio. The reaction is carried out in nitrogen atmosphere in order to exclude oxygen. The PEDOT: PSS used for the study is purchased from Bayer (Baytron PH1000). Composites are prepared with different percentage of PEDOT: PSS with iodine doped NR. Spin coated films of different layer thickness are prepared with the above solution. The rotational speed was adjusted to get layers of different nanometer thickness. Preliminary electrical and optical characterization of the films is done and the result shows that the films can be used for electrode application in optoelectronics and photonic devices.

87. Dielectric Properties of Opto-Electronic Compounds

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Keywords: Average energy gap, Optical refractive index, Di-electric model, Opto-electronic compounds, Polar and Non-polar liquids.

The average energy gap (E_g) and optical refractive index (n) of mixed and complex crystals are computed from the measured values of E_g and n of pure crystals. The pure crystals have fixed values of optical and dielectric parameters, which do not in general match exactly with the values required in opto-electronic compounds for specific uses. Thus, it is proposed to develop the mixtures of binary compounds which may have their properties matching exactly with the values required in opto-electronic compounds. An empirical relation between n and E_g is developed for mixed compound families by using these computed values. This relation shows a fine agreement with ion dependent dielectric model of compounds. This prescribed theory can therefore be used for different mixed crystal as well as for complex compounds. The theoretical validity of the relation is also established. This theory is applicable for explaining the intermolecular behaviour of solids which can be extended for polar and non polar liquids. Certain industrial and environmental applications are also proposed.

88. Synthesis and Luminescent Properties of $\text{Ba}_2\text{CdWO}_6:\text{U}$

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Keywords: *Photoluminescence, U^{6+} , Tungstates, Solid State Lighting, LEDs.*

In this paper we have reported luminescent properties of uranium activated double perovskite structured Ba_2CdWO_6 . The excitation bands are assigned to charge transfer transitions involving the 5f state of the uranium ion. We have synthesized title compound at 1300 °C and its photoluminescence characteristics are discussed in this paper. It is further suggested that these characteristics can be used to obtain *near uv* blue excited white LEDs

89. A Comparative Analytical Characterization of Cut-Wire and Thin-Wire Structures for Metamaterial Applications

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Keywords: *Metamaterial, cut-wire, Thin-wire, Negative permittivity, Negative refractive index*

Analytical model equations for realization of negative effective permittivity over desired frequency range with resonant-type cut-wire (CW) structure have been derived. The effect of the geometrical parameters of CW structure on characteristic negative permittivity has been investigated in details. These model equations for CW in conjunction with the analytical model equations for effective permeability realizable with circular multiple inclusion magnetic structures (Labyrinth Resonator; acronym LR) has

been used to design Ka-band CW-LR type negative refractive index metamaterial. Also the design of metamaterial with conventional thin-wire (TW) and Labyrinth Resonator (LR) has been included. Performance characteristics of the resonant-resonant type (CW-LR) and the nonresonant-resonant type (TW-LR) metamaterial thus investigated has been compared from designer's point of view.

90. Analytical Design and Experimental Characterization of TW-LR Type Plasmonic Metamaterial at Ka-band

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Keywords: *Plasmonic metamaterial, Thin-wire, Labyrinth resonator, Negative permittivity, Negative permeability, Negative refractive index.*

Analytical model equations have been derived for Thin-Wire (TW) exhibiting negative permittivity and Labyrinth Resonator (LR) exhibiting negative permeability below plasma frequency and the two together arranged in a one dimensional periodic array exhibiting negative refractive index at millimeter-wave frequency (Ka-band). On the basis of the analytical modeling the plasmonic metamaterial structure has been designed and fabricated with thin metallic wires and labyrinth resonator rings imprinted on Rogers RT-duroid sheets and placed alternately. The analytical characterization shows a negative refractive index of -1.84 at 31.25 GHz and experimental result with a 15° prism of such metamaterial exhibit a negative refractive index of -1.89 at 30.858 GHz, which are very close to each other.

91. Metamaterial Loaded Waveguide Characterization -Some Basic Studies

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Keywords: *Metamaterial, split-ring resonator, Waveguide loaded metamaterial, Transmission characteristics.*

Metamaterial loaded waveguide characterization has been carried out to study some basic characteristics like resonant frequency, magnetic polarizability, and bandwidth of common type of negative permeability structure the Split-Ring Resonator (SRR) and its variants like Double-slit Resonator (DSR), Square SRR (SSRR) and U-shaped SRR (USRR). The transmission characteristics of metamaterial loaded waveguide to realize stop-band in the normal pass-band of waveguide and pass-band in the normal stop-band of waveguide tailorable by changing the geometrical dimensions of SRR has also been included. Such study is expected to be important in the design of microwave and millimetre-wave components using metamaterial loaded waveguide.

92. Re-visit of Electromagnetic View-Points for Metamaterials

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Keywords: *Metamaterial, backward wave, evanescent wave amplification, negative permittivity, negative permeability, negative refractive index.*

An analytical approach to re-visit the electromagnetic properties like backward waves and evanescent wave amplification for metamaterials (LHM) by studying the wave

impedance and transmission function has been presented. It has been found from the study of wave impedance that backward waves exist in LHM. The transmission function depicts the evanescent wave growth. Sub-wavelength slab thickness gives better evanescent wave amplification; however, from practical view-point a wavelength-thick plane slab would suffice at higher frequencies.

93. Novel Techniques to Determine Plasma Frequency of Wire Media

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Keywords: *Metamaterials, Wire Media, Plasma Frequency, Negative Permittivity*

A novel analytical technique to determine plasma frequency of wire media has been reported on the basis of a generalized Quasi-Static approach and compared with reported results. An Eigenmode Solver based simulation method has been used for plasma frequency extraction of infinite wire array. S-Parameter based simulation method has also been discussed including a Loss Factor method. High pass behavior of the fabricated wire array is observed in experiments which determine its plasma frequency. Also, Loss factor method has been validated using experimental data. Results of different methods are compared with experiment to establish the novelty of the present approach.

94. Analytical and Simulation Studies on Spiral Resonator (SR) and its Variants -- TTSR and NBSR

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Keywords: *Left-handed-material(LHM), Metamaterial, Spiral resonator(SR), Effective relative permeability, TTSR, NBSR.*

Analytical modeling for μ negative (MNG) material like spiral resonator (SR) and its two variants the two turn spiral resonator (TTSR), and non-bianisotropic spiral resonator (NBSR) has been done by using emf equation. The analytical result is then validated by using commercially available FEM based simulation software (Ansys HFSS-13). The analytical and simulation studies reveal that NBSR is a superior candidate than TTSR (and also SR) due to its higher LHM band width and its relatively larger negative effective permeability. The NBSR structure (10x10x12 array in X-band) has been designed, fabricated and experimentally characterized.

G. GENERAL PHYSICS, MATHEMATICAL PHYSICS

95. Fractal Growth in Electrolytic Deposition

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Keywords: *Fractal, Fractal dimension, Electroless deposition, dendritic pattern*

Study of irregular shapes assumed importance after the introduction of the concept of fractals and fractal dimensions. Growth of irregular patterns and dendrites in many cases exhibit fractal character with scale invariance and self similarity. Under certain conditions such dendritic patterns finer details having nano structures. We have presented electrolytic deposition using copper sulphate solution and aluminum plate as cathode. The driving force for the deposition of the copper ions comes from the electrode potential. The irregular shapes of deposited dendritic patterns are analysed for fractal character. It is found that they exhibit scale invariance and possess fractal character. Details are presented.

96. Frequency Spectrum of Noise from Cutting Machines

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Keywords: *Noise, Frequency spectrum, Cutting machine, Fourier transform*

The noise produced by various urban activities is becoming serious concern as the noise is found to have serious effects on quality of life, particularly with reference to health and psychology. Therefore the study of noise assumed importance in recent times. Major component of noise in urban areas comes from traffic, heavy industry construction activity and machinery. The noise resulting from traffic and similar activities is found to be prominent at lower frequencies. We studied the noise contributed by cutting machines mostly used during construction activity. The noise was analyzed for frequency distribution and it was found that there is qualitative difference in the frequency distribution of noise. The noise due to cutting machines is found to be spread over a wide range of frequencies in contrast to that due to other sources. It is known that the noise at higher frequencies is more annoying and has adverse effect both on health and psychology of the residents in nearby areas. Details of findings are presented.

97. Heat Transfer in the Unsteady Couette Flow of Oldroyd Liquid between Two Horizontal Parallel Porous Plates with Heat Sources when the Lower Plate Moves with Time Varying Velocity

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Key words: Heat transfer, Couette flow, Oldroyd liquid, Porous plates

The effect of heat transfer in the unsteady Couette flow of Oldroyd liquid between two horizontal parallel porous plates with heat sources has been studied when the lower plate suddenly starts to move with time varying velocity. The non-dimensional constitutive equation of the flow has been solved for velocity and temperature using Galerkin technique, and skin-friction and the rates of heat transfer have been derived. The flow behavior has been studied through graphs and tables. It is observed that the velocity of the flow decreases as elastic parameter increases, but the reverse effect is marked with permeability parameter.

98. Thermal Energy Transmission in Oscillatory Magneto- hydrodynamic Flow of a Visco-Elastic Fluid Past an Infinite Vertical Porous Plate with Constant Suction

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Keywords: Unsteady MHD flow, Visco-elastic, Plate, Suction

This paper deals with thermal energy transmission in oscillatory magnetohydrodynamic flow of a visco-elastic fluid past an infinite vertical porous plate with constant suction. Constitutive equations of the problem have been developed involving velocity and temperature of the fluid and employing Walters' B' fluid model. After nondimensionalizing these equations of momentum and energy, solutions are obtained with the required boundary conditions. Then, velocity and temperature profiles are plotted using numerical values of various fluid parameters like non-Newtonian parameter R_c , Grashof number G , Hartmann number M , Prandtl number P_r and Eckert number E_c . The values of skin-friction and rate of heat transfer are entered in tables. It is observed that the magnetic field decelerates the flow. The temperature of the fluid falls with the rise of Prandtl number.

99. Computational Study of Nanofluids in a Heat Exchanger Proving Their Thermal Energy Efficiency

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Keywords: *convective heat transfer, nanofluids, particle concentration, turbulent flow, pressure loss*

A three-dimensional turbulent flow and heat transfer with two different nanofluids, Al_2O_3 and CuO , in an ethylene glycol and water mixture circulating through the flat tubes of a heat exchanger have been numerically studied to evaluate their superiority over the base fluid. New correlations for viscosity and thermal conductivity of nanofluids as a function of particle volumetric concentration and temperature developed from the experiments have been used in this study. Numerical results from the simulation were first validated for the flow of water by comparing the friction factor and the Nusselt number in flat tubes of an exchanger, for which accurate results are available in the literature. Next, the model has been applied to study the peripheral variations of shear

stress and convective heat transfer coefficient, both showing higher magnitudes in the flat regions of the tube. Convective heat transfer coefficient in the developing and developed regions along the flat tubes with the nanofluid flow showed marked improvement over the base fluid. Results for the local and the average friction factor and convective heat transfer coefficient show an increase with increasing particle volumetric concentration of the nanofluids. Quantitative results of the increase of the heat transfer coefficient and the friction factor with increasing volumetric concentrations of nanofluids at various Reynolds numbers are presented. The pressure loss increases with increasing particle volumetric concentration of nanofluids; however, due to the reduced volumetric flow needed for the same amount of heat transfer, the required pumping power is found to diminish. Nanofluids reduce the size of heat exchangers on the basis of equal heat transfer.

H. INTERDISCIPLINARY STUDIES INCLUDING ENERGY SCIENCE, BIOPHYSICS, ELECTRONICS, COMMUNICATIONS

100. Energy Infrastructure for India's Sustainable Future

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Keywords: *Development–energy–climate nexus, Energy efficiency, Infrastructure investment strategies*

Presently India is facing the twin challenge of energy universalization as well as emission reduction. Nearly 0.4 billion people in India—mostly residing in rural areas—do not have access to electricity and more than 0.8 billion people do not use modern cooking fuels. Provision of energy services however needs to take into account the energy-induced CO₂ emission. As per International Energy Agency estimates India is projected to account for more than 14% share of such emissions during 2005–2030, though India's global incremental energy share is 6%. Energy infrastructure plays a key role to meet the energy needs with reduced emissions. Assessing India's infrastructure, this study presents a sustainable development scenario by developing a mathematical model, which predicts future demand of different energy carriers by considering various macroeconomic and demographic, supply-side, and demand-side factors. A comparison with business as usual scenario shows a decline in growth rate of fossil fuels and increased share of nuclear and other renewable options, which leads to an average annual energy saving of 129 MTOE in between 2010 to 2030 and reduction in energy-induced emissions. The paper estimates the infrastructure needs, and discusses investment options, financing mechanisms and the key policy issues.

101. Bistable Memory Device Based on Natural Rubber Molecules

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Keywords: *Bistable memory, Natural rubber, Fullerene, Thermal evaporation*

Organic electronics is a fast growing research area providing organic counterparts for the conventional silicon based electronics. It paved the way for new generation displays, organic photovoltaic cells and thin film transistors with capability of image sensing. Organic memory is a device in which a bistable memory implementation is achieved by switching the resistance. In fact, the device resistance is being switched from one state to the other by the application of a suitable voltage and the information is stored in the form of resistance states of the device.

Here we attempt to modify existing organic memory with Fullerene (C60) as active material. In this study, a pioneering effort has been made to fabricate a memory device in which a blend of Natural rubber (NR) and Fullerene (C60), sandwiched between two aluminum electrodes form the active layer. Simple fabrication techniques have been employed like spin coating method for the active layer deposition and electrodes deposition by vacuum thermal evaporation. Characterizations have been made by highly precise source meters. Current-voltage (I-V) characteristics of the device show switching behavior from a low resistance state at 2.75V and returned to the initial high resistance state at 4V. The device exhibits nonvolatile characteristics with an ON/OFF current ratio of 10^3 . The read-write erase stability, an important feature of the memory device, also has been tested by sequential application of read-write erase voltage pulses and observing the corresponding stable resistance states. Discussions on the switching mechanism of the device on the basis of electrical doping of NR chains due to the electron accepting nature of C60 are also included.

102. Conformational Properties and Catalytic Action of Enzymes – Role of Dielectric Polarization

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Keywords: *Enzyme, Catalytic Action, Conformational Properties, Dielectric Polarization*

From the viewpoint of physics the catalytic action of enzyme may involve the changes in conformation properties of enzyme under influence of changes in polarization storage at the active site. An enzyme macromolecule contains polarizable groups- cationic and anionic amino acid residues. The polarizable groups are also present in coenzymes, activators, and substrates. The change in polarization may induce the local changes in the structure that alter the configuration of the active center thereby facilitating the substrate association- dissociation reaction. From very general theoretical considerations it has been predicted that enzyme macromolecules should have highly polar meta-stable states, however experimental evidence is needed in a variety of enzymes. In the present work the polarization storage properties of an enzyme EC 3.2.2.1 (1,4- α -D-glucan-glucohydrolase) have been studied and the results are discussed in the foresaid context. The enzyme has been found to be able to store large amount of polarization via four relaxation polarizations characterized by long enough relaxation time, supporting the suggestion of polar meta-stable states.

103. UV-Visible Spectrophotometric Analysis of Liver of Albino Mice Treated with Sildenafil Citrate (Caverta) and Ethanol

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Keywords: *Albino mice, Sildenafil citrate, Ethanol, Antioxidants and Lipid, Peroxidation*

Sildenafil citrate is a potent orally active cGMP – specific Phospho diesterase type 5 (PDE5) inhibitor that is effective as a peripheral conditioner in the treatment of male erectile dysfunction. Ethanol is a potent central nervous system depressant, with a range of side effects. Albino mice, one of the most drug sensitive animals, were co-exposed to Sildenafil citrate and Ethanol. The present study was conducted with an intention of evaluating the drug induced changes in the level of antioxidants such as SOD, CAT, GSH and GPx present in Liver of Albino mice. The co-administration of Sildenafil citrate and Ethanol has been found to result in weakening of the antioxidant defense system.

104. A Spectral Analysis of Foot and Mouth Disease Vaccine on Cattle

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Keywords: *Highly contagious, Desiccation, Anorexia, Denuded areas, FTIR spectrometer.*

Spectral study can emerge as an alternate and cost effective test for screening vaccinated animal. In the present work, pre and post vaccinated sera samples of cattle were collected from the Animal Disease Intelligence Unit, Kanchipuram. Sera samples were tested using the Fourier Transform Infrared (FTIR) Spectrometer. The internal standards among the absorption peaks were calculated. There was a marked difference in the absorption levels of the pre and post vaccinated sera samples. The resultant variation was attributed to the production of antibodies in the animal. Foot and Mouth Disease (FMD) is an acute, highly contagious picornavirus infection of cloven hooved animal. The virus exists as seven serotypes: A, O, C, Asia1, SAT I, SAT II, and SAT III. The virus (FMDV) is sensitive to environmental influences, such as pH less than 5, sunlight and desiccation; however it can survive for long period of time at freezing temperatures. Cattle are mainly infected by inhalation, often from pigs, which excrete large amounts of virus by respiratory aerosols and are considered highly important in disease spread. Large amounts of virus are excreted by infected animals before clinical signs are evident, and wind may spread the virus over long distances. The incubation period is 2-21 days. Clinical signs in cattle are salivation, depression, anorexia and lameness caused by the presence or painful vesicles (blisters) in the skin of the lips, tongue, gums, nostrils, coronary bands, inter digital spaces and teats. Fever and decreased milk production usually precede the appearance of vesicles. The vesicles rupture, leaving large denuded areas which may become secondarily infected. In pigs, sheep and goats the clinical signs are similar but milder. Lameness is the predominant sign. Vaccination is one of the routine procedures adopted to control specific diseases. FMD monovalent vaccine is a liquid preparation containing any one type (O, A, C, ASIA-I) of FMD virus inactivated with formalin and adsorbed on buffered aluminium hydroxide gel.

105. Effect of Altered Gravity (Hypergravity) on Germination (Growth) of Mungbean & Chlorophyll Pigment

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Keywords: *High g stimuli, Hypergravity, chlorophyll content, Mungbean (Vigna radiata)*

Gravity is very important concept now a day-today life. We choose the topic of altered gravity because it is very necessary to see the effect of altered gravity on plants because we are trying to search the planet which is appreciate to earth where human can live, plants can germinate because it is necessary for our survival. But for every planet gravity is not same, on some planet it is greater than earth or less. In hypergravity treatment (gravity greater than that of the earth) we observed the seed germination. For this we gave hypergravity treatment to seeds (mungbean) by means of centrifuge machine. Then grow them on agar gel for 5 days under the condition of appropriate temperature, humidity. After 5 days to check chlorophyll content, place the leaf in DMF solution for one day and then take absorption spectra. For calculating chlorophyll content and carotenoid, choose appropriate wavelength and calculate it from armons formula. In this study we choose the different orientations of seeds and the different gravitation value and check the result. In general, in hypergravity the germination of plant is slow as we increase the gravitation value like 500g, 1000g, 1500g. At 90 angle orientation, the chlorophyll content, carotenoid and growth is satisfactory for all gravitational values. This implies orientation affect on germination.

106. Linear and Mass Attenuation Coefficients of Gamma Radiations for Various Particle densities of Soil Samples from Nanded, Latur (Maharashtra) and Bidar (Karnataka) Districts of India at 123 keV to 1330 keV

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Keywords: *Linear and mass attenuation Coefficients, Interaction cross-section.*

The study of mass attenuation coefficient of various materials has been an important role of research in Nuclear Physics, medicine, Industrial areas, agriculture etc. In this experimental work number of readings has taken to measure attenuation coefficients by using irradiation and transmission method for soil samples of various composite materials and elements from Nanded, Latur (Maharashtra) and Bidar (Karnataka) districts of India. This method is useful for the study of properties the soils for agricultural purpose. The effect of particle density on mass attenuation coefficient of soil samples of various compositions and elements have been investigated at eight gamma ray energies from 123 keV to 1330 keV. The results have been presented in graphical forms, which confirms the interaction of gamma radiations with composite materials of various soil Samples. It clarifies gamma transmission method for determination of the Soil parameters has advantages such as practical, inexpensive, nondestructive and fast analysis. Chances of interaction between radiation and atoms of the soil are relatively lower. The results validate the gamma absorption law.

107. Printed Rectangular Monopole Antenna with Stubs

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Keywords: Printed Monopole Antenna, Impedance Bandwidth, Stubs

For the purpose of wideband operations, a printed rectangular monopole antenna fed by a microstrip line is designed and studied. The proposed antenna is having compact size (16X18) mm including the ground plane. The stubs have been imposed in the proposed antenna to enhance the bandwidth. Impedance bandwidth of the proposed antenna is ranging from 4.7GHz to 12.35GHz. Design and performances are analyzed using Mentor Graphics IE3D Simulation Software.

108. Studies on of Radiation from Ores and Rocks in and around Hospet, Karnataka

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Keywords: Dose assessment; Dose equivalent, Effective; Dose, Absorbed; Gamma radiation

Several Iron ore and rock samples of Hospet of north Karnataka region were analyzed for the concentrations of ²²⁶Ra, ²³²Th, and ⁴⁰K by gamma ray spectrometry. The concentration of ²²⁶Ra in iron ore varied in the range 2.07-5.6 Bq kg⁻¹ with a mean value

of 4.89 Bq kg^{-1} , ^{232}Th in the range $0 - 6.9 \text{ Bq kg}^{-1}$ with a mean of 3.3 Bq kg^{-1} , and that of ^{40}K in the range $0-26 \text{ Bq kg}^{-1}$ with a mean of 17.1 Bq kg^{-1} . In rock samples the concentration of ^{226}Ra varied in the range $21.5-64.4 \text{ Bq kg}^{-1}$ with a mean value of 40.1 Bq kg^{-1} , ^{232}Th in the range $19.2-84.5 \text{ Bq kg}^{-1}$ with a mean of 48.8 Bq kg^{-1} , and that of ^{40}K in the range $501.1-705 \text{ Bq kg}^{-1}$ with a mean of 595.2 Bq kg^{-1} . The results are discussed and compared with the literature values reported for other regions of India as well as worldwide average value in this paper.

109. Study of Cascade Amplifier using PSPICE

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Keywords: *Electronic Circuit Design, cascade amplifier, Ac Analysis, Parametric Analysis, Simulation software*

This paper addresses performance of cascade amplifier circuit by using Pspice software. Traditionally, electronic circuit design was verified by building prototypes, subjecting the circuit to various stimuli and then measuring its response using appropriate laboratory equipments. Prototype building is somewhat time consuming, but produces practical experience from which we judge the manufacturability of the design. Computer programs that simulate the performance of an electronic circuit provide a simple cost-effective means of confirming the intended operation prior to circuit construction and of verifying new ideas that could lead to improve circuit performance. Such computer programs are revolutionized the electronic industry which provides the resent products in the service of human being. In this paper we had performed the transient, Ac & Parametric analysis of the cascade amplifier circuit by Pspice software. for to study the

reliability of this software, now a day's it is essential to use such a kind of software's for the efficient progress in the learning of electronics. Through this paper one can get the idea about the use if it and which gives the better results. Because it is the low cost, fast simulation techniques for the linearity and the accuracy of the circuit performance and reliability is reported by using these test tools. The results are explored with browsing output data facility.

110. Solar based Energy Transition with Zero Emission

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Keywords: *Space based solar power, Clean energy, Electromagnetic energy beaming*

Preventing resource conflicts in the face of increasing global populations and demands in the 21st century is a high priority for the Department of Defense and for common people. All solution options to these challenges should be explored, including opportunities from space. Space based solar power (SBSP) can be developed and deployed to provide affordable, clean, safe, reliable, sustainable and expandable energy for mankind. The basic idea is very straightforward: place very large solar arrays into continuously and intensely sunlit Earth orbit ($1,366 \text{ watts/m}^2$), collect gigawatts of electrical energy, electromagnetically beam it to Earth, and receive it on the surface for use either as base load power via direct connection to the existing electrical grid, conversion into manufactured synthetic hydrocarbon fuels, or as low-intensity broadcast power beamed directly to consumers. This SBSP based energy transition is briefly reviewed.

111. Effect of Hydration on the Tautomerism in the Anticarcinogenic Drug 5-Fluorouracil

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Keywords: *Cheotherapeutic agent, Tautomerism, Nucleic acid bases, Vibrational spectroscopy.*

5-fluorouracil (5-FU) has a long history of use as a chemotherapeutic agent. It affects the synthesis and repair of DNA and RNA processing in Cancer Cells. Despite its side effects, clinical studies on patients have shown that 5-FU is of some benefit as a chemotherapeutic drug. The geometrical parameters of 5-FU have been discussed many times both experimentally and theoretically. Also from the spectroscopy point of view, the vibrational spectra of 5-FU have been studied recently by us [M A Palafox and V K Rastogi, *Spectrochimica Acta*, A79(2011)970] and other authors specially by Raman spectroscopy. Also a large amount of work has been performed on the tautomerism of nucleic acid bases, using both theoretical and experimental approaches. Much of the interest is due to the fact that tautomers induce alterations in the normal base pairing, leading to the possibility of spontaneous mutations in the DNA or RNA helices. Tautomerism in nucleic acid bases and their derivatives has a role in mutagenesis of DNA. The process is intimately connected with the energetics of the chemical bonds. The occurrence of the rare tautomeric forms might lead to a point mutation developing during RNA replications. 5-FU residues in messenger RNAs produce coding errors, apparently by mis-pairing with guanine during translation processes.

5-FU as analog of uracil, may exist in various tautomeric forms differing from each other by the position of the proton which may be bound to either ring nitrogen atoms or oxygen atoms. Examination of the experimental data strongly suggests that the dioxo-tautomers of uracil and 5-FU are only stable in the solid state. From the biological point

of view, it is necessary to perform calculations in solution to understand the tautomerism of purine and pyrimidine bases. Therefore in this work we investigate the tautomerism of 5-FU in solution and estimate the influence of the substituent effect on the tautomerization process for 5-FU. Other authors have investigated the effect of the water on the tautomerism of several nucleic acid bases, but they use only one or two water molecules explicitly or a continuum model. Many questions about the hydration effect on the tautomerism appear still unclear. In the present paper we try to give answer to these questions, and for this purpose the tautomerism of uracil and 5-FU is studied with 10 explicit water molecules for the first time.

We have predicted and optimized seven tautomers of 5-FU. Six of them are related to those of uracil molecule, with the same stability order. Solvent effects were considered using a variable number (1-10) of explicit water molecules surrounding 5-FU in order to simulate the first hydration shell. More than 100 cluster structures with water were analyzed. Attachment of a fluorine atom changes the relative free energy order of uracil tautomers in the gas phase and in solution. For cases where literature data are available, the computed values were in good agreement with previous experimental and theoretical studies. Depending on the nature of the tautomers, cyclic, distributed water molecules, or clustered structures are formed. The hydration energies of various tautomers are large and vary dramatically between tautomers. The microhydrated environment stabilizes remarkably the *enol* forms more than the canonical *keto* one, although this one continues being the most stable.

I. THEMATIC: WOMEN IN SCIENCE

112. Gender Bias in Physics –A Case Study

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Keywords: *Gender, Mechanics, Achievement level, Cognitive domain, Strategies*

Significant gender gap (disparity) in both achievement and professional representation in physics has been reported worldwide. In this research paper an attempt has been made to ascertain the gender gap if it exists in the achievement level of students in mechanics which is an important component of physics, under Indian conditions. The sample is a large sample consisting of students of class ninth and eleventh studying in CBSE stream. The factors promoting the gender gap and strategies for reducing the gender gap will be discussed in the paper.

113. Woman as a Catalyst for Technological Innovation

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D.A.V. Public School, Cuttack, Odisha

Keywords: *Girl education, Prejudice against woman, Gender related biases*

Women have a great stellar role to play in the domain of Science and Technology, which is in general a male dominated field. Evidence suggests that this is due to the stereotypes as well as self- fulfilling prophecies. Experiments have shown that parents challenge and explain more to boys than girls, asking them to reflect more deeply and logically. Physicist Evelyn Fox Keller argues that Science may suffer for it's mainly stereotypes when ego and competitiveness obstruct progress, since these tendencies

prevent collaboration and sharing of information. For women to play a big role in technological innovation there should be universalization of primary education. Educating the girl should not be discontinued and it must be made more accessible. Each individual has the right to pursue studies according to their personal interest. If she is allowed to do so then she can really contribute in a long scale as it is observed that women have better concentration ability and greater perseverance. No country can achieve a high literacy if there is strong prejudice against women. The persistent efforts of our educationists and government have put India on the list of literate countries & the onus lies on the next generation to take in forward. They say Gene is a biological concept to when a child is born if it has to carry the essence of multidimensional wisdom to enable him to exhibit his/ her immaculate expertise in physiological researches then it has to be acquired from both the parents and not from a single parent (father). Special effort is needed to make Science education accessible to the under-represented category of students. Right from School and College days, efforts have to be made to dispel gender related differences in learning abilities.

114. Journal Publication Productivity of Women Scientist at Bhabha Atomic Research Centre

**Rekha P. Upadhye, Priya V. Girap, Shalini Tiwari, Tara Ashok,
K. Bhanumurthy* and R. K. Sinha**

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Keywords: *Women scientists, Gender, Scientometrics, Publication productivity*

Women's role and participation in academia especially science and technology are important indicators to gauge the progress and participation of women. Various

studies and efforts to promote gender parity to correct the under-participation of women. There is a vast repositories of facts figures and commentaries and recommendations available on the above subject. The making of science in India has its roots in the universities and governmental agencies like CSIR, DST, DAE, DBT, ICMR, DRDO and ICAR. The present study analyses the publications of Bhabha Atomic Research Centre (BARC) for the period 2006-2009. The objective of the study was to evaluate the contribution of BARC women scientists, with respect to their publications in journals. Average contributing women scientist, authorship pattern, domain-wise distribution of publications, collaboration pattern, and highly preferred journals for publication. This analysis needed information from women scientists and it is possible that the information may not be exhaustive in this study.

A total of 4069 publications were published during the period of the study. Out of which 1140 (28.02%) publications had atleast one author as BARC women scientist. Average contributing women authors were 36% out of 1265 both men and women contributing authors. Highest number of publications was found to be in the domain Chemical sciences (27.54%), followed by Physical sciences (26.58%), Biological sciences (20%), Materials sciences (13.25%), Engineering and Technology (5.18%) and Library & Information science (0.17%). Collaborative analysis indicated 72.65% intra-BARC, 15.82% national and 11.53% international collaboration. Many of the papers have been published in prestigious journals having high impact factor. Based on critical analysis it was found that there were 634 women scientist which is a mere 16% of the total number of scientist and they contribute about 36% of the papers.

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VI

LIST OF
PAST SECTIONAL PRESIDENTS

PAST SECTIONAL PRESIDENTS

PHYSICAL SCIENCES

V.K. Rastogi	(2011)	S.P.Khare	(1988)
S. H. Behere	(2010)	V.S.Nanda	(1987)
S. P. Ojha	(2009)	P.S.Narayanan	(1986)
Lalan Jha	(2008)	Vachaspati	(1985)
R. N. Singh	(2007)	G.P.Srivastava	(1984)
Vitthal Kumar Farkya Gupta	(2006)	Krishnaji	(1983)
R.S.Sirohi	(2005)	C.Ramasastri	(1982)
Kehar Singh	(2004)	B.V.Sreekantan	(1981)
R.P.Singh	(2003)	C.Mande	(1980)
Physics		Harnam Singh Hans	(1979)
R.Nath	(2002)	B.Ramachandra Rao	(1978)
S.B.Rai	(2001)	M.K.Vainu Bappu	(1977)
J.P.Shukla	(2000)	R.P.Singh	(1976)
T.N.Misra	(1999)	N.A.Narasimham	(1975)
G.D.Baruah	(1998)	L.S.Kothari	(1974)
K.P.Rajappan Nair	(1997)	P.K.Iyengar	(1973)
A.N.Singh	(1996)	A.P.Mitra	(1972)
Ran B.Singh	(1995)	V.G.Bhide	(1971)
S.S.Kapoor	(1994)	N.K.Saha	(1970)
Chanchal Kumar Majumdar	(1993)	B.V.Thosar	(1969)
R.Chidambaram	(1992)	A.R.Verma	(1968)
S.N.Thakur	(1991)	F.C.Auluck	(1967)
M.I.Savadatti	(1990)	W.M.Vaidya	(1966)
D.K.Rai	(1989)		

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List of Past Sectional Presidents*

G.N.Ramachandran	(1965-1964)	C.W.B.Normand	(1938)
R.Ramanna	(1963)	S.Datta	(1937)
Vikram A.Sarabhai	(1962)	T.Royds	(1936)
S.R.Khastgir	(1961)	N.R.Sen	(1935)
S.Parthasarathy	(1960)	S.K.Mitra	(1934)
A.K.Dutta	(1959)	A.L.Narayan	(1933)
S.L.Malurkar	(1958)	Ganesh Prasad	(1932)
K.R.Dixit	(1957)	C.W.B.Normand	(1931)
B.Peters	(1956)	B.Venkatesachar	(1930)
R.K.Asundi	(1955)	S.N.Bose	(1929)
P.S.Gill	(1954)	J.de Graaff Hunter	(1928)
N.R.Tawde	(1953)	D.M.Bose	(1927)
S.Ramchandra Rao	(1952)	Meghnad Saha	(1926)
C.S.Venkateswaran	(1951)	E.P.Metcalf	(1925)
R.N.Ghosh	(1950)	C.V.Raman	(1924)
R.S.Krishnan	(1949)		(1923)
L.A.Ramdas	(1948)	T.P.Bhaskara Shastri	(1922)
K.Banerjee	(1947)	J.M.Field	(1921)
S.Bhagavantam	(1946)	N.A.F.Moos	(1920)
R.C.Majumdar	(1945)	D.N.Mallik	(1919)
D.S.Kothari	(1944)	Wali Mohammad	(1918)
H.J.Bhabha	(1943)	Rev. D.Mackichan	(1917)
R.K.Asundi	(1942)		
P.N.Ghosh	(1941)	Physics	
K.S.Krishnan	(1940)	G.C.Simpson	(1916)
Mathematics and Physics		C.V.Raman	(1915)
K.R.Ramanathan	(1939)	V.H.Jackson	(1914)