isamp
NEWS LETTER

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CONTENTS

Erratum

In the **Editorial of Issue#4**, while discussing the article on **Velocity Map Imaging**, a reference was made to an abstract by the same authors. This gives an impression that the above article was giving details of *site specific fragmentation of molecules*, which was not the case.

Error is regretted.

EDITOR, ISAMP NL

FROM THE EDITOR'S DESK

In a few days, the year 2005 shall become a history. The first issue of Phys. Rev. Lett. of the year carried "Rabi Oscillations Revival Induced by Time Reversal: A Test of Mesoscopic Quantum Coherence" of Haroche and collaborators as the first letter. It was a comforting start of a new year, knowing at a basic level, dynamics is reversible. Many remarkable results were reported in atomic and molecular physics as the year progressed.

Ketterle and co-workers reported the observation of a clinching evidence (Zwierlein et al., Nature, 23 June 2005) of formation of vortices, of superfluidity in dilute ultracold fermionic atoms. It was a fitting conclusion of a quest initiated with the observation of degenerate ultracold fermionic atoms by De Marco and Deborah Jin (Science 285, 1703 (1999)). This work is an important link in the chain, that physics is connecting phenomena in condensed matter physics with those of dilute atomic clouds. The future direction of research holds the promise of gaining further insights of phenomena related to condensed matter physics through the study of ultracold atoms. As the year progressed, several interesting theoretical and experimental results on ultracold atoms were reported.

As the year 2005 completed middle age, Perreault and Cronin reported (Phys. Rev. Lett 95, 133201 (2005)) their remarkable results on atom-surface interactions. They measured the phase shift of sodium atom deBroglie waves after interacting with a surface and concludes atoms retain their coherence even at very small separations from the surface. Their work has implications to manipulations of atoms close to surfaces and future applications of such techniques to nanotechnology.

The Nobel Prize in physics was announced during the ripe old age of the year. Half of the prize was shared by John Hall of NIST, Colorado, USA and Theodore Haensch of Max Planck Institute of Quantum Optics, Munich, Germany. Their work relates to the precision spectroscopy of atom and molecules and application in metrology. Interestingly, the year made its final leg with the walking molecule 9,10-dithioanthracene (DTA). This was reported in the experiments of Ludwig Bartel and his colleagues at Kansas State University.

For the ISAMP members, the Topical Conference in IACS, Kolkata (TC2005) was the appropriate ode to the year 2005. As we bid adieu to the eventful year, we at ISAMP newsletter wishes all members of ISAMP

MERRY X'MAS & A HAPPY NEW YEAR!!

K.P. Subramanian
EDITOR, ISAMP Newsletter

Dilip Angom
Guest Editor

December 21, 2005

LETTER TO THE EDITOR

Letter-1
Date: Mon, 24 Oct 2005 13:25:23 +0530 (IST)
From: pmg.nambissan@saha.ac.in
To: ISAMP <isamp@prl.res.in>
Subject: Re: ISAMP News Letter

Dear Editor,
Thank you for the ISAMP News Letter. It really looks marvellous, not only in form but also in substance. I wish each area of active research in science should bring out such a regular bulletin for mutual academic exchange. I wish your endeavour all success in future as well.
With best regards.
P.M.G. Nambissan
SINP, Kolkata

Letter-2
Date: Fri, 25 Nov 2005 22:09:17 -0800 (PST)
From: K N Joshipura <knjoshipura@yahoo.com>
To: ISAMP <isamp@prl.res.in>
Subject: Re: Input invited
Parts/Attachments:
1 Shown 50 lines Text
2 OK 26 KB Application, "Creativity.doc"

Dear Editor,
Thanks inviting inputs. I am sending herewith as attachment a short general article, pl see??!
K.N. Joshipura
SP Uni., Vallabh Vidyanagar (Gujarat)

The article is given here... Editor, ISAMP NL

Creativity in Science

K. N. Joshipura
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What is creativity?! It needs a creative mind to answer this question effectively. In simple terms creativity is a trait of human mind that brings out something not just new or different, but also eye-catching and appealing. A creative mind will see what every one does, but will think in a way that none has thought. An innovative idea is a novel output from someone in response to the same general input to everyone. Creativity or innovation encompasses all spheres of humanity including science and technology, arts, painting, music and even marketing! These days computers have added new dimensions to simple practical creativity.

Scientific creativity as a precursor to all discoveries and inventions has been known since ages i.e. much before 'research' as we call it today came into being. Scientific creativity manifests itself diversely. In one form it is the innovative skill that makes things work or brings about the invention of gadgets and devices. This trait was best personified in the legendary inventor Thomas Alva Edison. Edison is not formally referred to as a physicist but Michael Faraday, another genius of early 19^{th} century, finds a unique place in history for his discoveries of several physical and chemical phenomena. In medieval Europe Leonardo de Vinci of Italy was a scientist, an engineer, a painter, a writer and a philosopher, all in one! In India Homi Bhabha was described as our Leonardo de Vinci by C.V. Raman.

Why do inventors invent things? Well, not just out of necessity (as the famous proverb goes), but also out of curiosity which ignites a creative mind whimsically preoccupied with one or the other scientific problem. And then the solution of a problem can come even in dreams, as it used to happen with mathematician Ramanujan or scientists like Kekule who discovered the ring structure of benzene. The three most creative minds known in the human history were those of Archimedes, Newton and Einstein. Newton laid the foundation of Physics; Einstein revolutionized it through his breakthrough theories, in the miraculous year 1905. The year 2005 is celebrated as International Year of Physics by the whole world, and as the year ends soon it is worthwhile to ponder over creativity in science particularly in Physics. Innovative ideas in physics can be either theoretical or experimental. There is an interesting example in Enrico Fermi, who was both a theoretician and an experimentalist par excellence. All innovative ideas do not actually work, at least immediately. In modern physics the proposals like that of tachyons or magnetic monopoles is yet to see the light of the day. But scientific creativity paves way for new theories or discoveries that culminate into new technology, and technology transforms our lives.

Is creativity just all about high-brow high profile research? No, not necessarily. There is a scope of creative, innovative ideas in areas like physics education, i.e. teaching physics in theory as well as laboratory. This kind of creativity, being prompted by organizations like Indian Association of Physics Teachers, Indian Physics Association etc, can be really fruitful and rewarding.

Is creativity something of a natural gift?! How does a creative mind work? One cannot say clearly. But let us ask; is it possible to inculcate creativity by training and practice? Yes, it can be done. The first lesson towards this is to have an eye for creativity around, and a mind to appreciate it. And this can be done through interest and practice. Brilliant ideas do not come aplenty, true. But often it is helpful if one collects *all* possible solutions of a given problem at hand. This process itself can germinate a few more ideas. The next step is to recognize the failure not just as failure, but also as a deferred success. An optimistic mind sees every challenge as an opportunity.

Creativity is a new age mantra! However, it must be admitted that scientific creativity is not always rewarding. It is slow in general; solutions of problems in physics do not come as rapidly as new models of computers! Nonetheless, creativity is a way of life; indeed life itself! If not anything else, creative attitude makes us happy and content.

ABSTRACTS OF PAPERS

Abstract#1

Quantum theory of a Bose–Einstein condensate out of equilibrium

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We consider the interaction between a single-mode quantized perturbing external field and a Bose–Einstein condensate (BEC) out of equilibrium. The usual Rabi type oscillations between the ground and the excited state of the coherent topological modes are observed with a Rabi frequency modified by the two-body atomic interactions. Taking into account the granular structure of the external perturbing field reveals the well know phenomena of collapse and revival of the Rabi oscillations. In particular, we find that atomic interactions reduce the Rabi frequency and also affect the collapse and revival sequence.

Optics Communications **249** 587–593 (2005)

PACS: 03.75.Fi; 42.50.Fx; 32.80._t; 42.50.Dv

Abstract#2

Complementary PIGE, PIXE, EDXRF and γ-ray spectroscopic investigation on natural chromites

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Elemental analysis has been carried out on a selected number of natural chromites by using various non-destructive nuclear analytical techniques like simultaneous particle-induced X-ray emission - particle-induced g-ray emission (PIXE-PIGE), energy dispersive X-ray fluorescence (EDXRF) and g-ray spectroscopic measurements. For PIXE-PIGE investigation, a 3 MeV proton beam from a 3 MV pelletron accelerator was utilized for irradiating the samples, whereas EDXRF was carried out by exciting a secondary Molybdenum target by an X-ray tube. Twenty-two major, minor and trace elements including Ca, Ti, V, Co, Ni, Zn, Sr, Zr and Y have been quantified in these chromites. The study advocates the simultaneous use of nuclear techniques for quantifying various elements especially where large number of elements are of interest and need to be accurately determined with optimum precision.

Status: Accepted in Nuclear Instruments and Methods B

Abstract#3

Calculated energy levels, oscillator strengths and lifetimes in Mg-like argon

Vikas Tayal, G. P. Gupta and A. N. Tripathi*

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We have calculated the excitation energies for the lowest 86 fine-structure levels as well as oscillator strength and radiative decay rates for the transition among $(1s^2 2s^2 2p^6)3s^2(^1S)$, $3s3p(^{1,3}P^o)$, $3s3d(^{1,3}D)$, $3s4s(^{1,3}S)$, $3s4p(^{1,3}P^o)$, $3s4d(^{1,3}D)$, $3s4f(^{1,3}F^o)$, $3p^2(^1S, ^3P, ^1D)$, $3p3d(^{1,3}P^o, ^{1,3}D^o, ^{1,3}F^o)$, $3p4s(^{1,3}P^o)$, $3p4p(^{1,3}S, ^{1,3}P, ^{1,3}D)$, $3p4d(^{1,3}P^0, ^{1,3}D^0, ^{1,3}F^0)$, $3p4f(^{1,3}D, ^{1,3}F, ^{1,3}G)$ and $3d^2(^1S, ^3P, ^1D, ^3F, ^1G)$ states in Ar VII. These states are represented by extensive configuration-interaction (CI) wave functions obtained with the CIV3 computer code of Hibbert. The relativistic effects in intermediate coupling are incorporated by means of the Breit-Pauli Hamiltonian which consists of the non-relativistic term plus the one-body mass correction, Darwin term, and spin-orbit, spin-other-orbit, and spin-spin operators. In order to keep our calculated energy splitting as close as possible to the experimental values, we have made small adjustments to the diagonal elements of the Hamiltonian matrices. The energy splitting of 87 fine-structure levels, the oscillator strengths and transition probabilities for some strong dipole-allowed and intercombination transitions and the lifetimes of some fine-structure levels are presented and compared with available experimental and other theoretical values. Our calculated fine-structure energies, including their ordering, show excellent agreement (better than 1.0%) with the available experimental results. In this calculation we also predict new data for several levels where no other theoretical and experimental results are available.

STATUS: In press Indian Journal of Physics (2005)

Abstract#4

Fine-structure energy levels and lifetimes in Br XXIV

Vikas Tayal and G. P. Gupta

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We have performed large-scale CIV3 calculations of excitation energies from the ground state for 48 fine-structure levels as well as of oscillator strengths and radiative decay rates for all electric-dipole-allowed and intercombination transitions among the $(1s^2 2s^2 2p^6)3s^2(^1S)$, $3s3p(^{1,3}P^o)$, $3s3d(^{1,3}D)$, $3s4s(^{1,3}S)$, $3s4p(^{1,3}P^o)$, $3s4d(^{1,3}D)$, $3s4f(^{1,3}F^o)$, $3p^2(^1S, ^3P, ^1D)$, $3p3d(^{1,3}P^o, ^{1,3}D^o, ^{1,3}F^o)$, $3p4s(^{1,3}P^o)$, and $3d^2(^1S, ^3P, ^1D)$ states of Br XXIV. These states are represented by extensive configuration-interaction (CI) wavefunctions obtained using the CIV3 computer code of Hibbert. The relativistic effects in intermediate coupling are incorporated by means of the Breit-Pauli Hamiltonian which consists of the non-relativistic term plus the one-body mass correction, Darwin term, and spin-orbit, spin-other-orbit, and spin-spin operators. Small adjustments to the diagonal elements of the Hamiltonian matrices have been made so that the energy spliting are as close as possible to the experimental values. Our calculated excitation energies, including their ordering, are in excellent agreement with the available experimental results except that the levels ^1D and ^3P belonging to the same configuration $3p^2$ interchanged their positions compared to the experiment. This interchange in our calculation is discussed and explained through eigenvector compositions of the two levels. From our radiative decay rates, we have calculated radiative lifetimes of some fine-structure levels. Our calculated lifetimes of the levels $3s3p(^3P_1)$ and $3s3p(^1P_1)$ are found in good agreement with the experimental and other theoretical results. In this calculation we also predict new data for several fine-structure levels where no other theoretical and experimental results are available.

STATUS: In press, J. Phys. B: At. Mol. Opt. Phys. (2005)

Abstract#5

A setup for probing ion-molecule collision dynamics

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We describe a setup for studies of dissociation dynamics of multiply charged molecules formed due to highly charged ion impact. The setup consists of a multihit, position-sensitive, time of flight measurement system along with an electrostatic analyzer with offset detector. Brief description of different components of the setup and electronics for multihit data acquisition is presented in this paper. Coulomb explosion of multiply ionized N2 and charge exchange studies on Ar with highly charged projectile ion is carried out to test the performance of the spectrometer and its multifold coincidence capabilities.

Status: In Press, Nuclear Instruments and Methods B

PACS: 39.90.+d; 34.50.Gb

Abstract#6

Mesoscopic superposition and sub-Planck scale structure in molecular wave packets

Suranjana Ghosh[a], Aravind Chiruvelli[b], J. Banerji[a], and P.K. Panigrahi[a]

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We demonstrate the possibility of realizing sub-Planck scale structures in the mesoscopic superposition of molecular wave packets involving vibrational levels. The time evolution of the wave packet, taken here as the SU(2) coherent state of the Morse potential describing hydrogen iodide molecule, produces cat-like states, responsible for the above phenomenon. We investigate the phase space dynamics of the coherent state through the Wigner function approach and identify the interference phenomena behind the sub-Planck scale structures. The optimal parameter ranges are specified for observing these features.

Status: Accepted, Phys. Rev. A

Abstract#7

Xe(4d) Triple Differential Cross Section: Modified Semiclassical Exchange Approximation in Electron-Atom Collision

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A Modified Semiclassical Exchange Potential (MSCEP) has been used in the Distorted Wave Born Approximation (DWBA) to calculate the triple differential cross section of Xe(4d) in the coplanar asymmetric geometry at intermediate energy. The scattered and ejected electron energies are fixed at 1000 eV and 100 eV respectively. Calculations have been carried out for the ejected electron angle of 2° and 8°. Agreement between the present calculations and experiment is better compared to that of earlier calculations using corrected form of local exchange potential of Furness and McCarthy.

Status: Accepted J. Phys. B. (2005)

Abstract#8

Quantum spectrum as a time series : Fluctuations and self-similarity

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Email : santh@prl.res.in

The fluctuations in the quantum spectrum could be treated like a time series. In this framework, we explore the statistical self-similarity in the quantum spectrum using the detrended fluctuation analysis (DFA) and random matrix theory (RMT). We calculate the Hausdorff measure for the spectra of atoms and Gaussian ensembles and study their self-affine properties. We show that DFA is equivalent to Δ_3 statistics of RMT, unifying two different approaches. We exploit this connection to obtain theoretical estimates for the Hausdorff measure. We discuss the application of this result to other fields where quantum effects does not play any role.

To appear in Phys. Rev. E (Rapid Communications)

Also at : www.arXiv.org/abs/nlin.CD/0508035

ISAMP NEWS

Emerging Areas of AMO Physics: ISAMP Topical Conference (TC2005)

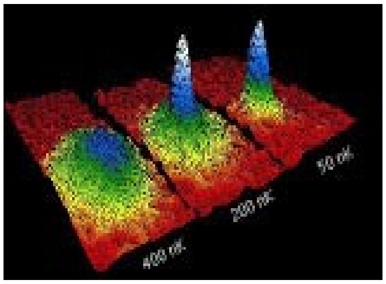
The ISAMP Topical Conference was convened at Indian Association for the Cultivation of Science, Kolkata during 13-15 December 2005.

The emphasis was on the emerging areas of AMO physics, *viz.* cold atoms, traps, BEC and quantum computation. A large number of theorists from India as well as abroad presented their work. The few experimental efforts in the country were also represented.

This conference sets the trend for our community in the years to come. Historically ISAMP members were largely engaged in collision physics and spectroscopy, which is now set for a change.

We hope that the current generation of ISAMP members contribute fruitfully to these areas and the future conferences reflect their efforts.

K.P. Subramanian
Editor, ISAMP NL



Matter Wave Solitons in Bose-Einstein Condensates

Prasanta K. Panigrahi
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Email: *prasanta@prl.res.in*

Bose-Einstein condensates (BECs) in dilute alkali gases is a subject of intense current research [1, 2]. Observation of solitons and solitary waves, manipulation of matter waves in the trap through Feshbach resonance have generated considerable interest in cigar-shaped BEC [3, 4, 5]. BEC on a chip and observation of vortices have put pancake type BEC, as a forefront research area [6]. In the present article, we confine ourselves to one dimension and draw attention to analytical tools for handling these interacting non-linear systems, in the presence of a trap. We highlight the procedure for controlling the matter wave dynamics.

As is well-known, Bose-Einstein condensation has been observed at nano Kelvin temperatures in a variety of alkali atoms e.g. ^{87}Rb, ^{23}Na, ^{7}Li etc [7]. The atomic interaction, playing a crucial role in the formation of Bose-Einstein condensate (BEC), is primarily two-body and is characterized by the scattering length. Three body interaction can play a significant role in the loss of atoms near the Feshbach resonance. For the case of ^{7}Li the two-body interaction is attractive, whereas for the ^{87}Rb and ^{23}Na it is repulsive. Although BEC is stable in the presence of repulsive interactions, the presence of trap, as also lower dimension in case of cigar-shaped BEC, can result in stable BECs in the attractive domain.

In the mean field approximation, the Gross-Pitaevskii (GP) equation governs the dynamics of BEC in three dimensions:

$$i\hbar\frac{\partial\Psi(r,t)}{\partial t}=\left\{-\frac{\hbar^2}{2m}\nabla^2+U|\Psi(r,t)|^2+V_0+V_1+i\frac{\gamma(t)}{2}\right\}\Psi(r,t) \qquad (1)$$

where $V_0(x,y)=m\,\omega_\perp^2(x^2+y^2)/2$ and, $V_1(z,t)=m\,\omega_0^2(t)z^2/2$ which can be both attractive and expulsive. Here, $U=4\pi\hbar^2 a_s(t)/m$ is the strength of the nonlinearity and a_s is the scattering length.

The reduction to lower dimensions can be carried out in a systematic manner, both in the weak and strong coupling regimes. In the absence of the trap, the resulting equations are the familiar non-linear Schrodinger equation (NLSE), with different type of non-linear interactions. In the weak coupling domain, the NLSE with Kerr type cubic non-linearity has been well studied since the early seventies. Apart from mathematical investigations, the same has been exhaustively investigated in the context of optical solitons. Dark and bright moving solitons have been experimentally observed recently. The dark solitons, representing localized profiles, having lower intensity as compared to the asymptotic value of the condensate and occur in the repulsive regime. Bright solitons and solitary wave trains are themselves condensates, manifesting in the attractive coupling arena. The controlled production of these non-linear excitations have been made possible through the temporal variation of the scattering length (strength of the non-linearity) via Feshbach resonance. The oscillator trap potential can be varied and made expulsive or regular harmonic type, to control the movement of the condensate profile. Loss of atoms, as seen in experimental situations, necessitates the incorporation of a loss term in the mean field GP equation. The unexplained instabilities in BEC leading to soliton production as also the possibility of controlling their dynamics have led to the study of the GP equation with couplings and other parameters depending on time:

$$i\partial_t\psi=-\frac{1}{2}\partial_{zz}\psi+\gamma(t)|\psi|^2\psi+\frac{1}{2}M(t)z^2\psi+i\frac{g(t)}{2}\psi \qquad (2)$$

Here, $\gamma=2a_s(t)/a_B$, $M(t)=\omega_0^2(t)/\omega_\perp^2$ $g(t)=\gamma(t)/\hbar\omega_\perp$ $a_\perp=(\hbar/m\omega_\perp)^{1/2}$ and a_B is the Bohr's radius.

Poor reproduction of maths in this article is regretted. Pri-print of this article may be downloaded from www.prl.res.in/~prasanta/BEC_ISAMP.pdf

Editor, ISAMP NL

Some of the special cases of the above system have been earlier investigated in the context of pulse compression and modulational instability in optical fibers [8].

Recently, a procedure of finding analytical solutions of the above equation has been given [9]. The obtained solutions are necessarily chirped with time varying amplitudes and widths. Both propagating and non-propagating localized solitons and soliton trains are found to be exact solutions of the above equation. The general form of the solution is given by:

$$\psi(z,t)=\sqrt{A(t)}F\left[A(t)\{z-l(t)\}\right]\exp\left[i\Phi(z,t)+G(t)/2\right] \qquad (3)$$

where, $G(t)=\int_0^t g(t')dt'$ $\quad l(t)=\int_0^t v(t')dt'$ and $\Phi(z,t)$ is an appropriately chirped phase.

These solutions can be used to engineer the condensate profile in a number of desired ways. Below we explicate the same with few examples. Figure 1. shows the building up of a soliton profile

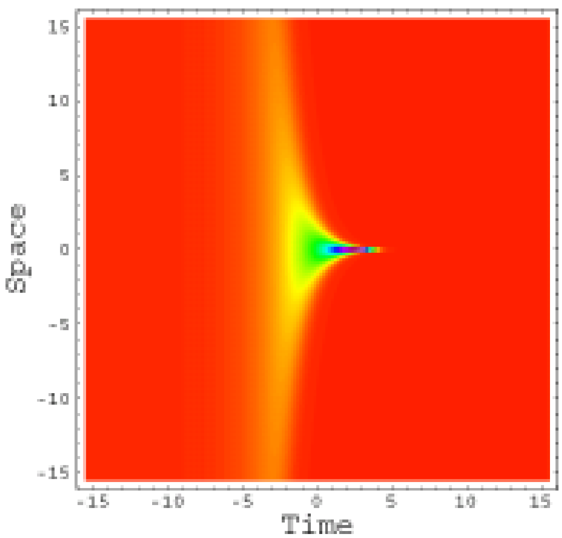
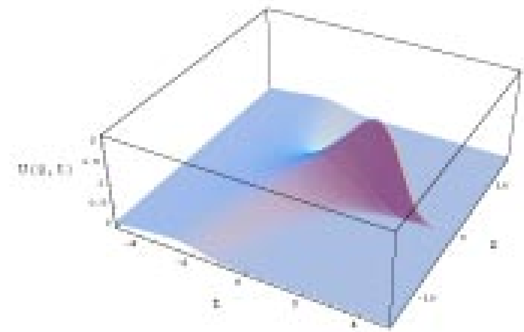


Figure depicting the compression and building up of the soliton profile in the presence of expulsive harmonic potential with increasing nonlinearity in the attractive regime.

in the presence of an expulsive harmonic oscillator potential and an exponentially increasing scattering length in the attractive domain. One smoothly go from strong expulsive to no oscillator confinement in an analytically tractable manner. The effect of the same on the condensate profile is depicted in Fig. 2. It is interesting to pint out that, an efficient atom laser can be laser can be realized by tailoring the gain/loss term.

The study of BEC in optical lattices is an area where the above procedure may find profitable



Formation of a soliton profile in the presence of a smoothly varying oscillator frequency.

application. The analysis of modulational instabilities [10] and nonlinear excitations like Lieb mode, as also the question of stability of the above exact solutions needs careful investigations. There are very few analytical results regarding BEC in strong coupling Thomas-Fermi regime [11]. The crossover regime from lower to higher dimension is also a rich area whose study can be quite rewarding.

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As part of the celebration of the **International (World) Year of Physics**, **UNESCO**, the **Abdus Salam International Centre for Theoretical Physics (ICTP)**, the **International Union of Pure and Applied Physics (IUPAP)**, and the **South African Institute of Physics (SAIP)** have joined together to sponsor the World Conference on Physics and Sustainable Development. This Conference was very much different from the other conferences, in the sense there was a great emphasis on planning rather than presenting one's own research. The following article outlines the changing world view of science and technology.

Physics and Sustainable Development

Sameen Ahmed Khan

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We live in a world of ever increasing connectivity: we travel fast and far; we communicate rapidly and with ease; and conduct business with distant customers. The technologies that have enabled such a remarkable connectivity are intimately tied to physics. The electronics revolution and the information communication technologies (ICT) are based on physics. The ever increasing connectivity is paradoxically accompanied by a division – a widening gap in the economic conditions of the rich and poor. The average per-capita income in industrialized nations is $27000 per year, compared with barely $2000 in the developing world. There are similar disparities in the other key-indicators including literacy and health. Science – and physics in particular – can play a vital role in overcoming this division. Physics has made numerous contributions to the global economy in areas such as electronics, materials and computer technology, and to health through x-rays, synchrotron radiation, magnetic resonance imaging and nuclear medicine. We shall elaborate on these and see how the revolutionary technologies can benefit the people in the developing world. A brief report of the first conference on physics and sustainable development is also presented.

Role of Physics in Energy and Environment

Energy technologies are deeply rooted in the science of physics. Physics provides the theoretical foundation for essentially all of the technologies and processes involved from resource exploration and extraction, conversion, transmission and distribution to providing the energy services demanded by our societies. Without thermodynamics there would be no heat engines that from the mainstay of the world's current electricity generation and transportation systems; without the laws of classical mechanics, classical electro-magnetics or relativity theory, there would be no nuclear fission, photovoltaics or fuel cells. In the past, the extensive use of energy technologies, especially when utilizing fossil energy resources, has also generated undesirable by-products, wastes and pollution that threaten human health, climate and ecosystems. The fundamental laws of physics tell us that there is no technology without wastes, risks and interaction with the environment. Again, physics has been instrumental in our understanding of the adverse impacts of energy production and use ranging from climate change, the interaction of the atmosphere and the oceans to the abatement of pollutants in flue gases. Understanding and assisting in putting to use the laws of nature for the transition towards a sustainable energy system is the fundamental challenge of today's and tomorrow's physicists. One of the greatest challenges ahead is to connect the 1.6 billion people in developing countries currently without access to modern energy services in an environmentally benign manner. Other challenges include the ongoing urbanization throughout the world creating higher and higher energy demand densities, increasing demand for mobility, especially in developing countries, and additional energy needs for new processes such as desalination. Clearly, without a proactive contribution of physics and physicists working along with engineers, economists, sociologists, etc, this challenge can not be met.

Role of Physics in Health and Medicine

The health of a population is a fundamental element contributing to progressive sustainable development in all regions of the world. Virtually all sciences contribute to the maintenance of human health and the practice of medicine; each makes its specific contributions. Throughout the course of medical history, physics has been one of the fundamental medical sciences. First, it was applied to understand the functions of the human body. There is a long and rich history of applying physical principles and the development of many types of technology for both the diagnosis of disease and injury and for a variety of therapeutic purposes.

Physics and health experienced a major revolution following the discovery of a new kind of radiation by a physicist, Professor Wilmhelm Conrad Röntgen in November 1895. This was soon followed by the discovery of radioactivity. Roentgen radiation (X-rays) and radiation from radioactive materials soon became the physical agents for major medical diagnostic and therapeutic procedures. For over a century physicists and engineers have developed and supported the clinical application of radiation. This has been complemented by the continuing developments in technology that utilize other forms of physical energy such as sound, light, lasers, heat and RF radiation and magnetic fields to expand the capabilities of the medical specialties of Radiology or Medical Imaging and Radiation Oncology. Associated with this is the extensive growth of Medical Physics and Biomedical Engineering as two of the major healthcare professions.

Role of Physics in Economic Development

Physics plays many vital roles in economic development, and its applications are as important in the developing world as in the developed world. It has a major role to play in many key sectors, including:

- Information and Communications Technologies, where the production of consumer devices continues to move from the developed world to lower cost centres of production, thus requiring local expertise.
- The emerging field of nanoscience and its associated nanotechnology, which will have deep impact in all areas of national economies of the developing countries allowing them, for the first time, to break free from traditional raw material-based production infrastructures and move into knowledge-based and modern economic, political and social systems.
- Green eco-friendly energy production, including the local generation of electricity in remote areas by solar, and wind, energy, etc.
- Transport, where physics provides solutions to difficult problems;
- Understanding, prediction, modeling and communication of ecological, meteorological and other such events and conditions (including tsunamis and earth quakes) and action to be taken.
- Monitoring environmental impact by human activities.
- Health care, sanitation, clean water and priority deceases in developing countries.
- Modern, knowledge-based agriculture and food production and other areas.

Basic research may be the field that attracts most publicity, and this does lead to new and important technologies, the role of the physicists in economic development is much more extensive. Many physicists are employed in a range of roles within industry. Advantages of physics training include the flexibility to tackle a wide range of problems and to be able to move from one discipline to another. It also gives the ability to solve problems from first principles, when standard solutions do not apply and where a range of disciplines needs to be called on. This can be of particular importance in the developing world where, for reasons of scale, economics or other local conditions, approaches developed and used elsewhere may be inappropriate.

Atomic and molecular physics is central to the nanotechnology. Nanosciences and nanotechnology research aims to control the fundamental structure and behaviour of matter at the level of atoms and molecules so as to improve the performance and added value of existing products and processes. The market for such products and processes is estimated to be around $3 billion today worldwide. However, analysts predict it could be worth hundreds of billions by 2010, later exceeding a trillion. Examples of nanotechnology-based products already on the market include new computer displays, scratch-free paints, surfaces with specific functions, creams and medical products such as heart valves. These products, however, represent only the tip of the iceberg and nanotechnology research is expected to have an impact upon virtually all technological sectors in the coming years and lead to new developments, in particular, in healthcare, information technologies, energy production and storage, new materials, manufacturing, and environmental research.

World Conference on Physics and Sustainable Development

In view of the important position which physics holds for sustainable development a special conference was organized to work out a plan. The *World Conference on Physics and Sustainable Development* (WCPSD), a landmark event organized to celebrate the International Year of Physics, was held during 31 October – 3 November 2005, at the International Conference Centre in Durban, South Africa. The Conference brought together, students, educators, scholars, representatives and decision-makers from numerous government and non-government agencies around the world, who formulated a plan aimed at resolving the challenges posed by sustainable development. Physics has made numerous contributions to the global economy in areas such as electronics, materials and computer technology, and to health through X-rays, synchrotron radiation, magnetic resonance imaging and nuclear medicine. However, these revolutionary technologies have been of greater benefit to people in the developed world than in the developing world. The Durban Conference was, in the words of Dr. Edmund Zingu, President of the South African Institute of Physics, "*an attempt to re-direct the attention and efforts of physicists towards the Millennium Development Goals*", endorsed by world leaders at the United Nations Millennium Summit in September 2000. The conference served as the first global forum to focus the physics community on development goals and to create new mechanisms of cooperation toward their achievement. It created an intellectual platform for an assessment of physics in development and the role it can play for sustainable development, particularly in the emerging and the developing countries. Participants from developed and developing nations examined the contributions that physics has made to society in the past in order to formulate and sharpen action-oriented plans for the contributions that it can and should make in future.

The above Conference was a follow-up on the 1999 UNESCO-ICSU World Conference on Science, which sought to strengthen the ties between science and society, as well as the broader UN World Summit on Sustainable Development that took place in Johannesburg in 2002. This Conference was cosponsored by several international organizations including: *International/ World Year of Physics*, UNESCO; the Abdus Salam International Centre for Theoretical Physics (ICTP); the International Union of Pure and Applied Physics (IUPAP); and the South African Institute of Physics (SAIP). About five-hundred physicists participated. Importantly there were several observers/representatives from numerous agencies including, American Physical Society, European Laboratory for Particle Physics (CERN) in Geneva, European Physical Society, IAEA, IUPAP, UNESCO, World Bank and several of the African organizations.

WCPSD was preceded by the *25th General Assembly* of the IUPAP in Cape Town. It is the first time that the General Assembly (held once in three years) was held in the Continent of Africa; and the second time that it was held outside of USA/Canada and Europe (held once in Asia; in Japan in 1993). WCPSD was immediately followed by two major Physics events in Durban: *US-Africa Advanced Studies Institute on Photon Interactions with Atoms and Molecules* and the *IAEA Technical Meeting on Accelerator-based Physics for sustaining the flow of Technology and Skills*.

WCPSD was much different from most of the other conferences, where the individual presentations of one's own research are the chief focus. WCPSD laid a great emphasis on chalking out programmes to work towards sustainable development. The Conference covered the following four focal themes:

1. Physics Education (330 registered participants)
2. Energy & Environment (80 registered participants)
3. Physics & Economic Development (52 registered participants)
4. Physics & Health (47 registered participants)

The Conference was inaugurated by His Excellency, Mosibudi MANGNENA, Minister of Science and Technology, South Africa. A welcome civic reception & banquet was held on the first day by the Mayor Councilor Obed MLABA. The first day consisted of a Plenary Session with presentations by the Organizers, Keynote Speakers and the Programme Chairs of each theme. The second day was devoted to active discussions among the sub-groups under each of the four themes. A brief summary of each of the four is outlined below.

An urgent need was felt to strengthen the *Physics Education*. Physicists pledged to make high-quality physics resources widely available in developing countries by establishing a website along with Resource Centres in Africa, Asia and Latin America. These will prepare instructional materials and model workshops for teacher trainers in Asia, Latin America and Africa. The resulting resource material will be made available on the web. A multidisciplinary mobile science team will also be created to provide online support.

Under the umbrella of *Energy and Environment*, efforts to enhance efficiency and reduce pollution in transportation will include investigating new battery technologies and improved internal combustion technology for hybrid application. Teams will develop solar photovoltaic technologies, including new and environmentally-friendly processes for generating and storing electricity. Efforts shall be made to enhance the usage of wind power.

The focal theme, *Physics & Economic Development*, drew a lot of attention with active participation from representatives of UNESCO, IAEA, IUPAP, World Bank, among others. This working group has come up with a series of recommendations and initiatives on how to strengthen Research and Development (R&D). Physics makes a vital contribution to the economy. It was pointed out that physics-based industries account for 43% of manufacturing employment in the United Kingdom. A Training Facility for Physicists in Economic Development is proposed, which shall provide training in entrepreneurship and related skills. The group further proposed to launch a joint research project on nanoscience and nanotechnology with a focus on clean water, air and energy. It proposes an integrated approach to strengthen R&D in nanosciences and help turn nanotechnologies into commercially viable products for the benefit of society, in the developing countries. An online network devoted to physics and agriculture was also proposed. Most members of this group will be following up with laboratory work and liaison with the industry. The group also urged the creation of International/Regional Science Centres (including the AfSRF: *African Synchrotron Radiation Facility*) in the developing countries.

Under the fourth and final theme, *Physics & Health*, educational resources will be made available through the Physics and Engineering Resources for Healthcare Development (PERHD) website, sponsored by the World Conference. Further projects include creating a network of training centres in physics of radiation therapy using shared resources from institutions around the world and providing guidelines to elaborate educational programmes in medical physics.

The Conference had about 200 Poster Presentations, displayed for two days. The third and the last day was devoted to the presentations of the summaries of the deliberations of each of the sub-groups on the preceding day. There shall be some follow-up meetings to review the progress of the deliberations and proposals during the WCPSD. An interesting item in the Conference was *The Lab in a Lorry*. This mobile laboratory is a partnership between the Schlumberger Foundation and the Institute of Physics, UK. It is contributing to popularizing physics among school students and in creating a general awareness *(http://www.labinalorry.org.uk/)*.

In the conference the accelerators and accelerator facilities were mentioned in the context of the sustainable development. Radiation and the radiation sources were mentioned in the context of health physics and the materials sciences. Role of accelerator facilities (including synchrotron radiation facilities) in the arena of international cooperation was also covered.

Concluding Remarks

Physics is central to industrialization. We need to stimulate physics communities in nations across the world to collaborate on finding ways that physics can best be used to benefit diverse societies. Many countries, in particular the developing countries, question the rationale for global economies and are seeking alternative models of development. If physics is to benefit people in a culturally sensitive and environmentally sound way, then people from both rural and urban areas in all parts of the world must have access to quality physics education. This need for culturally rooted scientific progress is felt most acutely in developing nations.

References

1. 31 October - 02 November 2005, World Conference on Physics and Sustainable Development (WCPSD), Durban, South Africa, http://www.wcpsd.org/
2. *The Importance of Physics in the UK Economy*, Institute of Physics, UK (March 2003).

Physical Research Laboratory, Ahmedabad, India

International conference on Quantum Optics (ICQO-06) will be held at Physical Research Laboratory, Ahmedabad, India during 24 – 27 July 2006. The conference marks the sixtieth birthday of Prof. G. S. Agarwal, an outstanding member of the Quantum Optics fraternity.

In recent times, quantum optics has seen spectacular developments both in theoretical and experimental fronts. Applications ranging from information storage and retrieval, implementation of quantum logic gates in multilevel systems, control of decoherence & entanglement production, optical control of cold atoms leading to the test of exotic concepts of physics are but a few of the exciting developments.

ICQO-06 intends to take stock of the current scenario in quantum opticsand map out the possible paths for future growth. Some of the topics to becovered are:

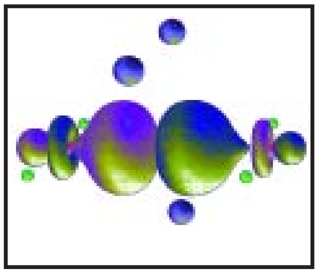
- Multilevel Systems & Coherent Control Cavity QED
- Nonlinear Processes in Quantum Optics
- Quantum Information Science
- Quantum State Tomography, Quantum Imaging
- Quantum Optics of Cold Atoms

Conveners: Dr. P.K. Panigrahi, PRL
Dr. R.P. Singh, PRL
Contact: <icqo2006@prl.res.in>

Computational Approaches in Materials Science-2006 (CAMS06)

(http://www.jncasr.ac.in/cams06)

A winter school is being organized from January 18 to 21, 2006 at J. Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore. Lectures in the school are aimed at doctoral students or post-doctoral researchers who would like to learn about different computational approaches and their applications in materials science. Topics covered in the school include:



- Molecular Dynamics
- Monte Carlo Methods
- Density Functional Theory
- Density Matrix Renormalization Group
- Dynamical Mean Field Theory
- Phase Field Methods
- Nano-structures
- Biological Systems
- Polymers
- Catalysis

Participants are expected to present posters on their work. Local hospitality and travel expense (II class by rail) will be covered by organizers. For more information and registration, please visit the CAMS06 web page or email to <cams06@jncasr.ac.in>

Organizers:

S. Balasubramanian
C. R. A. Catlow and
U. V.Waghmare

Sponsors:

JNCASR, Bangalore. EDMM Lab, GEITC, Bangalore. Royal Institution, UK.

Indian Institute of Technology, Kanpur

6-12 March 2006

This Conference will address the current impact of Quantum Computing on Science and Technology. The specific conference topic being Quantum Computing: Applications from Molecular control to developing new approaches to molecular structural studies, to be held in Indian Institute of Technology, Kanpur, India from 6 -12th March 2006.

Organized By:

- Prof Debabrata Goswami,IIT Kanpur
- Prof K.L.Kompa, Max Planck Institute, Garching
- Prof W.S.Warren, Duke University
- Prof Neil Gershenfeld, MIT

Outline of Conference:

Quite a bit of effort and workshops have been spent on popularizing quantum computing as this is relevant in the context of digital revolution that has revolutionized communication and computing and the fact that the future to miniaturization leads the way to quantum computing. However, the difficulty lies in the fact that every aspect of the promise is futuristic and the immediate prospects of quantum computing are difficult to be ascertained.

Presently, a more pragmatic aspect is evolving. In fact, it is becoming clear that quantum computing architectures and theoretical developments have a chance to have an even broader impact with more immediate and practical implications. For example, there is great interest at the moment in advanced contrast agents for Magnetic Resonance Imaging (MRI), which can be prepared with extremely high (50%) nuclear polarization using microwave or optical spectroscopy. However, the reagents only last for a time T1, which is seconds. In this case, decoherence algorithms and protected states might lengthen the relaxation time, and have an actual impact. Similarly, the traditional encoding and communication schemes would be finding new life and dimensions as a result of the quantum aspects of encoding. Such quantum computing concepts on entanglement with correlated photons enables high accuracy measurement methods for systems operating in the low photon counting regime. These back-action developments, as we refer, are yet to be highlighted or explored and this conference will be the first of its kind to focus on such issues.

There would be discussions on issues related to how entanglement between pairs of photons has been used to develop innovative quantum measurement techniques. Entangled photons offer greater sensitivity and absoluteness in a number of key metrological applications compared to conventional light sources and entanglement is a vital ingredient in quantum information processing schemes. Similarly, the ideas of decoherence minimization, protected states and selective excitation are critical developments of importance to imaging developments, molecular switching, secure communications and coherent control issues.

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