# PHOTONICS NEWS

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Inside this issue :



Prof. Leggett ( Nobel Prize 2003) sharing some pleasent moments with children at C-SiS

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

# FROM EDITOR'S DESK.....

**Editor in Chief**
**Prof. V.P.N Nampoori**

*Year 2011 was eventful as far as CUSAT in general and ISP & CELOS in particular. The new academic programme called Erudite- Scholars in Residence filled the campus with academic activities. ISP hosted the 2003 Noble Prize Winner, Professor Anthony Leggett during January 2011. He gave lecture series on Quantum entanglement and the Time paradox. Another important event hosted by ISP was the Inauguration of Inter University Centre for Studies on the Kerala Legacy of Astronomy and Mathematics on February 17th , 2011 by the Minister for Education and Culture Sri M A Baby. This Centre will support research in history and philosophy of Mathematics with special reference to the contributions from Kerala during 5th century to 19th Century AD..*

*Several of the MSc (Photonics) students got opportunities to attend International conferences and to do short term projects in reputed laboratories outside India. We take this opportunity to congratulate all of them and wish them bright academic future.*

*The student chapters ( ISP-OSA and ISP-SPIE) were active during 2010-2011 by designing various extension programme like Optics Fair and Optics to School. The Optics to School Programme in a school near Palakkad was well appreciated by students , teachers and parents of the school .*

*ISP has initiated new research fields in bio photonics and ultrafast phenomena. One of the papers published in Applied Physics Letters got a place in the Editor's choice in Virtual Journal. A paper on adverse effect of mobile phone radiation on human health will appear in the journal Laser Physics. Research collaborations of ISP with Institute of Plasma Research, University of Hyderabad and CGCRI ( Calcutta) are continuing effectively. In short, the period 2010 - 2011 was quite encouraging for ISP and CELOS*



- Research is what I'm doing when I don't know what I'm doing.~ Werner Von Braun

## Annual Photonics Workshop 2010

Annual Photoincs workshop 2010 was held on 27th & 28th of February, 2010. The focal theme of this year's workshop was 'Quantum Optics'. As many as 60 researchers from the various parts of the country came down to become a part of the annual event. The chief guest of the event was the Pro vice chancellor of Cochin University of Science and Technology Mr. Godfrey Louis. The two day event also witnessed the presentation of the 'Nalanda Endowment Award' instituted by Prof. N. Devaki for the student who gets the highest marks in the first semester of the Integrated M.Sc. course in Photonics. This year's award went to chapter member Mr. Ajan P.R. The chief guest released the annual magazine of the Photonics Department 'Photonics News – 2010' during the event. The participants were provided with a platform to strongly interact with all the speakers of the workshop during the intervals. Posters related to the topic were also exhibited in the courtyard of the Institute for the participants. The workshop was organized in collaboration with ISP-SPIE Students Chapter,ISP-OSA student chapter and Photonics Society of India (PSI)

## ERUDITE Program - Distinguished visitors

### Sir Anthony James Leggett

**Professor Sir Anthony James Leggett** has been a Professor of Physics at the University of Illinois at Urbana-Champaign since 1983.His main research interests lie in condensed matter physics, particularly high-temperature superconductivity, glasses and ultra cold atomic gases, and the foundations of quantum mechanics. He is widely recognized as a world leader in the theory of low-temperature physics, and his pioneering work on super fluidity was recognized by the 2003 Nobel Prize in Physics. He has shaped the theoretical understanding of normal and superfluid helium liquids and strongly coupled super fluids. He set directions for research in the quantum physics of macroscopic dissipative systems and use of condensed systems to test the foundations of quantum mechanics.

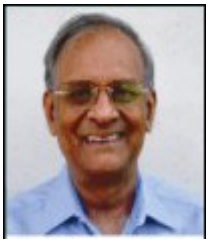
Professor Leggett is an Honorary Fellow of the Institute of Physics (U.K.). He was knighted (KBE) by Queen Elizabeth II in 2004 "for services to physics". He also won the **2002/2003 Wolf Foundation Prize** for research on condensed forms of matter (with B. I. Halperin). He was also honoured with the **Eugene Feenberg Memorial Medal (1999) Maxwell Medal and Prize (1975)** and **Paul Dirac Medal (1992)**

He delivered a lecture series on Quantum Entanglement and Foundations of Quantum Mechanics under Erudite program

### Derryck T. Reid

**Derryck T. Reid** is a Professor of Physics at Heriot-Watt University where he is Head of the Ultrafast Optics Group, within the School of Engineering and Physical Sciences. His research covers diverse aspects of ultrafast lasers and optical parametric oscillators, together with their applications in frequency combs, gas-sensing, waveguide inscription and nonlinear microscopy. His visit to ISP was sponsored by CUSAT under Erudite program in which he delivered his valuable words on Ultra Fast Laser Fundamentals and Current Research .

## Ajoy Ghatak



**Ajoy Ghatak** has recently retired as Professor of Physics from IIT Delhi. His research areas are Fiber Optics and Quantum Mechanics Persian.Professor Ghatak is a recipient of several awards including the 2003 Optical Society of America Esther Hoffman Beller award in recognition of his outstanding contributions to optical science and engineering education. He is also a recipient of the 1979 CSIR S S Bhatnagar award, the 2003 International Commission for Optics Galileo Galilei award and the 2008 SPIE Educator award. He came under the erudite pogramme and delivered lectures on Einstein, his photon and special theory of relativity

## CJR Sheppard

**CJR Sheppard** is a professor of Bioengineering, National University of Singapore, Previously, he has been Professor of Physics (Physical Optics) at the University of Sydney, and University Lecturer in Engineering Science at Oxford University. He delivered lectures on hot topics like Confocal and multiphoton microscopy, Three dimensional image formation under erudite program

# NEW CENTRES IN CUSAT

### Interuniversity Centre for Studies on Kerala Legacy on Astronomy and Mathematics

Recently Cochin University of Science and Technology with financial help from the Government of Kerala has established a unique centre called *Interuniversity Centre for Studies on the Kerala Legacy on Astronomy and Mathematics* to promote studies on Kerala's rich contributions to Mathematics and Astronomy. The Centre was inaugurated by Sri M A Baby ( Hon'ble Minister for Education and Culture)on 17th February 2010. The Centre offers short term visiting scientist scholarships for school and college students who wish to take up short term projects in the area of History and Philosophy of Mathematics with special reference to Kerala. We also invite experts in this field to get associated with the Centre to take up project work for decoding ancient manuscripts. We welcome interested Manuscriptologists, Sanskrit Scholars, Mathematicians, Scientists and Computer Scientists to associate with the programme. An extension centre called Aryabhata Centre for Studies on Indian Contributions of Astronomy and Mathematics will be established in Chamravattom, near Trichur.

### Center for Advanced Materials and Inter University Center for IPR Studies

**The Centre for Advanced Materials** was inaugurated on 15th January 2011 by Professor C N R Rao, Scientific Advisor to Prime Minister of India. The Centre is established to promote research and development in the field of new materials which have technological importance

Hon'ble Minister Sri M A Baby inaugurated another important centre in CUSAT called **Inter University Centre for I P R studies** on 13th February , 2011.

♦ Facts are not Science –as the Dictionary is not Literature ~ Martin H. Fischer

# WE HEAR THAT……

## NOBEL PRIZE FOR GRAPHENE; THINNEST, STRONGEST MATERIAL EVER….

Two University of Manchester scientists were awarded the 2010 Nobel Prize in physics Tuesday for their pioneering research on graphene, a one-atom-thick film of carbon whose strength, flexibility and electrical conductivity have opened up new horizons for pure physics research as well as high-tech applications.It's a worthy Nobel, for the simple reason that graphene may be one of the most promising and versatile materials ever discovered. It could hold the key to everything from supersmall computers to high-capacity batteries.

Graphene is stronger and stiffer than diamond, yet can be stretched by a quarter of its length, like rubber. Its surface area is the largest known for its weight."Geim and his colleague (and former postdoctoral assistant) Konstantin Novoselov first produced graphene in 2004 by repeatedly peeling away graphite strips with adhesive tape to isolate a single atomic plane. They analyzed its strength, transparency, and conductive properties in a paper for *Science* the same year.The energy applications of graphene are also extraordinarily rich. Texas's Graphene Energy is using the film to create new ultracapacitators to store and transmit electrical power. Companies currently using carbon nanotubes to create wearable electronics — clothes that can power and charge electrical devices — are beginning to switch to graphene, which is thinner and potentially less expensive to produce. Strong, flexible, light-sensitive graphene could improve the efficiency of solar cells and LEDs, as well as aiding in the production of next-generation devices like flexible touch screens, photodetectors and ultrafast lasers. In particular, graphene could replace rare and expensive metals like platinum and indium, performing the same tasks with greater efficiency at a fraction of the cost. Because graphene is effectively only two-dimensional, electrons can move through its lattice structure with virtually no resistance. In fact, they behave like Heisenberg's relative particles, with an effective resting mass of zero.

To have mass in the traditional sense, objects need to have volume; electrons squeezed through two-dimensional graphene have neither. In other words, the same properties that makes graphene such an efficient medium for storing and transmitting energy also demonstrate something fundamental about the nature of the subatomic universe.

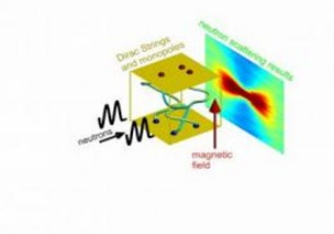
*This scanning-electron microscope image shows a crumpled graphene sheet of the single-atom-thick*

Andre Geim

Konstantin Novoselov

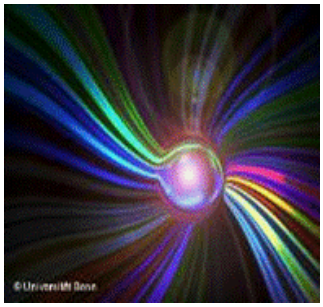
## MAGNETIC MONOPOLES DISCOVERED.

In 1931 the physicist Paul Dirac was led by his calculations to the conclusion that magnetic monopoles can exist at the end of tubes - called Dirac strings - that carry magnetic field. Until now they have remained undetected. Researchers from the Helmholtz Centre Berlin, in cooperation with colleagues from Dresden, St. Andrews, La Plata and Oxford, have for the first time observed magnetic monopoles and how they emerge in a real material. They performed a neutron scattering experiment with a single crystal of Dysprosium Titanate. With the help of neutron scattering Morris and Tennant show that the magnetic moments inside the material had reorganised into so-called„Spin-paghetti".During the neutron scattering measurements a magnetic field was applied to the crystal by the researchers.As a result, at temperatures from 0.6 to 2 Kelvin, the strings are visible and have magnetic monopoles at their ends. This is a schematic diagram of the neutron scattering experiment: Neutrons are fired towards the sample, and when a magnetic field is



applied the Dirac strings align against the field with magnetic monopoles at their ends. The neutrons scatter from the strings providing data which show us the strings properties. Credit: HZB / D.J.P. Morris & A. Tennant

## SUPER PHOTON OR BOSE – EINSTEIN CONDENSTATE OF PHOTONS



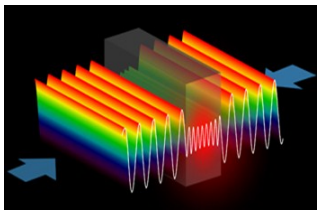
*Bildunterschrift:*
*: Martin Weitz and his team worked on the experiment for three years to realize BEC in photons.*

Bose-Einstein condensates (BEC) were first proposed in the 1920s by Satyendra Nath Bose and Albert Einstein, who asserted that atoms, chilled to very near absolute zero, would take on quantum characteristics, so that the atoms "overlap, and behave as a giant meta-wave," or a sort of super-atom. The BEC state was previously believed to apply only to atoms and not to photons, since the cooling process would force the photons to be absorbed by surrounding atoms in the apparatus. But a team of physicists, from University of Bonn, lead by Martin Weitz along with Jan Klaers, Julian Schmitt and Frank Vewinger, has managed to create a photonic BEC at room temperature by trapping photons between two concave mirrors.

The experiment also made use of liquid dye pigment that cooled the photons down to room temperature while they were trapped between the two mirrors. When enough photons were pumped into this apparatus, a BEC state was observed "which appeared as a yellow peak in the middle and there the photons marched in step," Weitz said.

The discovery took three years of research and is being hailed as a major breakthrough in the field of quantum physics. Matthias Weidemueller, a quantum physicist at the University of Freiburg, said in the journal Nature that the experiment was "truly ingenious." "Compared to Bose-Einstein condensation with ultracold atoms, the current experiment is ridiculously simple," he said. But some in the field maintain that, while the results are welcome and that the concept of a BEC of photons was controversial, it's not completely unexpected. Aephraim Steinberg, a quantum physicist at the University of Toronto, says quantum mechanics basically dictate that all bosons, a category which includes Rubidium-87 atoms used in atomic BEC, as well as photons, want to act in the same way. This discovery could be used to develop better microchips for computers or more efficient solar energy technology

## SCIENTISTS BUILD THE WORLD'S FIRST ANTI-LASER



*In the anti-laser, incoming light waves are trapped in a cavity where they bounce back and forth until they are eventually absorbed. Their energy is dissipated as heat. (Photo: Yidong Chong)*

More than 50 years after the invention of the laser, scientists at Yale University have built the world's first anti-laser, in which incoming beams of light interfere with one another in such a way as to perfectly cancel each other out. The discovery could pave the way for a number of novel technologies with applications in everything from optical computing to radiology. Conventional lasers, which were first invented in 1960, use a so-called "gain medium," to produce a focused beam of coherent light-light waves with the same frequency and amplitude that are in step with one another.

Yale physicist A. Douglas Stone and his team published a study explaining the theory behind an anti-laser, demonstrating that such a device could be built using silicon, the most common semiconductor material. But it wasn't until now, after joining forces with the experimental group of his colleague Hui Cao, that the team actually built a functioning anti-laser, which they call a coherent perfect absorber (CPA). The team focused two laser beams with a specific frequency into a cavity containing a silicon wafer that acted as a "loss medium." The wafer aligned the light waves in such a way that they became perfectly trapped, bouncing back and forth indefinitely until they were eventually absorbed and transformed into heat. CPAs could be used as optical switches, detectors and other components in the next generation of computers, called optical computers, which will be powered by light in addition to electrons. Another application might be in radiology, where Stone said the principle of the CPA could be employed to target electromagnetic radiation to a small region within normally opaque human tissue, either for therapeutic or imaging purposes.

## DISPERSION ENGINEERED METAMATERIAL FOR CONTROL OF SPONTANEOUS EMISSION

Metamaterials are nano-composites with length scales much smaller than the wavelength of light interacting with them. The subwavelength features control the electromagnetic properties of these systems. They have been studied extensively in the last decade due to their wide applications ranging from superlenses, optical cloaking, control of spontaneous emission and so on. However, most of these applications require systems with a negative refractive index. Fabrication of negative index materials is a serious challenge, especially in the visible spectral range.

Recently, non-magnetic metamaterials exhibiting positive or negative anisotropy have been developed, which support the existence of large-wavevevector states. Such materials do not have a negative refractive index and can easily be fabricated. Already, they have lead to many applications such as the optical hyperlens, acoustic hyperlens etc. The presence of large-wavevector states in these materials can also be used to enhance the rate of spontaneous emission from emitters such as quantum dots.

The spherical dispersion relation in an isotropic medium places an upper-bound on the allowed value of the wave-vector. In contrast, hyperbolic dispersion allows propagating waves with unbounded wavevectors [Fig 1 (a)]. Hyperbolic dispersion is achieved by designing a medium in which the dielectric permittivities are of opposite signs in mutually perpendicular directions. The negative anisotropy leads to propagating states in the metamaterial which have large wavevectors which in turn results in an extremely high photon density of states (PDOS) within the material. Consequently, the radiative decay rate of an emitter embedded into the material will be enhanced. The same effect can be obtained with a medium that exhibits extreme positive anisotropy [Fig 1(b)]. Although the dispersion relation is bound, it can still support large-wavevector states. . Such a metamaterial typically consists of alternating layers of a metal and a dielectric of sub-wavelength thicknesses. By appropriate choice of the metal and the dielectric and their respective fill-factors, one can design a medium to exhibit either positive or negative anisotropy in the desired spectral range

Control of spontaneous emission is one of the fundamental concepts in the field of quantum optics with applications such as lasers, light emitting diodes, single photon sources etc. Microcavites are the most common approach to enhancing spontaneous emission. Due to the resonant nature of the interaction between the cavity mode and the emitter in a microcavity, this enhancement can be achieved only over a narrow spectral range. In a dispersion engineered metamaterial, the enhancement in PDOS is not a resonant phenomenon as it supports large-wavevector states over a wide spectral range. This opens up the potential to developing a material that can enhance spontaneous emission over a broad wavelength range.

We have been investigating the effect of a metamaterial exhibiting positive anisotropy on the spontaneous emission of colloidal quantum dots. Preliminary measurements have shown an enhancement of about 1.50 times in the Purcell factor. More importantly, this enhancement has been observed over a spectral range of approximately 25 nm.

**Harish Krishnamoorthy**
**Graduate Student in Physics**
**Queens College of the City University of New York,**

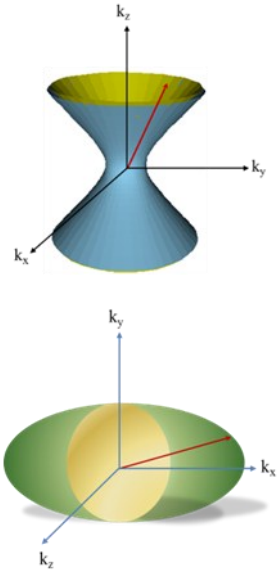



*Fig. 1. (a) and (b) Dispersion relation for a medium with strong negative (hyperboloid) and strong positive anisotropy (flat ellipsoid) compared with that for an isotropic medium (sphere),*

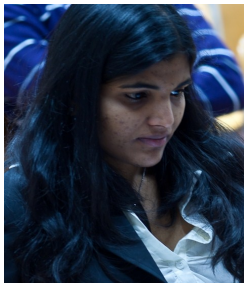
♦ Men love to wonder , and that is the seed of Science ~ Ralph Waldo Emerson

## PHOTONIC QUASICRYSTALS: ENGINEERING AND APPLICATIONS

Photonic band-gap materials are artificially engineered materials with which we can control and manipulate the electromagnetic radiation. The periodic photonic crystals are well known and have been studied for the last two decades. Recently Photonic structures lacking long-range translational order but with orientational order and higher-order rotational symmetries which are not compatible with the spatial periodicity, called "photonic quasicrystals"(PQCs) in analogy with solid-state physics, are gaining a growing attention in view of their unique characteristics.

To experimentally study the photonic band gap formation and the isotropy nature of two dimensional pqc, an experiment is designed and conducted in the microwave regime (8-20 GHz). We studied the transmission characteristics of the PQC structures as a function of polarization of incident radiation and the angle of incidence. Although complete photonic band gaps cannot exist in low-index-contrast structures, it is shown that two-dimensional band gaps are possible for specifically polarized electromagnetic modes. Notably, gaps in quasicrystal geometries are more isotropic than those in crystals, due to their disallowed rotational symmetries. Another interesting observation is the defect-free localized state in one of the PQC structures. The 8-fold interferential quasicrystal pattern showed a localized state within the band-gap frequencies. The waveguiding properties of this structure near the frequency of localization are altered by changing the properties of a central pillar placed inside the waveguide. Since this effect is very short range in terms of frequency, this effect provides a possibility of realizing optical Notch filters. It is also found that the effect is tunable, and thus by changing the environment of the localized state we can obtain different degree of localization.

To realize the pqc operating in the higher frequencies, the method computer generated holography along with spatial light modulation is employed. The advantage of this CGH-SLM technique is that it is a simple, single-beam technique which allows writing of mostly any 1 -, 2-or 3-dimensional patterns. Using other fabrication techniques like multiple beam holography, it is almost impossible to obtain quasicrystal patterns with higher order of rotational symmetry. But at the moment, CGH-SLM technique is limited by the maximum refractive index contrast that can be achieved (around0.2) and the limited resolution.



**Priya Rose was among the first batch of Integrated M.Sc Photonics. She completed PhD from Univeristy of Naples, Italy**

## AWARDS 2011

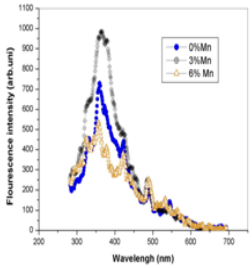
**PSI Prize to Bavishna Balagopal :** Ms. Bavishna Balagopal who topped the M. Tech Degree Examination in Optoelectronics and Laser Technology conducted by CUSAT, receives the Photonics Society of India prize. The PSI prize is given every year to the student who bags first rank in M.Tech Degree Examination (OE&LT) of Cochin University of Science And Technology. This prize is instituted by Prof. C.P. Girijavallabhan, former director, CELOS. The prize includes cash, memento and a merit certificate.

**Vikas R. receives the Nalanda Endowment prize**.

The 2010 Nalanda Endowment will be presented to Mr. Vikas R. during APW 2011. The Nalanda Endowment prize is instituted by Prof. N.G. Devaki of Department of Hindi, CUSAT. The prize includes cash, memento and merit certificate and is given every year to the student who stands first in the First Semester Examination of Integrated M.Sc (Photonics) Degree of CUSAT.

## Enhancement of fluorescence in ZnS nanoparticles by doping Manganese

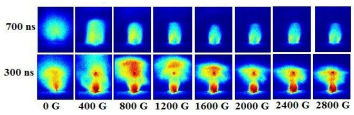
**S Mathew**




ZnS nanoparticles of size 1.3nm prepared by precipitation technique show fluorescence enhancement when doped with Mn. ZnS nanoparticles show a large blue-shift of the absorption edge and also fluorescence emission get blue-shifted. When the prepared ZnS nanoparticles are excited with 260nm, the emission spectrum contains a peak at 360nm,. There is also an edge at 422nm. It is observed that doping with Mn causes an enhancement of 360nm emission peak,for the ZnS nanoparticles, which are doped with Mn..As has been pointed out, the surface states or defect sites in nanoparticles are so abundant that the trapping of carriers is a very fast process. Fluorescence enhancement is due to the vacancy of $Zn^{2+}$.As shown in Fig. 1, undoped nanoparticles of ZnS for the same size showed blue emission at 360nm with an excitation wavelength of 260 nm, which is blue shifted with respect to the emission from the bulk ZnS. This is due to the strong confinement effect. When doped with Mn, the intensity of this peak is enhanced, which is shown in Figure 1. When the percentage of Mn increased to 6%, fluorescence get quenched.

## Image analysis of expanding lithium plasma plume in variable transverse magnetic field

**Sony T George**




In the recent years, the effect of magnetic field on the expansion of laser-produced plasma plume has been the subject of intensive research because of its applicability in various application e.g. thin film deposition, debris mitigation, development of XUV lithographic sources, analytic detection limit enhancement in laser-induced-breakdown-spectroscopy (LIBS) etc. The presence of magnetic field may initiate several phenomena in the overall plume dynamics e.g. confinement, plume compression and adiabatic heating, onset of instabilities etc

Time resolved imaging of plasma plume is important in understanding the expansion dynamics of plume in the presence of the magnetic field. For the present study, experiment has been carried out in a cylindrical stainless steel chamber, evacuated to a base pressure < $2x10^{-5}$Torr. The target is ½ inch diameter solid pure (99.999%) Li rod. An ICCD camera having variable gain and gating on time, has been used to record the time resolved images of the plume luminescence in the spectral range of 350 - 750 nm In the present experiment, gate opening integration) time is set at 4 ns. Temporal evolution of the LPP plume has been obtained by varying the time delay (from 100 to 4000 ns) between the laser pulse and the opening time of ICCD gate. The evolution of the plasma plume across the transverse magnetic field obtained by fast imaging of the electronically excited plume species (driven by collisional processes between electrons, ions, and neutrals generated by laser-solid interaction) can provide the two dimensional snapshot of the expanding LBO plume. In the absence of the magnetic field, ablation of lithium into vacuum produces an intense luminous plume that expands normally to the target

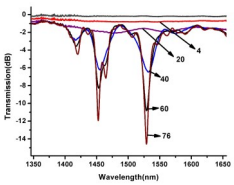
surface. The shape and the intensity of the plasma plume are completely modified on introducing the transverse magnetic field. It can be seen that enhancement in the emission takes place when the plume expands in the magnetic field. Initially in the presence of magnetic field (400G), the plume is splits into two lobes. We feel that the magnetic field significantly influences the plasma parameters and hence the associated atomic processes in different regions to different extents in the plume (as the composition changes along the expansion direction) causing the structure formation in magnetic field. This will significantly increase the probability of electron-atom/ion collisions, which in turn should lead to enhancement in the emission intensity of the expanding plume.

## Long Period Fiber Grating (LPFG) Fabrication using Electric Arc and $CO_2$ Laser

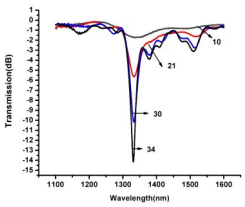
**Linesh J**

Since the discovery of photosensitivity in optical fibers, fiber gratings, especially Long Period Fiber Gratings or LPFGs have carved its niche in almost all areas of sensing applications. LPFGs are classically realized by exposing the photo sensitive optical fiber to ultra-violet laser, either through an amplitude mask or using point by point technique. Beforehand, the fiber need to be hydrogen loaded in order to increase the photosensitivity and facilitate the refractive index change. Also gratings can be written by laterally submitting the fiber to either a $CO_2$ laser, or to an electric discharge. The discharge can be performed in a standard non hydrogenated fiber or in pure silica-core fiber. Though UV inscription is expensive the cladding modes generated are symmetric, while electric arc or $CO_2$ inscription is simple, flexible and cost effective but produces antisymmetric cladding modes.

We have fabricated LPFG in commercially available standard telecommunications fiber (SMF-28) from Newport using point-by-point technique. A motorized translation stage with a resolution of 100nm (Newport) was used to shift the fiber. For electric arc we have used an arc fusion splicer (Fujikura FSM-50S) while a 12 W continuous wave $CO_2$ laser ((LASY-12, 10.6μm, 12W) was used for $CO_2$ pulses. The chosen grating period for the two sets of LPFGs were 600 $\mu$m for $CO_2$ and 500 $\mu$m for Electric arc. The optical transmission of the fiber was monitored during the LPFG fabrication process in order to obtain the desired spectral attenuation notches. The optical reading setup employed in the experiments were a white light source (Yokogawa AQ4305) coupled to one end, while the other end was connected to an optical spectrum analyzer, OSA (Yokogawa AQ6319), set to a resolution of 0.05 nm. In the case of $CO_2$ laser fabrication the fiber was exposed to $CO_2$ laser radiation using a shutter for less than a second and then translated by the required grating period. The beam diameter of the $CO_2$ laser limited the minimum grating period Λ to be 600μm and we got an attenuation of 14 dB at 1520nm after 76 periods producing a grating length of 4.5cm. For arc induced LPFG, an arc discharge with a current of 5mA was applied to the fiber for 0.2 s and along with each arc 50μm length tapering is done using the fusion splicer. We got an attenuation of 14 dB at 1320nm after 34 periods producing a grating length of 1.7cm.



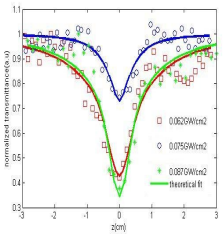

*Spectral evolution of $CO_2$ induced LPFG*




*Spectral evolution of arc induced*

## Optical Non - Linearity in TeO2–ZnO Glass

**Rose Leena Thomas**




*open aperture curve of ZincTellurite glass at three different powers*

Tellurium dioxide ($TeO_2$) is the most stable oxide of tellurium (Te). The stability of tellurium oxide is one of the properties that originally attracted researchers, to tellurite glasses. Tellurite glasses are known to be an important amorphous system that has many potential commercial applications. The $TeO_2$–ZnO glass system is expected to have a unique optoelectronic properties because of not only their low transition temperature but also their excellent infrared transmission. It has also been reported that these glasses are excellent candidates for hosting rare-earth ions since they provide a lowphonon-energy environment to minimize the nonradiative losses as well as possessing good chemical durability and optical properties. These would give them a potential application in pressure sensors or a new laser hostCation in pressure sensor or a new laser host.

In the present investigation, we have employed the single -beam z-scan technique,using Q-switched Nd:YAG laser (Spectra Physics LAB-1760, 532 nm, 7 ns, 10 Hz)with nanosecond laser pulses to measure the nonlinear optical absorption properties of ZincTellurite glasses .The data are analyzed by using the procedure described by Sheik Bahae *et al.* and the nonlinear coefficients are obtained by fitting the experimental z-scan plot with the theoretical plots. We could observe that the material exhibits reverse saturable absorption. Z scan data is used to study the optical limiting property of the glass. The result shows a significant value of non linear absorption coefficient , which is highly useful in optical limiting applications.

## Chalcogenide glass based nano composite films for photonic applications

Tintu R

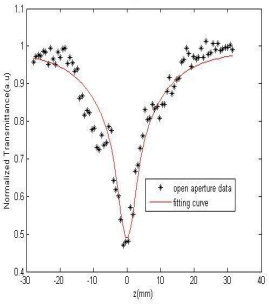
Presently, great interest has been devoted to the fabrication of new materials suitable for photonics applications. Among these, the amorphous chalcogenide structures are of considerable interest due to their effectiveness in nonlinear optical characterization. Nonlinear refractive indices and nonlinear optical absorption coefficients of a number of chalcogenide bulk glasses and thin films have been investigated by several researchers . Most of the optical nonlinear studies were done on thin films prepared by thermal evaporation, sputtering or pulsed laser deposition. Now- a -days, inorganic/polymeric composites have assured importance as a growing class of materials with promising physical and optical characteristics. The realisation of thin films using less conventional techniques such as spin-coating of glassy films from solution is advantageous for realizing large area, thick film, or localized material deposition with less cost. We have developed a low-cost, scalable method to fabricate optical grade composite thin films of chalcogenide glass/PVA(PMMA) for nonlinear optical applications. Optical band gap of the thin films were calculated using Tauc's extrapolation method. The band gap of the nano composite thin films were found to be tunable depending on the grain size of the films. This enables us to realize special requirements by engineering their concentration . The dependence of the grain size of the composite films with concentration of the chalcogenide glass was analysed using AFM .Dispersion of refractive index has been analysed using the Wemple–DiDomenico single oscillator model. Generalized Miller's rule and linear refractivei ndex were used to find the

nonlinear susceptibility and non linear refractive index of thin films. The films show large optical nonlinearity. . The calculated values of non linear susceptibility ($\chi$ (3) ) and non-linear refractive index (n 2 ) shows that they depends on the size of the clusters in the nano colloid chalcogenide glass solution used for the preparation of the composite films. It was shown from the studies that the addition of inorganic semiconductor into the polymer results in fabrication of new composite films with low cost and promising physical and optical characteristics. Nonlinear optical characterisation of samples were studied by the Z-scan technique using an Nd:YAG laser (532 nm, 7 ns, 10 Hz). The *Z*-scan spectra reveal a strong nonlinear absorption depending on the grain size of the films suggesting that the new materials are promising candidates for the development of nonlinear optical devices and are extremely perspective as optical limiters of intense short pulse radiation. The nonlinear absorption coefficient of the prepared composite films were of the same order as that of the bulk glasses. Due to the ease of tailoring and fabrication, we can expect better performance of optical properties through the change in chalcogenide glass concentration.

## Optical Nonlinearity in Lead Iodide Dihydrate

**Rajeena Noufal**

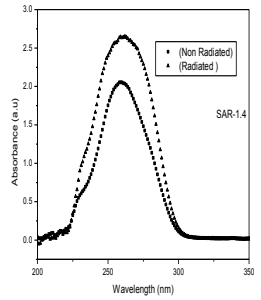
Lead Iodide is a wide band gap semiconductor which exhibit inherent properties such as larger band gap, higher electron mobility and higher breakdown field strength. There fore they are suitable for high power high temperature electronic devices. Nonlinear optics(NLO) have enormous potential applications on the technological front which include optical limiting, optical switching, optical data processing and opto electronic device fabrication. They have also been used as organic semiconductors and bistable devices and a good candidate for making prototype detectors for x-ray imaging . The lead iodide samples were prepared by Sol-gel method and optical limiting performance of the above samples are also investigated. The solution of lead iodide di hydrate shows reverse saturable absorption which makes it suitable for optical limiting applications. The compound prepared appears as deep yellowish luminescent crystals. Solution –phase route may benefit the symmetrical growth of the crystal due to the well proportional chemical driving forces around. In view of the wide bandgap , low vapour pressure and high resistivity, $PbI_2$ detectors are capable of low noise operation at elevated temperatures. The grown crystals have been subjected to single crystal X-ray diffraction studies (XPERT-PRO using k-Alpha 1.54060 $A^0$ (XRDML)). X-ray diffraction studies confirmed that the grown $PbI_2$ crystals have hexagonal structure. Surface morphological study was carried out on the sample under scanning electron microscope (SEM) reveals the hexagonal platelets Materials that exhibit RSA are currently of interest for use in optical limiting devices for protection of sensors and eyes from energetic light pulses. The maximum criteria identified for a material to act as an effective optical limiter are low limiting threshold, large dynamic range, longer excited state life time to accumulate the population, high optical damage threshold, broadband response, fast response time and high linear transmittance. In lead iodide sample optical limiting is due to TPA. The optical limiting studies are carried out at the same concentration of $1.47x10^{-5}$M. $PbI_2$ is a good optical limiter that transmit light at low input intensity while become opaque at high input fluencies.

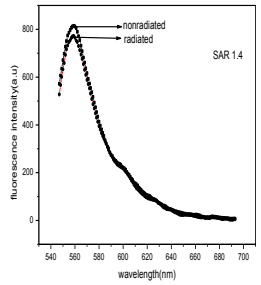



*Open aperture z-scan plot of $PbI_2.2H_2O$ for a concentration of $1.47x10^{-5}$ M*

## Studies on the effect of mobile phone radiation on DNA using laser induced fluorescence technique

**K.Vishnu**




*Absorption and fluorecence spectre spectra of the radiated and non radiated dye doped DNA sample at different SAR value*

The effect of mobile phone radiation on human health is the subject of recent concern and studies, due to enormous increase in mobile phone usage. Mobile phones use electromagnetic radiation in the microwave range, which on prolonged use causes an increase in temperature of the brain and a raise in blood pressure thereby acting on the whole central nervous system. As early as 1981, the WHO was recommending the authorities to restrict the proliferation of electromagnetic waves and ultra-high frequencies.

The present study is aimed at shedding light on the effect of mobile radiation on DNA. The major effect in cells is the breakage of DNA, either one or both strands. However, the latter has much more biological importance. Fluorescence emission from dye doped DNA matrix is very sensitive to structural variation of DNA strand. We have used dye doped aqueous solution of DNA for studying the radiation effects.

The irradiated sample (1hr radiation) shows significant increase in absorption peak .This hyperchromic shift describes an increase in light absorbance at 260nm region. Both native and denatured DNA are capable of absorbing UV light at a wavelength of 260nm due to the aromaticity of nitrogenous bases. However, the stacking of nitrogenous bases in native DNA interferes with UV absorption, resulting in a lower absorbance. Denaturation disrupts such stacking, allowing for more absorbance by the bases. Fluorescence intensity of the radiated sample is found to be decreasing in all cases. By adding dye into DNA molecules it is possible to create an enhanced fluorescence emission. Dyes can be attached to DNA at several locations: intercalated between base pairs, or bound to the minor or major grooves of the double helix. Because of the intercalation or groove binding of dyes in the DNA strand make molecules get isolated from each other thereby reducing the fluorescence quenching caused by aggregation. After irradiation unwinded DNA molecule will release intercalated dye molecule from DNA strand leading to aggregation of dye molecules in medium consequently decreasing the fluorescence intensity.

# IN NEWS……..

♦ **Prof. P Radhakrishnan** gave lectures on Guided Wave Optics in DST-SERC School held at CGCRI, Kolkotha during Feb 7-25, 2011 .

♦ The program ,**Stimulating Teachers Through Advanced Training (STAT)** for college teachers on recent trends in Photonics was held from 2010 Sept. 27 to Oct .01.This program was jointly organized by CUSAT and UGC Academic Staff College , University of Kerala , Trivandrum & sponsored by the Govt. of Kerala .

♦**Prof. P. Radhakrishnan** visited School of Engineering and Physical Sciences, Heriot-Watt University, Einburgh for 2 months (April and May 2010) on a collaborative program

# SPECIAL SEMINARS…….

♦ **9 Sept. 2010** :Introduction to mind control by Ms Deepthi

♦ **16 Sept. 2010**: Nanophotonics by Dr. Zubin Jacob.

♦**17 Sept 2010**: Soft skill development & career guidance by Prof. P. R. Venkataraman.

♦ **14 Oct. 2010**: On certain fundamental problems in particle physics by Sri. V.A Indduchoodan Menon.

♦ **21 0ct. 2010**:Red rain : The evidence of extra terrestrial life? by Dr. Godfrey Louis.

♦ **18 Nov 2010**:Hematite based hybrid nanoarchitectures for photoelectric water splitting by Mr. Debajeet Kumar Bora.

♦ **6 Jan 2011**: Dressing up nanoparticles for biomedical applications by Mr. Varun K.A Sreenivasan.

♦ **10 Jan 2011**: Introduction to MEMS by Dr. V . Natarajan.

♦ **22 Feb 2011**: Light emitting liquid crystals by Dr. Somanathan Narayana Sastri.

# NEW DOCTORATES FROM ISP

**Dr. Jijo P.U** has received his PhD for the thesis titled "Nonlinear Dynamics of multiple quantum well lasers chaos and multistability" . He has completed his doctoral work under the guidance of Prof. V.M Nandakumaran.

**Dr. P.M Radhakrishnan** has received his PhD for the thesis titled ""Speech Analysis using modern Nonlinear Techniques". He has completed his doctoral work under the guidance of Prof. V P N Nampoori.
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**Dr. Manu P. John** has received his PhD for the thesis titled " "Studies on the e ect of randomness on the synchronization of coupled systems and on the dynamics of intermittently driven systems" He has completed his doctoral work under the guidance of Prof. V.M Nandakumaran

**Dr. Lyjo. K. Joseph** has received his PhD for the thesis titled ""Optical and Thermal Characterization of Dye Intercalated Montmorillonites and Rare earth doped materials" He has completed his doctoral work under the guidance of Prof. P Radhakrishnan and VP.N. Nampoori

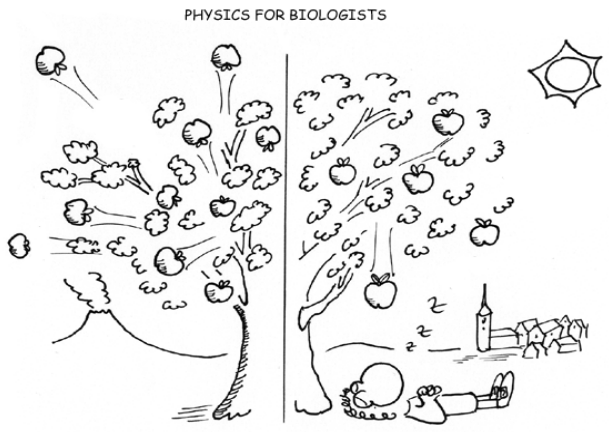
# PUBLICATIONS FROM ISP

- "Photoinduced changes in optical properties of Ga–Sb–Ge–Se glasses" R.Tintu , V.P.N. Nampoori, P. Radhakrishnan, Sheenu Thomas ; Optics Communications 284 (2011) 222–225.
- " Nonlinear optical studies on nanocolloidal Ga–Sb–Ge –Se chalcogenide Glass" R.Tintu, V. P. N. Nampoori, P. Radhakrishnan, and Sheenu Thomas; Journal of Applied Physics 108, 073525 (2010).
- " Preparation and optical characterization of novel Ge–Se–Sb/PVA composite films for optical limiting application", R. Tintu , V.P.N. Nampoori, P. Radhakrishnan, Sheenu Thomas ; J. Phys. D: Appl. Phys. 44 (2011) 025101.
- "Ge28Se60Sb12 /PVA composite films for photonic applications" R Tintu, K Sulakshna ,K Saurav, V P N Nampoori, P Radhakrishnan and Sheenu Thomas ; Journal of Non-Oxide Glasses Vol. 2, No 4( 2010) p. 167- 174
- "Effect of deoxyribonucleic acid on nonlinear optical properties of Rhodamine 6G- polyvinyl alcohol solution" B. Nithyaja, H. Misha, P. Radhakrishnan, and V. P. N. Nampoori; Journal of Applied Physics 109, 023110 (2011)
- "Shifting of Fluorescence Peak in CdS Nanoparticles by Excitation Wavelength Change" S. Mathew & Santhi Ani Joseph & P. Radhakrishnan & V. P. N. Nampoori & C. P. G. Vallabhan ; Journal of Fluorescence, DOI: 10.1007/s10895-011-0833-3
- "Non linear Optical Characterization of erbium doped Ge- Sb- Se thin films." R. Tintu , V.P.N. Nampoori, P. Radhakrishnan, Sheenu Thomas; Discourse - Science (In press)
- " A microring multimode laser using hollow polymer optical fibre". M kailasnath, VPN .Nampoori,P.Radhakrishnan, Pramana; Journal of Physics, Vol.75,No.5, 2010, 923-927.
- "Spectral and Nonlinear Optical Characteris tics of ZnO Nanocomposites" Litty Irimpan,; V P N Nampoori; and Radhakrish- nan, P. Sci. Adv. Mater. 2010, Vol. 2, No. 2
- "Automatic Redeye correction Algorithm with Multilevel Eye Confirmation" Sony George, Jon Y. Hardeberg, Tomson G. George, V.P.N. Nampoori; Journal of Imaging Science and technology, Vol. 54, No.3 (2010)
- "Students Chapter in Universities: Their Role in the School Level Technology Enabled Science Education." Praveen Cheriyan Ashok, V.P.N Nampoori; Educational Quest, Vol. No. 1.1,(33-37)(2010)

# SPIE STUDENT CHAPTER ACTIVITIES

**Optics Fair 2010:** The most popular student outreach program of the chapter Optics Fair 2010 was held on the 17th and 18th of December 2010.Students from several schools across the city participated in the two day event. The fair was divided into four sections: Kid section (class4 to 7), High school section (class 7 to 10), Higher secondary section (11th and 12th) and General section. The main idea behind this fair was to take optics to the masses. The 4th version of Optics kit with some new experiments was also released during the event. We received an overwhelming response from the students as well as the teachers.

**Optics to School :** The motto of the chapter has always been to spread the wonder of Optics around especially to the underprivileged. With this in mind the chapter members organized its 'Optics to School' program in a school for tribal students on 22nd February 2010. The chapter members spent an entire day demonstrating experiments and explaining the optics behind them to about 150 students of the school. The basic optics behind interference, polarization, diffraction etc was explained to the students along with demonstrating the same.



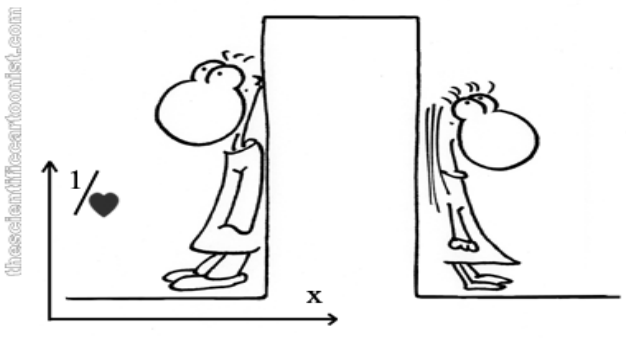

A long time ago the apple trees used to shoot the apples in all directions. Only those that did it downward got reproduced. Then, after millions years of natural selection and evolution, gravity was finally discovered.

**Thursday Seminars**: Students and research scholars from ISP and CELOS also took seminars on different topics. These seminars have proved to be of great help for both students and the audience. The purpose behind conducting this program is to enhance the interactive skills among the students.

**The Industrial tour :-** The chapter has organized a tour to NeST (a premier company of Photonics) to get familiar and feel the industrial work going in different R & D areas in Photonics. They had an interactive session with engineers . It was held with the co-operation of NeST Photonics.

**Trip to Sangamagram:-**There was a trip organized by the chapter to Sangamagramam (means "the village of Confluence" in Sanskrit) the ancient knowledge hub of Mathematics & Astronomy. It is belived to be the home of Kerala Astronomy & Mathematics founded by Madhava (the great mathematician –Astronomer)

**Optics Kit**: The fourth Edition Optics Kit was released during Optics fair 2010. Some new experiments were added to make it more attractive. The overwhelming response to the third edition has only increased the expectation from the next optics kit team. We have been regularly receiving enquiries about the latest version of Optics Kit form various Institutions across India.




Waiting for the tunnel effect.

The International School of Photonics was established on February 27, 1995 . Within its 16 years old existence, ISP has become one of the leading research centres of the country in the field of Optics and Photonics. The Department has produced ,many talents through various courses such as MTech. in Optoelectronics and Laser Technology and Phd. Degrees in Photonics and related fields.

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