

# PHOTONICS NEWS

Bulletin from the International School of Photonics

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## ISP to start MPhil in Photonics

**International School of Photonics of Cochin University of Science & Technology is going to offer MPhil degree course in Photonics from the year 2001 with an objective to train teachers in the area of Photonics.**

The proposed new course has a relevance since most of the colleges in Kerala offer Optoelectronics as one of the optional papers for graduate level course in Physics. The two semester course of one year duration has a unique curriculum structure. Apart from two core papers



*Workshop on New Frontiers in Teaching and Learning Methodology in Science Education at College level – a group discussion in progress.*

related to Photonics, one paper is devoted to a course on Teaching and Learning Methodology in Science Education at UG / PG levels.

The curriculum of the course was framed with the help of the Continuing Education Department of the Eindhoven University of Technology ( EUT), the Netherlands and Institute of Technical Teachers Training, Bangalore, India. The structure of the course was framed during a two-day workshop held at CUSAT during August 2000. The course structure was finalised during the technical discussions held at EUT during September 2000. The course is designed in such a manner that the students will be exposed to latest techniques in Educational Technology including Web learning and the use of multimedia in designing the course materials. As a part of the course, each student has to develop a course in science which is to be tested in real life situations.

The MTech students of OE & LT of ISP also will have a paper on non-technical course namely, Industrial Management.

## ISP and International Collaboration

### Indo-Dutch Colloquium on Low Dimensional Structures -- A report

**The Indo – Dutch Colloquium held during October 10-11, 2000 at ISP highlighted the increasing role played by quantum dots and quantum well structures in the future development of Communication and Computing Technology.**

The International School of Photonics (ISP) has established several collaborative research

activities with a number of academic and research institutions abroad. Most important among these is the academic tie up with the Eindhoven University of Technology (EUT) in Holland. The Netherlands government is offering major financial assistance for strengthening the activities of ISP under the Program of International Co-operation in Higher Education (MHO).

Ms. Priyamvada, an M.Tech student of ISP is currently doing her project at EUT in the field of Quantum dots under the Tinbergen scholarship.

## Photonics News

### ***From the Editor's Desk:***

*International School of Photonics (ISP) is entering its seventh year of existence. Within such a short span of time, the School has justified its existence through activities in various fields like man-power training, in-service courses and R&D activities. A number of its alumni are working in various R&D and academic institutions all over the world.*

*ISP with the help of EUT, Netherlands and ITTT, Bangalore has developed an MPhil course in photonics. A unique feature of the course is the introduction of a paper on Teaching and Learning Methodology in Science Education at College level. We are thankful to Dr Mark de Graaf and Dr Harry Wou of EUT and Dr Arunkumar of ITTT for their valuable help rendered during the designing of the course. MTech students of ISP will also have to study a paper on Industrial Management from the year 2001 onwards.*

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*Photonics is going to be the trademark of the 21<sup>st</sup> century. Lot of effort in terms of manpower development and R&D activities are being invested in this area by many countries like USA, UK, Japan and Holland. India has not yet entered in this field wholeheartedly. CUSAT took an early lead in this direction by establishing the International School of Photonics. Apart from the manpower training and R&D activities, this School should also act as one of the nucleating centres for the growth of Photonics in India. Already, there exist clear indications of ISP influencing the activities of some of the industries and national laboratories through collaborations and interactions. At present the activities of ISP are hindered due to lack of space and manpower. In the near future, ISP will be shifting to an independent building of its own. Through strong interactions with other institutes all over the world, the activities of ISP will be more visible in the coming years.*



*Dr Jos Haverkort of EUT inaugurates the Indo – Dutch Colloquium. Dr V M Nandakumaran, Director of ISP is also seen in the picture.*

Under the MHO programme, ISP and EUT jointly organized a colloquium on “Low Dimensional Structures” at ISP to discuss the state of the art in the technology of quantum dots and quantum wells. About fifty participants attended the colloquium.

Dr Jos Haverkort and Dr Andrei Silov from EUT, Dr K L Narasimhan from TIFR, Dr C Vijayan from IIT, Madras and Dr Abdulkhader from Kerala University led the discussions on various aspects of the subject. Mr B Aneeshkumar and Mr R Prasanth presented their latest findings in the field of QW structures. Both are doing their PhD at EUT deputed from ISP.

The colloquium recommended a close-knit network of photonics-related research in India. Institutions like ISP can take a lead in this respect.

## Conference News

### Workshop on Nonlinear Optics WONLOP -2001

Nonlinear Optics is an important field of R & D studies in the area of Photonics. Photonics based switching, development of optical computing and

development of a variety of photonics based devices is becoming a reality due to the nonlinear interaction between light and matter. ISP is organizing a National Workshop on “Nonlinear Optics and its Applications” during 27-28 February 2001. Tutorial lectures on various

aspects of NLO will be covered during the workshop. Details can be had from

**Dr P Radhakrishnan, Coordinator, WONLOP-2001, International School of Photonics, CUSAT, Cochin – 22.**

## We hear that...

**...then they said, “Halt”, and light stopped!!!**

Two independent teams of physicists ( Dr Hau et al of Harvard University and R Alworth et al of Harvard –Smithsonian Centre for Astrophysics) have found a technique to slow down light to dead stop, store it and release it as if it were an ordinary material particle. They used a technique called electromagnetically induced transparency in absorptive media like Rb vapour.

In the reported experiment, a light pulse is effectively decelerated and trapped in the Rb



*Let me hoard it to create a total darkness at noon!*

vapour, stored for a controlled period of time, and then released on demand. They accomplished this “ storage of light” by dynamically reducing the group velocity of light pulse to zero, so that the coherent excitation of the light is reversibly

mapped into a Zeeman ( spin) coherence of Rb atoms.

The process can be narrated as follows:

1. Two beams of light (signal beam and coupling beam) strike a vapour of Rb atoms, altering them so that they do not absorb light as they normally would.
2. The signal beam imprints a pattern in the spin orientation ( by Zeeman effect) of Rb atoms
3. As the coupling beam is turned off, the signal beam slows to a halt and virtually disappears.
4. As the coupling beam is turned on, the signal beam appears back and come out of the cell as though nothing has happened!!

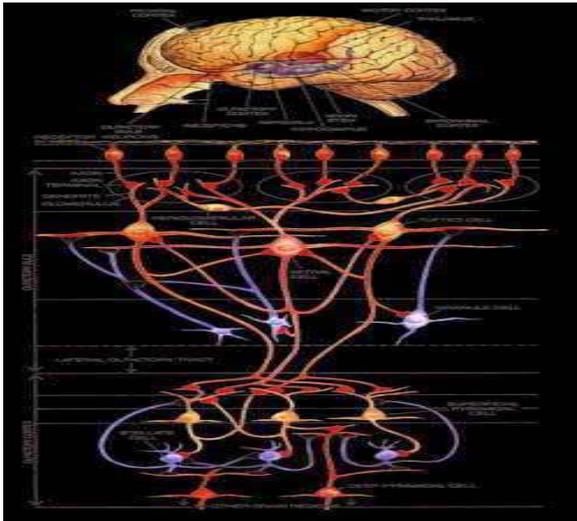
The nondestructive nature of the light storage technique makes it an attractive candidate for potential applications in coherent communication between distant quantum mechanical systems and teleportation . (Storage of light in atomic vapour, Philips et al, PRL 86(5) 29 Jan 2001)

## Neutron flashes may forecast earthquakes

Two Russian scientists, N Volodichkov and M Panasjuk noticed that earthquakes are heralded by bursts of neutrons from the earth’s surface and could be linked to the lunar cycle. They measured the levels of neutron emission in the Pamir mountains in Tajikistan – a seismically active region where Indian and Eurasian tectonic plates meet - and noticed that the neutron bursts are at their greatest when the sun, moon and the earth line up (new moon or full moon day). This led

them to believe that the tidal stress on the earth's crust opens up fissures through which radioactive gases and particles can escape. The radioactive materials quickly decay, emitting alpha particles and neutrons.

The researchers analysed data collected over the last 28 years from the Pacific 'ring of fire' and found that the most severe earthquakes took place around the time of a new moon or a full moon day. This discovery of neutron flashes could form the basis of a new system for forecasting earthquakes. (*Physics Web February 2001*)



### ***Laser light taps the neuron communication***

Researchers from Oregon Health Sciences University have viewed more clearly than ever the processes leading to communication between nerve cells and have observed vesicles carrying chemicals, known as neurotransmitters, to the cell surface before releasing them. These neurotransmitters carry information to the next neuron every time a neuron fires. Laser induced fluorescence creates images of vesicles which appear as points of increasing brightness when

neurons receive stimulation. For the first time, scientists could see the membrane in response to a stimulus. (*Biophotonics, November 2000*)

### ***Quantum size effects squeeze laser light from Silicon***

One of the problems faced by photonics technology is that semiconductor lasers cannot be easily fabricated on silicon chips. This is because gallium arsenide, the current material for diode laser fabrication, does not stick to silicon. Lorenzo Pavesi and his group from University of Trento, Italy have recently provided the breakthrough. They were able to generate laser like light emission from silicon exploiting "quantum size effects".

Silicon's ability to emit light can be enhanced by cutting it into very small pieces. When the material is shaped into wires or sheets of few nanometres thick, it starts emitting light when stimulated electrically. Thus the Italian physicists have taken a crucial step towards the creation of a silicon laser (*Nature, November 2000*)

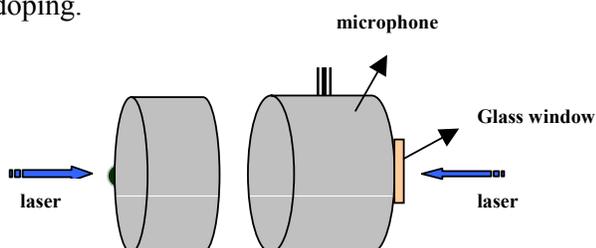
## **From ISP Labs...**

### **Devices for Optical Communication**

With the increasing applications of photonic devices in the field of communication, research programme on low dimensional structures has been initiated as a collaboration work between ISP and EUT. Studies on design and fabrication of quantum well structure for optical switches, modulators and amplifiers are being carried out. The group has designed a structure that exhibits high blue shift in optical absorption under linear Quantum Confined Stark Effect. This structure is expected to have applications in SEED. This is a collaboration programme under ISP-MHO project.

## Laser Applications

The work currently being carried out in this field is generally related to studies on photothermal effect and non-linear optics. Experimental set up has been perfected for making accurate measurements of optical and thermal properties of materials using photoacoustic technique. One of the recent measurements carried out using the above mentioned technique is the study of thermal behaviour of phase transitions of a set of liquid crystals. An open photoacoustic configuration adopted in this context appears to be well suited to explore the properties of very delicate materials like liquid crystals. These measurements are also extended to semiconductor materials such as GaAs and InP under different conditions of doping.



### *Photoacoustic Cell designed by the ISP group*

Another approach to the evaluation of thermal and optical properties of materials especially those of liquid sample is to use thermal lens technique. Usually we adopt a double beam thermal lens configuration to reduce noise and other spurious signals. A recently completed study using this method is related to the energy transfer in dye solutions. Thermal lens measurement appears to point out to some new mechanism for energy transfer in dye mixtures.

Nonlinear materials are also equally important in photonics research. We are interested in preparing and studying the optical properties of some nano-structure materials. Samples containing nano particles in PMMA and PVA

have been prepared and their non-linear optical properties are under investigation.

A new impetus for the study of nonlinear optics has been given by the installation of a Spectra Physics make MOPO. This new laser source is capable of giving pulsed tunable output from 400 nm – 2000 nm. The parametric amplifier section in this instrument is pumped by 800 mJ Nd:YAG laser. The group plans to undertake a number of nonlinear optical studies using the new laser source.

## Investigations in the area of Fibre Optic Sensors

The first thesis from the International School of Photonics in the area of fibre optic sensors entitled “Evanascent Wave Fibre Optic Sensors: Design, Fabrication and Characterisation” was submitted by Mr. Shelly John M during 2000. This thesis discusses the design and development of fibre optic sensors to determine the deposition rate of thin films, to measure glucose concentration and to detect nitrogen dioxide gas. The sensor work relating to the detection of nitrogen dioxide gas was carried out using uncladded fibres coated with metal phthalocyanines as the sensor element. The results of these investigations were presented at the International Conference on Fiber Optics & Photonics held at Calcutta during Dec 18-20, 2000. Another interesting work in this area was the development of a fibre optic pH sensor with dye-doped multi-layer sol-gel coatings. This work was also presented at the same conference.

Design and development of fibre optic sensors to detect ammonia, dissolved oxygen and common water contaminants were also initiated during this period. Sensors based on hollow-core fibres and fibre bragg gratings will be taken up in the near future.

Presently there are 3 research students working in the area of Fibre Optic Sensors. A project with a funding to the tune of Rs. 10 lakhs was sanctioned by AICTE to Dr. P Radhakrishnan of this School for the development of FO sensors to measure contaminants in water and to detect air pollutants.

### Synchronisation of Semiconductor Lasers

Synchronisation of two directly modulated semiconductor lasers with bidirectional coupling was numerically studied for various coupling strengths  $C$ . The synchronisation depends on the strengths of the coupling. Numerical results indicate that as  $C$  is increased the coupled system achieves synchronisation as well as stability together with an increase in the output power. The effectiveness of the synchronisation depends on the strength of  $C$ . For lower values of  $C$  the system does not regain synchronisation after it is perturbed from the synchronised state. However, for higher values of  $C$ , the synchronisation is quite stable.

### Time Series Analysis, Neural network and Chaos

Another field of work undertaken by the research group of ISP, is the application of nonlinear time series analysis for real physiological data like electroencephalogram (EEG). The studies model neural system with special reference to various pathological conditions of brain by introducing a parameter called coherence index. Theoretical model of complex systems is being worked out by introducing multi-path coupling between a number of nonlinear systems. One PhD thesis entitled "Nonlinear signal processing of EEG: Application in the study of Neurodynamics" by Mr P Indic has already been submitted to CUSAT.

### New Additions to the ISP Lab

Nd:YVO<sub>4</sub> Laser



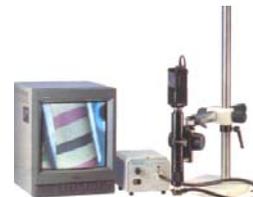
Optical Parametric Oscillator



Spectrophotometer



CCD based image scanner



### Awards / Recognitions

- Prof. C P Girijavallabhan has been elected as the Vice President of Indian Laser Association for the second time.
- The paper entitled "*Dynamics of the Ambient Molecules During Laser Ablation of a Solid Target*" by Pramod Gopinath, Binoy Paul, K P Unnikrishnan, V.P.N.Nampoori and C.P.G. Vallabhan, presented by Pramod Gopinath fetched the 2<sup>nd</sup> best paper award in the **PLASMA-2000**, 15<sup>th</sup> National Symposium on Plasma Science and Technology, Saha Institute of Nuclear Physics, Calcutta held during Dec 5-8, 2000.

### Seminars by Visitors

1. Dr Pramod Pratap, North Carolina State University, USA  
*Thermodynamics of Na-K Pump*  
20<sup>th</sup> July, 2000

2. Prof. R Unnikrishnan, Head, Dept. of Electrical Engineering, Rochester Institute of Technology, New York.  
*Distance education in the IT Age*  
30<sup>th</sup> Aug, 2000
3. Dr. S S Harilal, Ruhr Universitaat, Bochum, Germany  
*Soft X-ray Diagnostics of Colliding Laser Produced Plasmas*  
25<sup>th</sup> October, 2000
4. Dr. P S Anilkumar, University of Twente, Netherlands  
*Spin Valve Transistors*  
23<sup>rd</sup> November, 2000.
5. Dr. Riju C Issac, University of Strathclyde, UK  
*Intense Laser/Solid Interaction & X-ray Generations*  
4<sup>th</sup> January, 2001.

### Conferences organised by ISP during the year 2000

1. *Industrial & Medical Applications of Lasers - Feb 2000*
2. *Indo - Dutch Colloquium on Low Dimensional Structures - Oct 2000*
3. *Workshop on new frontiers in teaching and learning methodology in science education at college/university level - Aug 2000.*

### Looking into the Future

In the years to come ISP has a number of projects and programmes on anvil. R&D activities are envisaged in optical computing, optical neural network and the development of photonic devices for communication and sensor technology.

A programme involving interaction between scientists and technologists working in

India in the area of photonics is envisaged in the next year. The project which includes academic exchange programme will develop a network of interactions between ISP and various institutions like IITs, Raman Research Institute and Tata Institute of Fundamental Research.

A student-attachment programme is also planned in which selected students of UG/PG classes will be given opportunities to work in the ISP lab during summer period.

### In the limelight...

**Prof C P Girijavallabhan, Prof V M Nandakumaran, Prof V P N Nampoori and Prof P Radhakrishnan** visited EUT under the academic exchange programme of ISP-MHO project.

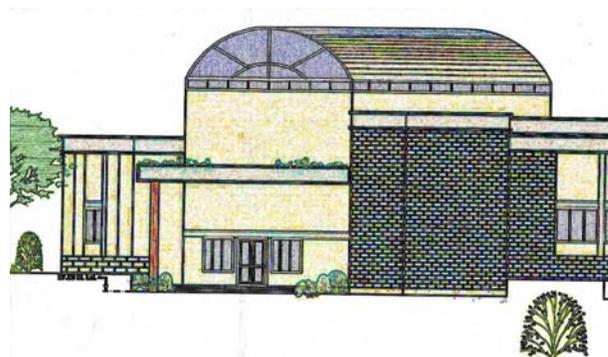
**Dr. Shelly John M**, former Ph.D student of ISP, has taken up position as a Post Doctoral Fellow in the **Nanyang Technological University, Singapore.**

**Mr. P Indic**, research scholar of ISP, who has submitted his Ph.D thesis has received Post Doctoral Fellowship to work in **Biomathematical Modeling Unit, Harvard University, USA.**

### Some of the recent publications from ISP

1. Dynamics of two coupled chaotic multimode Nd:YAG lasers with intracavity frequency doubling crystal.  
Thomas Kuruvilla and V M Nandakumaran,  
*PRAMANA-J.Phys.*,54, pp393-402(2000).
2. Cortical dynamics and phase synchronization during meditation.

- V P N Nampoore, P Indic, N Pradhan, R Pratap, R Sreenivasan,  
*Special issue of Indian National Science Academy on Non-linear Phenomenon, pp395(2000).*
3. Numerical studies on bi-directionally coupled directly modulated semiconductor lasers.  
V Bindhu and V M Nandakumaran.  
*Phys.Lett.A,277, pp345-351(2000).*
  4. Use of photoacoustic effect for the detection of phase transitions in liquid crystal mixtures.  
Nibu A George, C P G Vallabhan, V P N Nampoore and P Radhakrishnan  
*J.Phys.D: Appl.Phys,33, pp3228-3232(2000)*
  5. Photoacoustic investigations of the effect of excess lead oxide on thermal diffusivity of PLZT ceramic.  
N A George, T Paul, P Radhakrishnan, V P N Nampoore,  
C P G Vallabhan, and M T Sebastian.  
*J.Mat.Sci.Lett,19, pp499-501(2000).*
  6. Physical and optical properties of phthalocyanine doped inorganic glasses.  
G A Kumar, J Thomas, N A George, N V Unnikrishnan, P Radhakrishnan,  
V P N Nampoore and C P G Vallabhan.  
*J.Mat.Sci,35, pp2539(2000).*
  7. Optical absorption studies of free (H<sub>2</sub>Pc) and rare earth (RePc) phthalocyanine doped borate glasses.  
G A Kumar, J Thomas, N A George, N V Unnikrishnan, P Radhakrishnan,  
V P N Nampoore and C P G Vallabhan.  
*Phys.Chem.Glasses,41, pp89(2000).*
  8. Spectral studies of naphthalocyanine (Nc) and rare earth phthalocyanine(RePc) molecules in an inorganic glassy borate matrix.  
G A Kumar, J Thomas, N A George, N V Unnikrishnan, P Radhakrishnan,  
V P N Nampoore and C P G Vallabhan.  
*Phys.Chem.Glasses,41, pp199(2000).*
  9. Experimental investigation of optical limiting and thermal lensing in toluene solutions of C-70.  
C V Bindhu, S S Harilal, V P N Nampoore and C P G Vallabhan  
*Appl.Phys.B, 70, pp429(2000).*
  10. Fading of thermoluminescence from CaS and CaS:Ce phosphors.  
James Joseph, T R Ananthakrishnan, V P N Nampoore, M K Rudrawarier  
*Ind.J.Pure and Appl.Phys.74 A, pp21(2000).*
  11. Photoacoustic evaluation of the thermal effusivity in the isotropic phase of certain comb-shaped polymers.  
Nibu A George, C P G Vallabhan, V P N Nampoore, A K George and P Radhakrishnan.  
*J.Phys.Cond.Matter,13, pp365-371(2001)*
  12. Open cell photoacoustic investigations of the thermal effusivity of liquid crystals.  
N A George, C P G Vallabhan, V P N Nampoore, A K George and P Radhakrishnan.  
*Optical Engineering (In press).*



*Photonics Building nearing completion*

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**And the last word....**

*When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong.*

**Arther C Clarke**