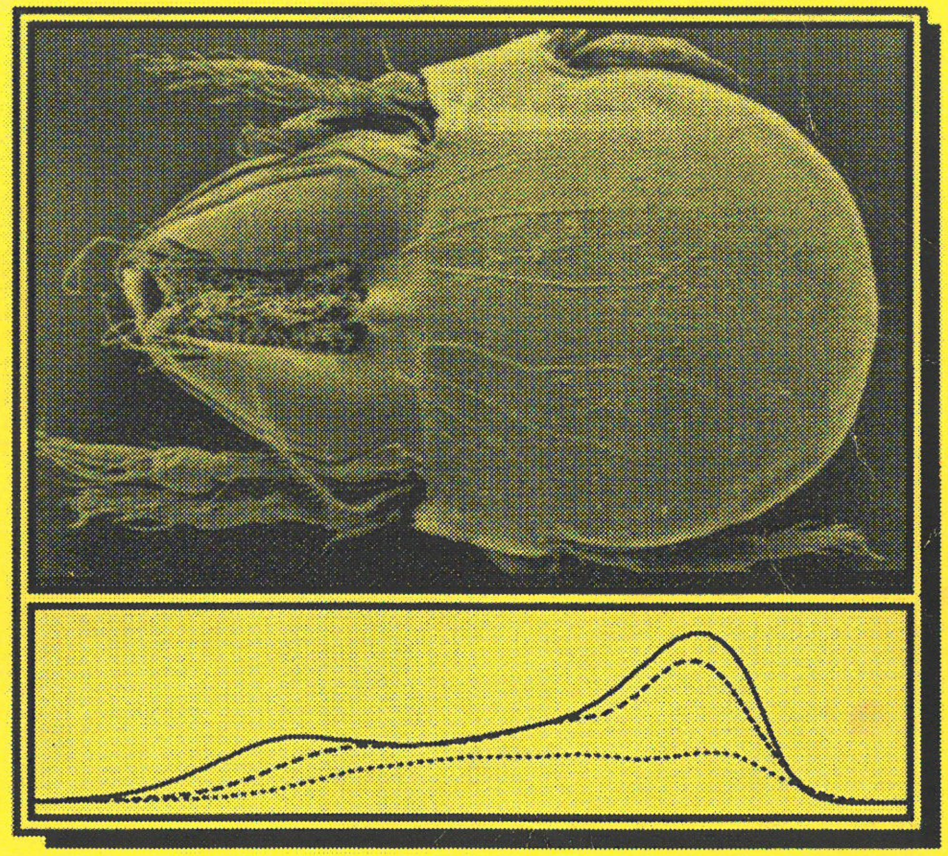
Australian Optical Society

NEWS



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AOS NEWS

COVER:
Electron micrograph of a soil mite, approximately 0.5 mm in length. The inset shows reflectivity scans along the back of a similar mite obtained at three different wavelengths (633 nm, 488 nm and 514 nm). Researchers at Macquarie University hope to use this information to identify different species in a non-contact, rapid and automatic routine as a part of their work in biodiversity. (Micrograph - Graham Osler, Centre for Biodiversity and Bioresources; Wavelength scan - Mark Gauci, Centre for Lasers and Applications, and the Microscopy Unit, School of Biological Sciences. All at Macquarie University).

SUBMISSION OF COPY:
Contributions on any topic of interest to the Australian optics community are solicited, and should be sent to the Editor or one of the Associate Editors. Use of electronic mail is encouraged, or else submission of hard copy together with an ASCII text file on floppy disk.

Where possible, diagrams should be contained within the document or sent as separate encapsulated post-script files. Figures on A4 paper will also be accepted.

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EDITOR
Duncan Butler
CSIRO Tel. & Ind. Phys.
PO Box 218
Lindfield NSW 2070
Tel: (02) 9413 7302
Fax: (02) 9413 7200
Email: duncanb@dap.csiro.au

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ARTICLES

DEPARTMENTS

AOS News is the official news magazine of the Australian Optical Society. The views expressed in AOS News do not necessarily represent the policies of the Australian Optical Society.

EDITOR - *Duncan Butler*
CSIRO Div. Telecomm.& Ind. Phys.
PO Box 218, Lindfield NSW 2070
Tel: (02) 9413 7302
Fax: (02) 9413 7200
duncanb@dap.csiro.au

ASSOCIATE EDITORS

QUANTUM OPTICS
Barry Sanders
School of MPCE
Macquarie University
Tel: (02) 9850 8935
Fax: (02) 9850 8983
barry@sanders.mpce.mq.edu.au

QLD
Halina Rubinsztein-Dunlop
Department of Physics
University of Queensland 4069
Tel: (07) 336 53412
Fax: (07) 365 1242
halina@kelvin.physics.uq.oz.au

NSW
Judith Dawes
School of MPCE
Macquarie University
North Ryde NSW 2109
Tel: (02) 9850 8903
Fax: (02) 9850 8983
judith@mpce1.mpce.mq.edu.au

Martijn de Sterke
Department of Theoretical Physics
University of Sydney NSW 2006
Tel: (02) 9351 2906
Fax: (02) 9660 2903
desterke@physics.su.oz.au

VIC
Chris Chantler
School of Physics
University of Melbourne
Parkville VIC 3052
Tel: (03) 9344 5437
Fax: (03) 9347 4783
chantler@physics.unimelb.edu.au

ACT
Ken Baldwin
Laser Physics Centre
Research School of Phys. Sci. and Eng.
ANU, Canberra ACT 0200
Tel: (06) 249 4702
Fax: (06) 249 0029
Kenneth.Baldwin@anu.edu.au

AOS COUNCIL (1996/7)

PRESIDENT
Brian Orr
School of Chemistry
Macquarie University
Sydney NSW 2109
Tel: (02) 9850 8289
Fax: (02) 9850 8313
brian.orr@mq.edu.au

VICE-PRESIDENT
Halina Rubinsztein-Dunlop
Department of Physics
University of Queensland, QLD 4069
Tel: (07) 336 53412
Fax: (07) 365 1242
halina@kelvin.physics.uq.oz.au

SECRETARY
Clyde Mitchell
CSIRO Div. Mat. Science and Tech.
Private Bag 33,
Clayton South MDC, Vic. 3169
Tel: (03) 9542 2942
Fax: (03) 9544 1128
mitchell@mst.csiro.au

TREASURER
Esa Jaatinen
CSIRO Div. Telecomm.& Ind. Phys.
PO Box 218, Lindfield NSW 2070
Tel: (02) 9413 7269
Fax: (02) 9413 7200
esaj@dap.csiro.au

PAST PRESIDENT
Chris Walsh
CSIRO Div. Telecomm.& Ind. Phys.
PO Box 218, Lindfield NSW 2070
Tel: (02) 9413 7156
Fax: (02) 9413 7200
cjw@dap.csiro.au

COUNCILLORS

Jesper Munch
Dept. of Physics and Maths
University of Adelaide
GPO Box 498
Adelaide SA 5001
Tel: (08) 303 4749
Fax: (08) 232 6541
jmunch@physics.adelaide.edu.au

Ken Baldwin
Laser Physics Centre
Research School of Phys. Sci. and Eng.
Australian National University
Canberra ACT 0200
Tel: (06) 249 4702
Fax: (06) 249 0029
Kenneth.Baldwin@anu.edu.au

Kieran Larkin
Department of Physical Optics
School of Physics
University of Sydney
NSW 2006
Tel: (02) 9351 3941
Fax: (02) 9351 0923
larkin@physics.usyd.edu.au

Chris Chantler
School of Physics
University of Melbourne
Parkville VIC 3052
Tel: (03) 9344 5437
Fax: (03) 9347 4783
chantler@physics.unimelb.edu.au

Ann Roberts
School of Physics
University of Melbourne
Parkville VIC 3052
Tel: (03) 9344 5038
Fax: (03) 9347 4783
annr@muon.ph.unimelb.edu.au

Peter Farrell
Optical Technology Research Laboratory
Department of Applied Physics
Victoria University
PO Box 14428, MCMC Melbourne
Tel: (03) 9688 4282
Fax: (03) 9688 4698
peterf@dingo.vut.edu.au

Lew Whitbourn
CSIRO DMST Optical
Systems Engineering
Private Bag 33, Rosebank MDC,
Clayton VIC 3169
Tel: (03) 9542 2948
Fax: (03) 9544 1128
lbw@dap.csiro.au

CORPORATE MEMBERS

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AUSTRALIAN OPTICAL SOCIETY
MINI-SYMPOSIUM

"CURRENT TOPICS IN OPTICS"

and Annual General Meeting 1997

Friday 2 May 1997, commencing at 3 p.m.

Macquarie University, Sydney 2109

Theatre E6A 102
(off Eastern Road, near Herring/Waterloo Road entrance)

The Australian Optical Society has organised a topical symposium on the same afternoon as its 1997 Annual General Meeting (see accompanying notice and agenda). Three leading opticists from the Sydney area have agreed to talk about their optical research interests, from basics to frontiers.

The programme of the afternoon is:

3.05 pm	Welcome & introduction (Professor Brian Orr, AOS President)
3.10 pm	"Nonlinear optics in gratings" Dr Martijn de Sterke (University of Sydney)
3.50 pm	Annual General Meeting of the Australian Optical Society (see accompanying notice and agenda overleaf)
4.10 pm	Refreshments
4.30 pm	"Optics in timekeeping" Dr Peter Fisk (CSIRO Division of Applied Physics)
5.10 pm	"Asymptotics for optics" Professor Greg Forbes (Macquarie University)
5.50 pm	Close of symposium
6.30 pm	Dinner at a local restaurant (optional)

There will be no registration fee for this symposium, but a parking fee is likely to be charged for entry to the Macquarie University campus.

How to get there:
Enter by the Herring/Waterloo Road entrance to the campus (near Macquarie Centre); parking areas E1, E3, E4, F3 and F5 are all conveniently located; theatre E6A 102 is on the ground level of the foyer at the north-west corner of the (relatively new) E6A building on Eastern Road.

Enquiries:
Professor Brian Orr (02-9850-8289 / brian.orr@mq.edu.au)

AUSTRALIAN OPTICAL SOCIETY

Notice of Annual General Meeting

The 1997 Annual General Meeting of the Australian Optical Society will be held at 3.50 p.m. on Friday 2 May, 1997 in E6A 102 at Macquarie University, Sydney.

AGENDA

1. Apologies
2. Agenda
3. Minutes of previous meeting
4. Business arising
5. President's report
6. Treasurer's report
7. Election of councillors and office bearers
8. Any other business

Members unable to attend this meeting are encouraged to complete the proxy nomination form below and submit it to the President or Secretary well before the meeting. This will ensure that your vote on important matters is counted.

Australian Optical Society Annual General Meeting 1997

PROXY NOMINATION FORM

I, ... [print name] being a member of the Australian Optical Society hereby appoint
.... [print name] of
.... as my proxy to vote for me and on my behalf at the general meeting of the Society to be held on Friday 2 May 1997 and at any adjournment thereof.

....SIGNED

this .... day of .... in the presence of:

....[witness]

Optical Guided Waves and Applications

The **Australian Photonics Cooperative Research Centre** is holding a meeting on **Optical Guided Waves and Applications** at the ANU, 9-11 July 1997. This meeting is open to all researchers working in the any area of theory, experiment or application. There will be a small number of invited talks covering fibre gratings, fibre sensors, photorefractive effects and nonlinear devices.

Further details can be obtained from :
Helen McMartin
Tel (06) 249 0693
Fax (06) 249 0029
e-mail: hjm111@rsphysse.anu.edu.au.

1997 Postgraduate Student Prize

The Australian Optical Society is pleased to announce that the winner of this year's prize is **Tanya M. Munro**, a Ph.D. student at the Sir Frank Packer Theoretical Physics Department of the University of Sydney.

There were disappointingly few applications for this year's prize, but there was nothing disappointing about the quality of the applications, and the selection panel had a difficult task in eventually choosing the winner.

Tanya is studying the self-writing of waveguides in photosensitive materials, both theoretically and experimentally. The new method of fabricating channel waveguides is expected to have important applications in optical networks.

The prize will assist Tanya to present her work at the Optical Society of America Fall Topical Meeting, entitled "Photosensitivity and Quadratic Nonlinearities in Guided Wave Optics" to be held in Williamsburg, Virginia, in October. As one of the conditions of the award, she will write a review of this conference for *AOS News*. She also plans to attend the OSA Annual Meeting in Long Beach, California.

We offer Tanya our best wishes for her travel to these conferences and for her future work, and we extend similar wishes to the unsuccessful applicants for the prize, whose work was also of a very high standard.

We urge all eligible postgraduate students working in Australia in any field of optics to consider applying for the 1998 prize. An announcement about this will be made in due course in *AOS News*, and the closing date is likely to be October 1997.

Editorial

Welcome to the *AOS News* in 1997! Firstly, I would like to draw your attention to the announcement of the Annual General Meeting to be held in Sydney as a part of an AOS "mini-symposium" (see p3-4), and also to some preliminary information about the AOS conference to be held in Adelaide in December later this year (see p7).

This issue features an article by the 1996 AOS Medal winner, Dr. Hariharan, on interferometry, as well as an article on photon coincidence spectra and a technical note on laser noise.

Also in this issue I have reproduced the ICO Newsletter for January, 1997 (see p39). The International Commission for Optics, ICO, is an organisation set up to aid with the progress and diffusion of optics on an international basis.

I spent the last quarter of 1996 overseas, and I would like to thank Esa Jaatinen for stepping in to edit the December issue. Having missed the last editorial, I would now like to take the opportunity to thank the associate editors for their assistance, and all those who contributed to the *AOS News* in 1996.

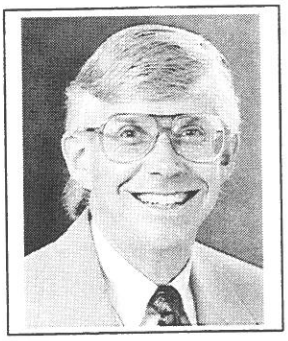
Duncan Butler

President's Report

by Brian Orr

Limits to measurement

As opticists and physicists, most of us will recognise that there is usually a limit to the fineness of any measurement that we make. This can arise, of course, through technological deficiency in our measuring instruments or from fundamental physical constraints, such as the Heisenberg Uncertainty Principle or the diffraction limit of an optical system. There are even times when we have to admit that we can't (or don't know how) to measure some things directly or quantitatively, even though we sense that they exist by inference from experiment or theory.



It is a pity that similar limitations are not widely appreciated by the decision-makers who govern our research funding allocations. In the current climate of economic rationalism and regulatory devices such as "Total Quality Management", an overriding consideration is to have performance measures that can be fed into an accountant's spreadsheet and processed according to formulae that are intended to meet financial targets, but are rarely sensitive to the genuine needs of the tasks ahead.

What can't be measured and fed into the spreadsheet doesn't get counted.

The level of government funding for basic research poses such a problem right now. Those of us in universities and government institutions such as the CSIRO will know what I mean. We spend more time formulating what are perceived as performance measures to be processed by non-scientists than justifying our activities and objectives in real scientific terms. It is clear that we need to be accountable to those (including taxpayers) who provide much of our financial support. Clearly too, this accountability needs to be in terms that can be processed quantitatively and understood at administrative and public-relations levels. The problem seems to be that much of the important information gets filtered out in the process, and what is left does not necessarily give an accurate measure of research performance or key priorities.

Our problem with basic research funding figured in the Council Meeting of FASTS at which I represented the Society last November. We were fortunate to have consultations with Science and Technology Minister, Mr Peter McGauran.* In his remarks, Mr McGauran mentioned that he had recently been congratulated by APEC science ministers on Australia's relatively high OECD ranking (fourth in the world, I recall, according to some set of performance measures) for its basic science output. When asked whether the government was aware of the fragility of Australia's basic research capability in the present harsh economic climate, the Minister's response startled many of us on the FASTS Council. Rather than seeming keen to maintain Australia's high OECD ranking, he suggested that it indicates that Australia is probably doing more basic research than it needs to, and that more emphasis should be placed on support for industry-oriented research. Presumably, this view reflects the current thinking of both the government and their advisers at a time when local industry seems to be winding down much of its R & D rather than encouraging innovative partnerships with basic researchers.

Already, a decline in Australia's scientific performance, based on its share of citations in the international literature, has been addressed by the Australian Academy of Science in its recently released report on "The Impact of Australian Science" - the outcome of an ARC-funded committee study chaired by Dr Keith Boardman. The report also notes "considerable concern" that funding in science and technology per higher-education research scientist had remained constant, despite increased costs. Similar concern about what it takes to do top-class research has also been expressed recently, perhaps with more public impact, by Nobel Laureate and Australian of the Year, Professor Peter Doherty. Moreover, among the "Top Ten Policies" recently released by FASTS (listed in full elsewhere in this issue), there is a specific proposal that "a higher proportion of Government funding for science should be directed to basic science, to underpin future developments in applied science". Other FASTS proposals cover related issues such as career paths for research scientists and the infrastructure needs of research organisations.

And now, at relatively short notice, the government has set up the West and Stocker Reviews to ask questions about higher education and research goals, respectively. Let's hope that they obtain constructive answers!

So what can we in the AOS do to improve the situation? I suggest that each of us should take opportunities to publicise the effects that funding shortfalls would have (or have already had, perhaps) on significant basic research projects. I should be pleased to hear from you in this regard, especially if there are compelling, well documented instances that could be broadcast, either through FASTS or by other means. However, that does not solve the intrinsic problem: we sense intuitively that basic research is essential for Australia's future but how do we convince others (politicians, policy-makers, public opinion, ...) that this is so if our arguments rest on inference, beyond our limit of measurement?

* Were you aware that the "T" in "DIS&T" (the acronym of Mr McGauran's department) now stands for "Tourism", in place of "Technology"?

OPTICS GRAPEVINE

News from the World of Optics

NEW BOOK HIGHLIGHTS NOVEL APPROACH TO SOLITONS

A comprehensive new text focusses attention on temporal solitons and spatial soliton beams. It has been written by two AOS members from the ANU in Canberra, Drs. Nail Akhmediev and Adrian Ankiewicz, and is entitled 'Solitons: Non-linear pulses and beams' (Chapman and Hall, London: publication date Feb.,1997). The point of the work is a self-consistent, self-contained treatment of the propagation of the stationary pulses (solitons) in optical fibres, and also spatial beams which are guided by nonlinear media. It also gives a thorough treatment of the applications of non-linear light pulses in optical fibres and spatial solitons in switching devices. It generally presents the results of the most recent research on the subject in an accessible manner and adopts a unified approach to solitons in fibres and the devices which use them.

Soliton communications in optical fibres, especially in conjunction with erbium-doped fibre amplifiers, offer the possibility of vast bandwidths, as pulses can be sent in close proximity as the dispersion of linear transmission is avoided. The book, which is suitable for both class-room use and private study, introduces a novel approach to the subject by analyzing the underlying stationary states of birefringent fibres and fibre couplers, including non-Kerr law examples, and using this to determine switching phenomena in terms of bifurcations.

'Solitons: Non-linear pulses and beams', N. Akhmediev and A. Ankiewicz, ISBN: 0-41275-450-9

PRELIMINARY ANNOUNCEMENT and CALL FOR PAPERS:

THE 11th CONFERENCE OF THE AUSTRALIAN OPTICAL SOCIETY

THE UNIVERSITY OF ADELAIDE, 10 - 12 DEC. 1997

The eleventh conference of The Australian Optical Society will be hosted by the Department of Physics and Mathematical Physics at The University of Adelaide in December 1997. The meeting will concentrate on all aspects of optics, lasers, and applications in Australia with contributions invited from all academic institutions, government laboratories and industry. There will also be a number of invited plenary speakers from overseas.

The meeting of the AOS will be immediately preceded by a workshop in Quantum Optics.

Details of the meetings will be appearing in forthcoming issues of the *AOS News*, and a web page will be established for registration. This will be a great meeting, and Adelaide is at its best in December!

If you have suggestions, please forward to:

Prof. Jesper Munch,
The University of Adelaide
South Australia 5005,
Fax. 08 232 6541, email:
jmunch@physics.adelaide.edu.au

"An elephant never forgets"

1997 subscriptions are now due.

Many thanks to those who have resubscribed already.

AUSTRALIAN TELESCOPE JUDGED WORLD'S BEST

Australia's Anglo-Australian Telescope (AAT) in outback NSW has been judged the world's best-performing optical telescope. The AAT, based at Siding Spring Mountain near Coonabarabran, came out tops in an international comparison of 25 telescopes from around the world. The results were published in the prestigious Quarterly Journal of the Royal Astronomical Society. The comparison was based on the number of "highly-cited" papers which were written on work carried out at the world's top telescopes.

1997

AOS Postgraduate Student Prize

Tanya Munro

see p5

The AOS on the World Wide Web
http://www.dap.csiro.au/OPTECH/Optics-Radiometry/aoshome.htm

1997 Annual General Meeting
- Announcement on p3 and 4.

Phase-shifting Without Changing the Optical Path: the Geometric Phase

*P. Hariharan**
CSIRO Division of Applied Physics, PO Box 218, Lindfield, NSW 2070
and, School of Physics, University of Sydney, NSW 2006

Some recent experiments involving the geometric (Pancharatnam) phase are reviewed.

**Dr P. Hariharan is the winner of the 1996 AOS Medal - Ed.*

1. Introduction

The most common method of shifting the phase of a light beam is by changing the length of the optical path. However, the phase shift introduced in this case (the dynamic phase) is inversely proportional to the wavelength.

There is, however, another way to change the phase of a light beam, and that is by a cyclic change in its state of polarisation. This phase shift (the Pancharatnam [1] phase) is actually a manifestation of a very general phenomenon - the geometric phase, or Berry's phase [2-5].

2. The Geometric (Pancharatnam) Phase

To understand this phenomenon, we have to go back to 1956 when Pancharatnam [1] was studying the interference patterns in plates of an anisotropic crystal and was faced with the problem of defining the phase difference between two beams in different polarisation states. He did this in a very ingenious way, by considering the intensity produced when the two beams were made to interfere and defining the two beams as being 'in phase' when the resultant intensity was a maximum.

Since the two beams could also be regarded as representing different states in the polarisation history of a single beam, this approach made it possible to define how the phase of a beam changed when its state of polarisation was altered. It led to the important observation that a beam could be taken from a polarisation state A to a second polarisation state B without changing its phase, then to a third polarisation state C, and finally back to its original polarisation state A, and end up with a different phase. He also showed that the magnitude of this phase shift (now known as the Pancharatnam phase) could be obtained from the geometry of the cycle on the Poincaré sphere [6,7].

3. The Poincaré Sphere

As shown in Fig. 1, states of polarisation are represented as points on the Poincaré sphere [6,7]. The poles represent left- and right-handed circular polarisations, while points on the equator represent linear polarisations (with the orientation of the plane of polarisation rotating by 180° in a 360° circuit, since the polarisation then returns to its original direction). All other points on the sphere represent elliptic polarisations.

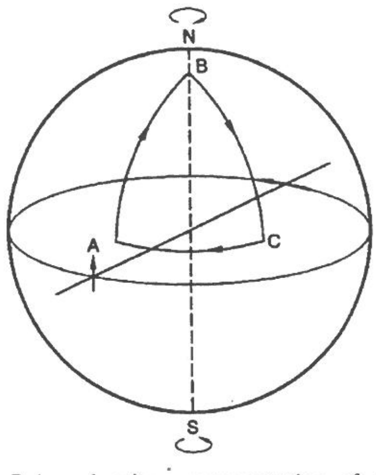


Figure 1: *Poincaré sphere representation of polarisation states. The phase change associated with the circuit ABC is equal to half the solid angle subtended by it at the centre of the sphere.*

Pancharatnam [1] showed that the phase change associated with a circuit *ABC* on the Poincaré sphere was equal to half the solid angle subtended by the circuit at the center of the sphere.

4. Experimental Observations

Several experiments have been carried out to demonstrate the Pancharatnam phase [8-10]. Fig. 2 is a schematic of an interferometer we have set up for this purpose [11].

In this interferometer, light from a He-Ne laser, linearly polarised at 45° to the plane of the figure by a polariser

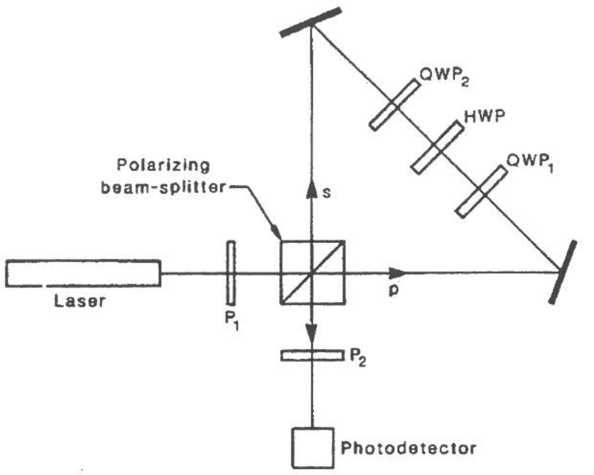


Figure 2: Optical system of the interferometer used to demonstrate the Pancharatnam phase.

P1, is divided at a polarising beam splitter into two orthogonally polarised beams that traverse the same closed triangular path in opposite directions. A second polariser P2 brings the two beams leaving the interferometer into a condition to interfere at a photodetector.

The phase difference between the beams is varied by a half-wave plate HWP located between two quarter-wave plates, QWP1 and QWP2. The two quarter-wave plates have their optic axes fixed at an angle of 45° to the plane of the figure, while the half-wave plate can be rotated by known amounts.

The operation of this interferometer can be followed by means of the Poincaré sphere. We consider, in the first instance, the p-polarised beam transmitted by the polarising beam splitter. As shown in Fig. 3, the first quarter-wave plate QWP1, converts this linearly polarised state represented by the point A_1 on the equator of the sphere, to the left- circularly polarised state represented by S, the South pole of the sphere. If, then, the half-wave plate HWP is set with its optic axis at an angle θ to the optic axis of QWP1, it moves this left-circularly polarised state through an arc that cuts the equator of the sphere at the point A_2, located at an angular distance 2θ from A_1, to the right- circularly polarised state represented by N, the North pole of the sphere. Finally, the second quarter-wave plate QWP2 brings the right-circularly polarised state back to the original linearly polarised state represented by A_1. Since the input state has been taken around the closed circuit $A_1SA_2NA_1$, which subtends a solid angle equal to 4θ at the centre of the Poincaré sphere, it acquires a phase shift equal to 2θ .

On the other hand, the s-polarised beam traverses the circuit $B_1SB_2NB_1$ n the opposite sense, so that it experiences a phase shift of -2θ .

Rotation of the half-wave plate through an angle θ therefore introduces an additional phase difference 4θ between the two beams.

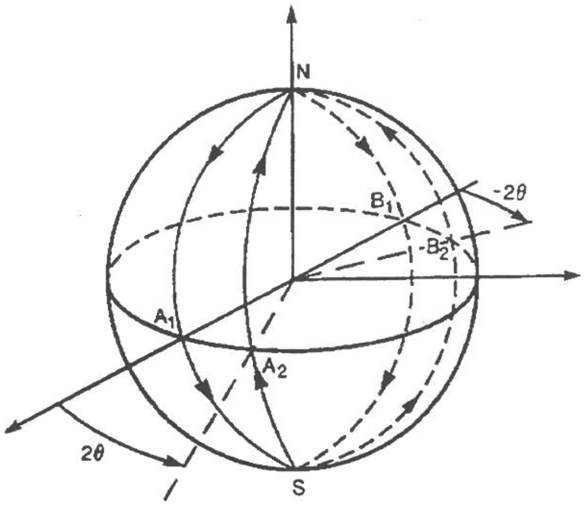


Figure 3: Poincaré sphere representation of the operation of the interferometer.

A typical set of results obtained with this interferometer is presented in Fig. 4. As can be seen, the normalised output intensity exhibits a sinusoidal variation, corresponding to a phase difference equal to 4θ .

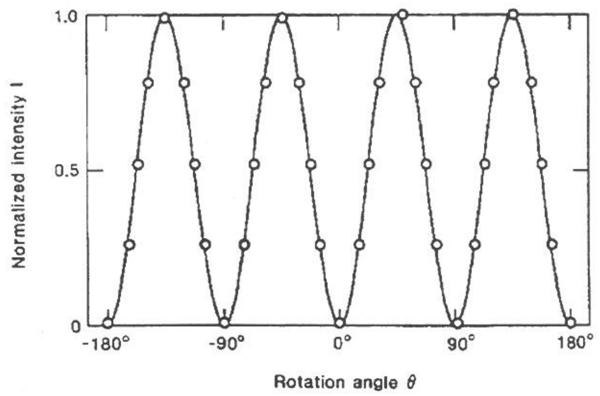


Figure 4: Output intensity as a function of the azimuth angle of the half-wave plate.

We have also carried out experiments at extremely low light levels, in which this sinusoidal intensity variation was observed, with no change in the visibility, even when the probability of more than one photon being present in the apparatus at the same time was negligible [12]. This experiment supports the conclusion that the geometric (Pancharatnam) phase persists down to the single-photon level.

5. Achromatic phase-shifting

Because the geometric phase is a topological phenomenon, the phase shift produced in this manner is intrinsically independent of the wavelength. Even if we use ordinary quarter-wave and half-wave plates in the phase shifter, the maximum deviation of the phase shift

from its nominal values is less than ± 6° over the whole visible spectrum [13].

With white light, the interference pattern consists, as shown in Fig. 5, of a central black fringe flanked on each side by a white fringe and a few coloured fringes. However, while a change in the optical path would produce a movement of the entire fringe pattern across the field, a rotation of the HWP by ~ 45° merely results in the central black fringe being replaced by a white fringe. A rotation through +90° brings back the central black fringe [14].

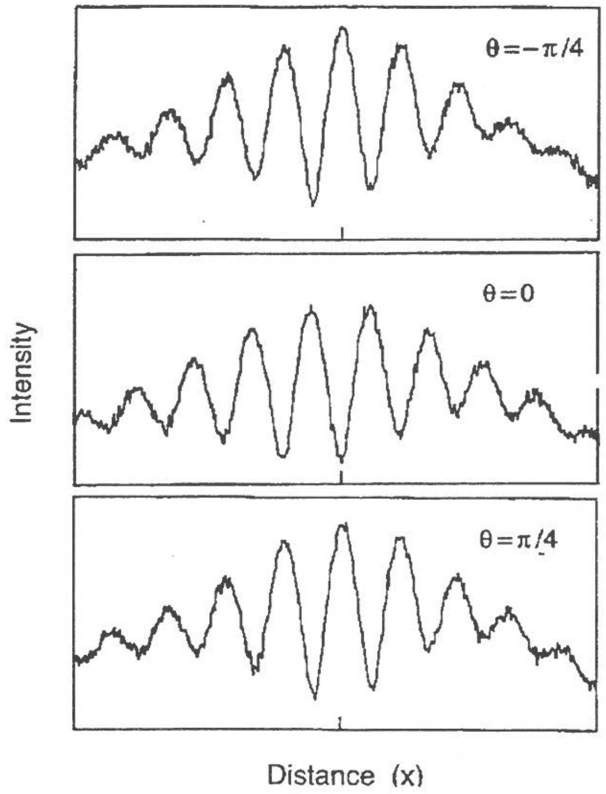


Figure 5: Intensity distribution in the interference pattern with white light.

This is because the effect of a change in the geometric phase of 2π is to move the fringes formed at all wavelengths by an integral number of fringe spacings, so that the interference pattern returns to its original configuration. The intensity at any point varies between its maximum and minimum values, but the position of the fringe envelope remains unchanged.

Achromatic phase-shifting, using the geometric phase, has opened up completely new possibilities in white-light interferometry, ranging from surface profiling [15] to the measurement of stellar diameters [16].

6. The Pancharatnam Phase as a Strictly Geometric Phase

All the demonstrations of the Pancharatnam phase described so far use retarders. The observed phase difference may therefore contain contributions due to changes in the dynamic phase [17] (even if the sum of these contributions is zero).

We have set up an interferometer in which a variable phase difference can be introduced between the two beams that is *purely* a geometric phase [18]. The only elements used to vary the state of polarisation of the beam are analysers, which transmit the desired polarisation state and reflect or absorb the orthogonal polarisation state.

As shown in Fig. 6, a monochromatic left-circularly polarised beam from a He-Ne laser (λ = 633 nm) is divided at the non-polarising beam splitter BS into two beams that traverse the same rectangular optical path in opposite directions. A rotatable linear analyser LA in one arm of the interferometer converts these two left-circularly polarised beams to linearly polarised beams. Note that if the axis of LA is rotated through an angle θ from the vertical, it appears, from one side to be set at an azimuth angle $+\theta$ and, from the other side to be set at an azimuth angle $-\theta$. These two linearly polarised beams are recombined at BS and brought into a state of right-circular polarisation by the circular analyser CA.

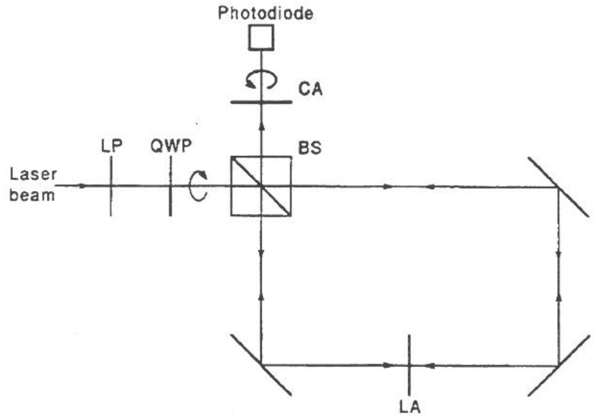


Figure 6: Interferometer used to demonstrate the Pancharatnam phase as a purely geometric phase.

The crucial element in this experiment is the circular analyser CA, which transmits only one circular polarisation and reflects or absorbs the other. We have used a cholesteric liquid crystal film which acts as an almost perfect circular analyser over a bandwidth of 20 nm, centred around 638 nm.

The operation of this interferometer can be followed, as before, by means of the Poincaré sphere. As shown in Fig. 7, the input left-circularly polarised state, represented by S, incident on the two sides of the linear analyser LA is projected as the linearly polarised states A_1 and A_2 which lie on the equator at azimuthal angles $+2\theta$ to the point A_0 representing the vertical. These two states are then projected onto the circular analyser CA, from which they emerge as the right-circularly

polarised state represented by *N*.

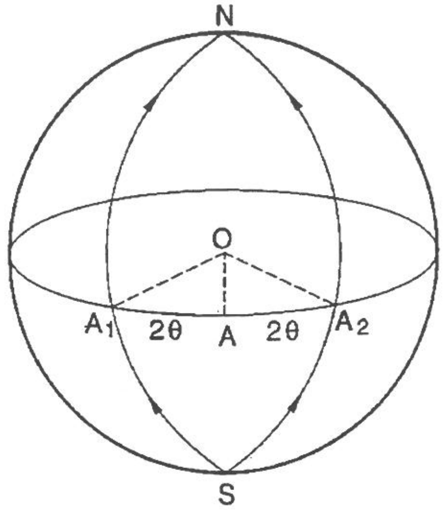


Figure 7: *Poincaré sphere representation of the operation of the interferometer.*

The phase difference $\Delta\phi$ between the two beams that is introduced by a rotation of LA through an angle θ is equal to half the solid angle subtended by the loop SA_2NA_1S at the centre of the Poincaré sphere, so that

$$\Delta\phi = 4\theta \tag{1}$$

In this interferometer, the divided beams do not traverse any birefringent elements. Since there are no contributions due to changes in the dynamic phase, the phase difference introduced between the two beams by a rotation of LA is a purely geometric phase.

7. Quantum Measurements and the Geometric Phase

This experiment can also be viewed as an example of a geometric or Berry's phase arising purely from quantum measurements [19].

When a measurement is made on a quantum system, the wave function collapses to an eigenstate $|\psi\rangle$ of the measured operator, corresponding to the measured eigenvalue. This collapse is described by a projection operator

$$P = |\psi\rangle\langle\psi| \tag{2}$$

If we consider a system, initially in the state $|\psi_1\rangle$, on which three successive measurements are made, their effect is to project the state of the system first onto-(say) $|\psi_3\rangle$, then onto $|\psi_2\rangle$ and then back onto $|\psi_1\rangle$. The final state of the system then exhibits a phase shift, with respect to its initial state, equal to the imaginary part of the complex number

$$\langle\psi_1|\psi_2\rangle\langle\psi_2|\psi_3\rangle\langle\psi_3|\psi_1\rangle \tag{2}$$

This phase shift is given by a flux integral over the geodesic triangle connecting the rays 1, 2 and 3, where we define a ray as a family of states differing only by an overall phase.

In the present experiment, the system is projected from the initial left-circularly polarised state, represented by the point S on the Poincaré sphere, to the right-circularly polarised state represented by the point N, *via* either of the linearly polarised states A_1 or A_2. If these points are joined by geodesics, we obtain the two trajectories SA_1N and SA_2N. The phase difference introduced between the two beams is equal to half the solid angle enclosed by these two paths and is purely a consequence of this succession of measurements.

8. Acknowledgment

Part of this work was carried out at the Raman Research Institute, Bangalore, India.

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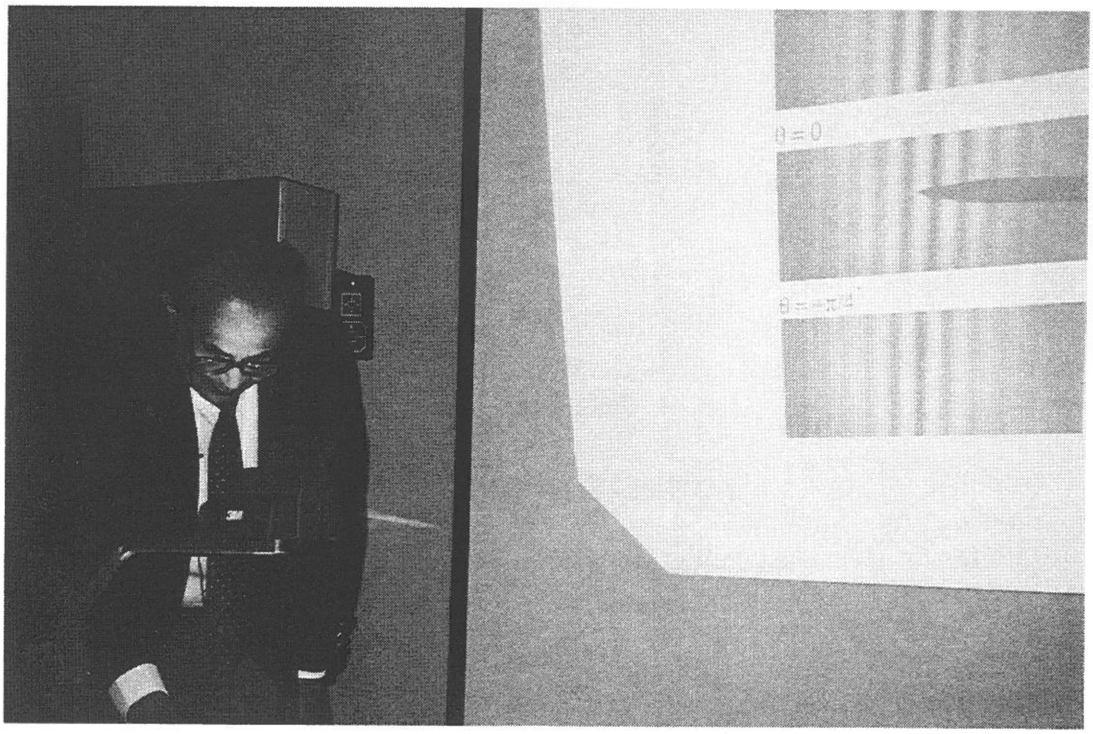
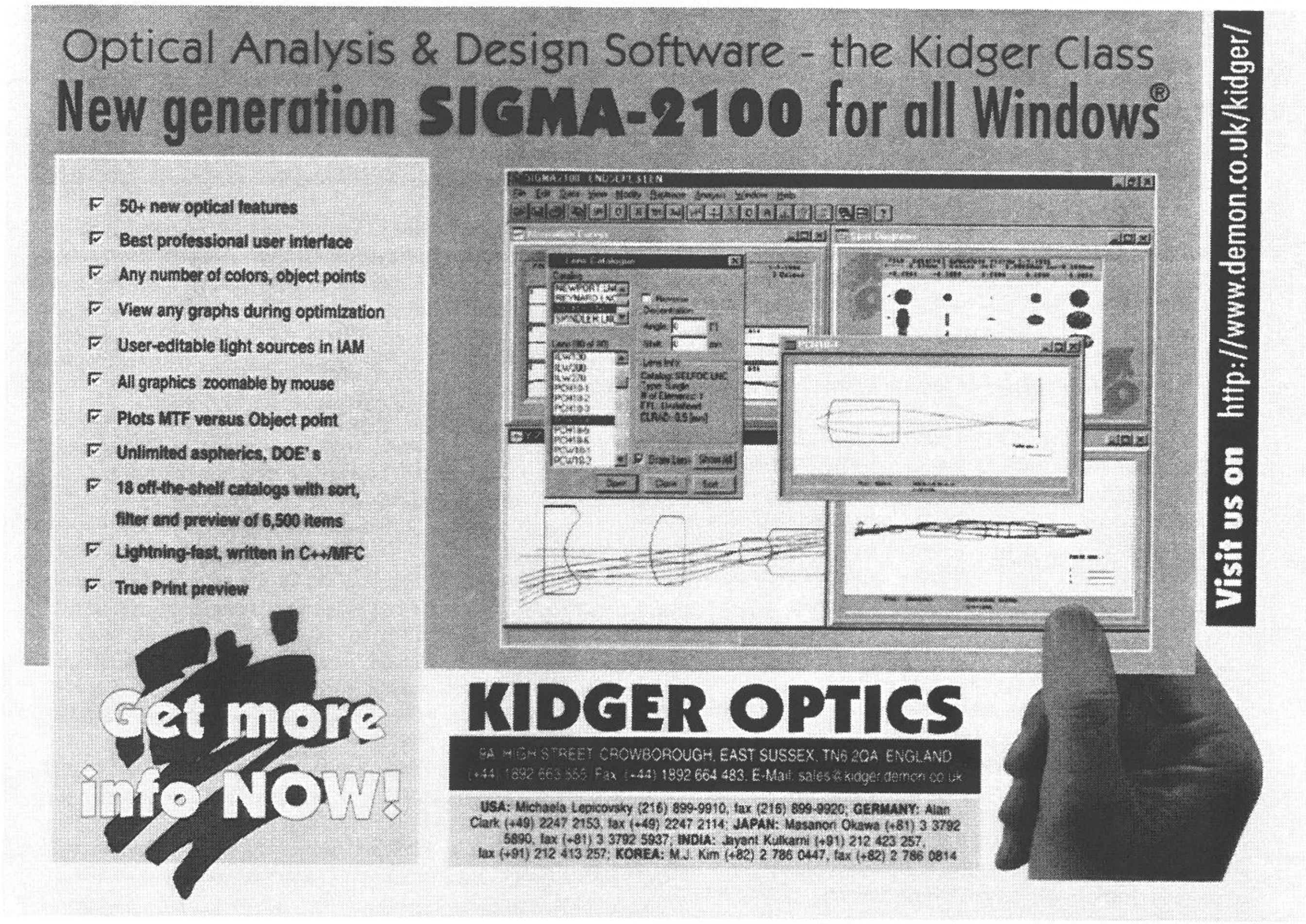
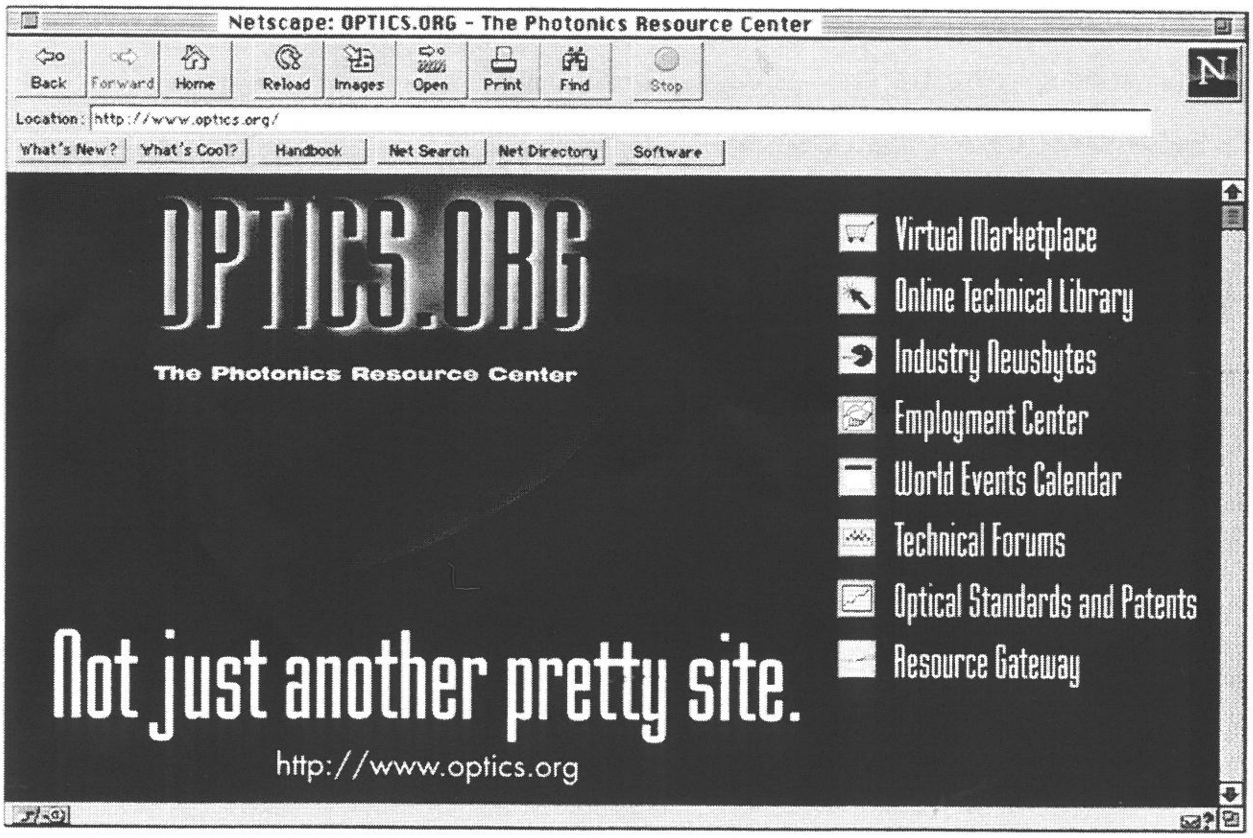


Dr Parmeswaran 'Hari' Hariharan during his presentation to the AOS during IQEC '96. Dr Hariharan was awarded the AOS Medal in 1996 for his extensive research in interferometry and holography. During his distinguished career Dr Hariharan has recẽived the Fraunhofer Medal from the Optical Society of America, the Henderson Medal from the Royal Photographic Society, the Walter Boas Medal of the Australian Institute of Physics, the Denis Gabor award of the SPIE, and the Thomas Young Award of the Institude of Physics London.





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Adelaide HQ tel: (08) 438 668 fax (08) 438 427 e-mail: lastek@www.saschools.edu.au

FASTS : "TEN TOP" ISSUES FOR 1997

Dr Joe Baker, President of the Federation of Australian Scientific and Technological Societies, released the FASTS "Ten Top Policies" for 1997 on January 1. It lists the ten most pressing issues facing science and technology in Australia, and represents the views of 40,000 working scientists and technologists through their representative peak body.

"One of the Government's New Year's Resolutions should be to make better use of the capacity of science and technology to generate wealth-creating industries," Dr Baker said. "New industries means more jobs, and a secure future for Australia in a hotly competitive part of the world.

"Any long term solution to the problem of unemployment in Australia must be based on science and technology. The Prime Minister recognised the value of S&T by revitalising his Science and Engineering Council," he said. "Now it is time to go one step further, and include science in the forefront of social, economic and employment planning in Australia."

The "Ten Top Issues" covers subjects ranging from restructuring the universities to guarantee access to high-quality science education and research boosting the scientific exploration of Australia's Ocean Territory in order to exploit marine and seabed resources in a sustainable manner; and addressing the looming shortage of properly trained mathematics and science teachers. Top of the list is a call for the Government to develop a national vision for Australia, with a clear place for science and technology.

"Other countries in our region are not afraid to make a clear statement of national goals in support of industry and sustainable development, but Australia seems strangely reluctant to enter this area," Dr Baker said. "If we don't know where we're going, how can our scientists and technologists work to build a sustainable development for the country?

Dr Baker said that FASTS was leading a push to resolve another "Ten Top" issue, that of a lack of career paths for young research scientists.

FASTS is organising a Forum at the National Press Club in March. The Forum, to be called "A Gross Waste of Talent?" will seek imaginative solutions to a problem which drives many of Australia's best young scientists away from a career in S&T, and is jointly sponsored with the National Tertiary Education Union.

FASTS TOP TEN POLICIES

January 1st, 1997

1. A NATIONAL VISION FOR AUSTRALIA TO 2020 AND BEYOND
FASTS urges the Government to determine a national vision for Australia's sustainable development, and to establish what science and technology is needed to support that future. This process, working through a national summit, should set broad national priorities.

2. THE DIFFERENTIAL HECS FEES AND SCIENCE
FASTS recommends that the Government monitors science enrolments in universities and the impact of differential HECS fees, and takes immediate remedial action should there be any significant decline in numbers.

3. SCIENCE AND MATHEMATICS TEACHING
The Government must address the decline in the quality and quantity of teachers in science and mathematics, and the lack of rigour and substance in Australia's science and mathematics curricula and teaching practices. All students are taught by appropriately qualified teachers. HECS charges for teaching education should be in the lowest bracket.

4. ENCOURAGEMENT OF PRIVATE R&D
Funding for private R&D should be increased to internationally competitive levels. Peer-reviewed competitive grants should be used as a mechanism to distribute funds and ensure the quality of research, and the Government should address the shortage of long term venture capital by encouraging superannuation funds to invest in R&D.

5. RESTRUCTURING THE UNIVERSITIES
Australia has too many universities to be able to offer high-quality science courses in all disciplines at all institutions. FASTS advocates a restructuring process that guarantees access to high-quality science education and research, and which may involve amalgamation or shared teaching.

6. PROVISION OF CAREER PATHS FOR SCIENTISTS
Too many young scientists face uncertain careers on short term funding. More talented people, especially women, need to be attracted into scientific careers through better remuneration and more secure career paths, with real opportunities to obtain competitive research funding.

7. INFRASTRUCTURE IN RESEARCH ORGANISATIONS
The Government is urged to accelerate its program of replacing worn-out equipment, libraries, computer facilities and buildings in research organisations

8. BASIC SCIENCE
A higher proportion of Government funding for science should be directed to basic science, to underpin future developments in applied science.

9. THE AUSTRALIAN OCEAN TERRITORY
Australia needs to boost its scientific exploration of the AOT in order to exploit marine and seabed resources in a sustainable manner. Government should ensure adequate funding is directed the research agencies in this area, including the provision of a scientific marine fleet.

10. PROTECTION OF INTELLECTUAL PROPERTY
The protection of Australian intellectual property is as vital as its discovery and development. Patent costs should be an allowable R&D expenditure.

Mr Toss Gascoigne, Executive Director, FASTS
PO Box 218, Deakin West, ACT 2601
Phone: 06-257 2891 (work); 06-249 7400 (home)
Fax: 06-257 2897 (Mobile: 0411-88 3418)
Email: fasts@anu.edu.au
http://bimbo.pharmacol.su.oz.au/fasts/fastshome.html

FASTS November '96 circular

FASTS has written to the Minister for Education Senator Amanda Vanstone to ask her when the review of the Higher Education system will begin. The Review was announced on August 9 when the Minister made a pre-Budget statement, ostensibly to clear up a confusing situation in the Higher Education sector.

Since then the situation has worsened. The sector is simultaneously grappling with savage funding cuts, the proposed differential HECS allowance, and mounting industrial trouble over claimed salary increases. Confusion and uncertainty reign.

All notions of strategic planning seem to have gone out the window, to be replaced by a market-driven "reform" of the Higher Education system. Science departments have been closed or amalgamated as university administrators scramble to balance their budgets, and FASTS is concerned that these actions do not prejudice the gains of the past two decades.

Clearly, the universities need a sense of purpose and direction. They need to know what the universities are expected to do and what sort of funding is available to them. Science is particularly vulnerable in this climate of uncertainty. Science departments can be expensive to run, and the benefits lie beyond the time-horizon of most of the people who make policy decisions. It's time to set a clear and steady path for Higher Education, and it's time for Minister Vanstone to announce the terms of reference for her Review.

1. FASTS supports Reef fishing experiment

A series of experiments planned for the Great Barrier Reef to establish best management practices came under threat from the Australian Democrats in Parliament last month. FASTS was contacted by the Australian Marine Sciences Association (AMSA) when the Democrats issued an media release using terms "rip the heart out", "science gone feral", "absurd experiments" and "plundered".

FASTS helped AMSA counter the Democrat release, and contacted politicians in all parties. ALP Science spokesperson Martyn Evans spoke directly to the scientists involved, and took up the issue within the Labor Party. The ALP eventually agreed to support the research. The experiment has now been accepted by Parliament, but FASTS has followed up the issue with Cheryl Kernot. I have written to her to express concern at the approach the Democrats took, and offering to act as a source of expert scientific reference on other S&T matters.

2. FASTS Council

Both Minister Peter McGauran and Shadow Minister Martyn Evans sparked vigorous discussion when they addressed Council on November 20. Representatives of Member Societies were able to question them directly on a whole range of issues.

The meeting was surprised to hear the Minister's perception that basic research was well-funded and thriving in Australia. The Board is preparing a submission to acquaint the him with the real picture and the real importance of basic research.

Position papers are being prepared by the following Board and Executive members, and Members with a particular interest should contact these people directly:

Basic research support:
Chris Powell - cpowell@geol.uwa.edu.au
Patricia Angus - pma@rschp1.anu.edu.au

HECS:
John Humble - John.Humble@phys.utas.edu.au
Jan Thomas - JanThomas@VUT.edu.au

S&T and maths and science teaching:
Jan Thomas - JanThomas@VUT.edu.au
Jaan Oitmaa - otja@newt.phys.unsw.edu.au

University restructuring:
Chris Powell - cpowell@geol.uwa.edu.au
Patricia Angus - pma@rschp1.anu.edu.au

Marine exclusive economic zone:
Peter Rothlisberg
- Peter.Rothlisberg@qld.ml.csiro.au

Chemical deficit:
Graham Johnston - grahamj@extro.ucc.su.oz.au

Career paths:
John Humble - John.Humble@phys.utas.edu.au
Jaan Oitmaa - otja@newt.phys.unsw.edu.au

Emerging diseases:
Dick Groot Obbink - dickgo@med.su.oz.au

University-industry collaboration and R&D funding:
Graham Johnston - grahamj@extro.ucc.su.oz.au
Peter Cullen - cullen@science.canberra.edu.au

3. Peter Cullen new President-elect

I am delighted to announce that Professor Peter Cullen, Director of the CRC for Freshwater Ecology and Professor of Resource and Environmental Science at the University of Canberra, has agreed to serve as President-elect of FASTS. He will become President in November 1997.

Peter Cullen has been an outstanding advocate of the problems facing Australia as the driest inhabited continent, and has worked tirelessly to convey the concerns of the scientific world to Parliament and the public.

Former President Professor Graham Johnston finishes his term with the special thanks of scientists and technologists across Australia. His great contributions helped to revitalise FASTS and to build effective organisational and communication structures.

I would like to welcome Board newcomers Dr Peter Rothlisberg, Professor Jaan Oitmaa and Professor Snow Barlow; and to thank retiring Treasurer Marion Burgess and Board members Barry Fox, Ron Macdonald and Jason Middleton for their work.

4. Chief scientist

John Stocker is an admirable person to fill the role of Chief Scientist and we congratulate him on his appointment. I have arranged to meet him this week.

But FASTS raised two concerns in a media release following the announcement. The first is that he will only work in the role one day a week, which seems hardly enough to fill this important and sensitive position as well as to chair ASTEC.

He will continue to work for the consultancy group Foursight and for Pratt Industries; and the issue of potential conflict of interest is one for the Government to address rather than ignore. I believe Dr Stocker's wide experience will serve Australia well.

5. FASTS Mathematics and science education forum

The FASTS Forum in Canberra in November brought together 80 teachers, academics and industry people concerned about the looming crisis in maths and science education. Australia expects a shortage in trained school teachers before the turn of the century.

FASTS Board member Jan Thomas organised this successful Forum, and said that although neither Minister Vanstone nor Kemp was able to attend, they have been receiving very clear messages from the subsequent media coverage! (President Clinton's visit was head-on competition for the time of the Ministers.)

6. Ideas for PMSEC

Member Societies are invited to suggest ideas FASTS could raise at the next PMSEC meeting scheduled for May 30 1997. Members are also invited to suggest ideas for a special afternoon session devoted to a more entertaining aspect of science, technology or engineering. Planned to run 30 minutes, it might be a video-based presentation on highly visual science, such as the work of the Anglo-Australian

telescope, or computer graphics research.

7. Differential HECS for S&T degrees
FASTS Policy Chair Ken Baldwin and secretary Chris Easton made a submission to the Senate Committee on Employment Education and Training to oppose the new HECS fees. The full text is available on the FASTS' web site.

HECS is currently being considered by the Senate. The Committee's Report showed that FASTS' arguments appear to have struck home, and we are hopeful that the final result will be a good one for S&T.

8. Budget submissions
FASTS has been invited by the Treasury Department to make a submission for next year's Budget. Last year we raised several matters, including the short supply of trained science and maths teachers in high school and the chemical deficit issue.

Members are invited to bring issues to our attention. Final submissions have to be in by January 10, so please let me have your ideas by Christmas. Fax or email them direct to me: (06) 207 2630; environment_commissioner@dpa.act.gov.au

9. Careers for young scientists
FASTS is planning a high-level Forum to devise solutions and raise public awareness of an acute problem facing young research scientists in Australia today. A draft program is being discussed with groups such as the NTEU, the Academy of Science and the CRCs Association. We hope to announce firm details shortly. February 1997 is the target month.

10. Media
FASTS has built an active presence in the media, with articles in the Sydney Morning Herald, Campus Review, the Australian, and the Canberra Times all featuring FASTS. Headlines include:

"Scientists back reef research"
"Crisis forecast in maths"
"Reformers move on wide maths-science curriculum"
"Numeracy levels under spotlight"
"Maths decline adds up to division"
"Chief scientist role raises fears"
"Crisis in student science numbers"

Please keep in mind that coverage at local levels and in your own Society's interests, are equally of great value. Policy makers read and are influenced by this constant exposure in the media.

Joe Baker, 3 December 1996

FASTS January '97 circular

On January 7, the Government declared 1997 to be "The Year for Youth in Science." In making what is largely a symbolic declaration (there was no new money for initiatives in this area!), Minister Peter McGauran said that Australia needed more scientists, technologists and engineers, and not more doctors, lawyers and accountants.

FASTS believes the most useful step the Government could take to boost youth interest in science is to improve the quantity of properly qualified science and mathematics teachers, and to modernise science laboratories in schools.

The evidence of difficulties in teaching is mounting. Reports have pointed out the weaknesses - a huge projected shortfall of teachers, the dissatisfaction of the existing workforce, lower numbers entering the discipline areas.

The Preston Report by the College of Deans of Education confirms anecdotal reports of the situation in Australian schools and universities:
* that too many school students are being taught mathematics and science subjects by teachers not qualified to teach these subjects
* that the universities are not producing enough teachers with qualifications in areas such as mathematics, physics and chemistry
* that the pool of graduates in science and mathematics available to go on to gain teaching qualifications is growing smaller in number and weaker in quality

Australia needs to boost the supply of good science and mathematics teachers to inspire students to enter these courses at university. All sorts of career opportunities open up to people with qualifications in science and mathematics.

The corollary is that all sorts of difficulties lie ahead for the nation which fails to educate the next generation to cope with the challenges of the future.

1. Careers Forum
FASTS and the National Tertiary Education Union are organising a one day Forum to examine the question of career opportunities for younger research scientists.

It will be at the National Press Club in Canberra on Wednesday March 19, and features a nationally-televised lunch time address by Professor Ian Lowe of Griffith University. The Minister for Science and Technology and his shadow counterparts have been invited to speak, along with young scientists and leading figures from industry, research and the universities.

The Forum goes all day, and the registration fee includes a seat at the Press Club lunch. This is an opportunity to devise constructive solutions to a problem which threatens the next generation of Australia's research scientists.

2. The West Review of Higher Education
FASTS' Secretary Dr Chris Easton, of the Research School of Chemistry at the ANU, is coordinating FASTS' submission to the Review. (ph 06-279 8201, email easton@rsc.anu.edu.au)

The advertisement calling for submissions will appear on Feb 19, and submissions have to be in by April 4. Review Secretary is Ian Creagh (ph. (06) 240 7344, fax (06) 240 8854, email ian.creagh@deetya.gov.au).

An indication of FASTS' approach to this Review is in an article I wrote for the Sydney Morning Herald last month: "Scientists working in the Universities are walking a funding and budgetary tightrope. All they can see ahead are red lights and danger signs, as the Universities face up to a series of challenges.

"These include providing quality teaching for students, and adequate careers for staff in a time of declining budgets; coping with a shrinking demand for S&T courses (particularly from quality students with high tertiary entrance scores) and the uncertain effects of differential HECS; finding the funds for sophisticated equipment; and meeting the challenges of international competitiveness and industry and commerce."

3. The Factor (f) Scheme
I have asked to Prime Minister to extend the life of the Factor (f) Scheme. Under this Scheme, Government incentives for companies to undertake R&D are compensated for by lower-cost pharmaceuticals to the Australian public. It has led to strong growth, significant private investment in infrastructure and research, and the development of a world-leading pharmaceutical industry in Australia.

FASTS supports Factor (f) as an example of the way Government can encourage industry to undertake R&D, and believes that the

Government could well consider how the concept could be extended to other scientific and technological areas.

As Robert Gottliebsen said in the Business Review Weekly recently: "Many countries to our north would walk over hot coals to get the technology we have developed here as a result of Factor f. I suspect many European countries would have the same view." (December 16, p. 6)

The Factor (f) scheme is a clear example of good science combined with good business. It would be to the detriment of Australia's interests if this scheme were to be curtailed or abandoned.

4. Meeting with Chief Scientist, Prof. John Stocker
Members of the Board and Executive of FASTS had a profitable half day meeting with John Stocker and Eric James from DIST on 24 January. Much of the discussion revolved about FASTS "Ten Top" issues for 1997, and the Review of S&T that the Chief Scientist will carry out. (Details have already been distributed to Member Societies.)

It is interesting that the Chief Scientist's terms of reference nominate FASTS (along with the academies of science) as an organisation he must consult.

5. "Ten Top" policy issues for 1997
Release of the "Ten Top" issues sparked much discussion this year, particularly number five which began "Australia has too many universities..." Lots of people reached for the phone and email before finishing the sentence: "...to be able to offer high quality science courses in all disciplines at all institutions."

Since then I have expanded on this sentence, to say in the SMH article that in any reorganisation of the universities, the views of academic scientists working at the coalface must be prominent:

"They alone know how to arrange their resources in the science and technology-based discipline areas. They should be the ones to identify and analyse alternative approaches to maintain student access, and standards of teaching and research in S&T. "They are closest to the problem, they are best able to understand the resources available, and have the best appreciation of the non-financial impacts of any recommended course of action."

6. Media
There has been a lot of interest in science lately, with HECS, the shortage of teachers, cuts to funding, the Nobel Prize winner becoming "Australian of the Year," and editorials on science in several papers. The interest is spreading, and it is good to see "non-scientists" recognising the impact of a society inadequate in S&T.

Member Societies can contribute to this interest by drawing matters of interest to the attention of the press. Often these ideas are contained in your newsletters. An idea from the Statistical Society Newsletter faxed to the Age newspaper made a good page three story on the economies of buying cold petrol. This sort of coverage can lift the profile of a Society and underline the relevance of science to everyday life.

FASTS recent coverage includes appearances on national ABC radio and Channel 7 TV; and among the headlines were:
"Call for Review of Maths"
"Scientists warn of threats to uni standards"
"Call for unis to consider merger of resources"
"Scientists in call for quality, not quantity"
"Flight from science feared"
"Vanstone defiant on uni cut-offs"
"Vanstone concedes as science cut-offs fall"
"Science walks a tightrope"

Joe Baker, 3 February 1997

Corporate Membership Address List

Australian Holographics Studios Pty Ltd
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Fax: (08) 383 7244
austholo@camtech.net.au

AVIMO Electro-Optics Pty Ltd
14 Fifth Lok Yang Road
Singapore, 2262
Tel: +65 265 5122
Fax: +65 265 1479

British Aerospace Australia
PO Box 180
Salisbury SA 5108
Head Office:
14 Park Way
Technology Park
The Levels, SA 5095

Coherent Scientific Pty Ltd
116 Burbridge Road
HILTON, SA, 5033
Tel: (08) 8352 1111
Fax: (08) 8352 2020
cohsci@cohsci.com.au

Electro Optic Systems
55A Monaro St
Queenbeyan, NSW, 2620
Tel: (06) 299 2470
Fax: (06) 299 2477

Electro Optics Pty Ltd
PO Box 67
Kenthurst, NSW, 2156
Tel: (02) 9654 1873
Fax: (02) 9654 1539

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Gladesviile, NSW, 2111
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Tel: (08) 287 2422
Fax: (08) 287 2706

Kidger Optics Limited
9a High Street
Crowborougb, East Sussex
TN6 2QA, UK
Tel: +44 1892 663555
Fax: +44 1892 664483
sales@kidger.demon.co.uk

Laser Electronics (operations) Pty Ltd
PO Box 359
Southport, QLD, 4215
Tel: (075) 96 0177
Fax: (075) 96 3530

Lastek Pty Ltd
GPO Box 2212
Adelaide, SA, 5001
Tel: (08) 8443 8668
Fax: (08) 8443 8427
lastek@saschools.edu.au

OptiScan Pty Ltd
PO Box 1066
Mt. Waverley MDC
Vic 3149
Tel: (613) 9562 7741
Fax: (613) 9562 7742

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16 Ross Street
Newport Beach, NSW, 2106
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Tel: (03) 761 5200
Fax: (03) 761 5600

Warsash Pty Ltd
PO Box 1685
Strawberry Hills, NSW, 2012
Tel: (02) 9319 0122
Fax: (02) 9318 2192

Meetings Calendar at a Glance

Date	Meeting 1997	Contact	Location
Apr 2-4	8th European Conference On Integrated Optics (ECIO'97)	OSA	Stockholm, Sweden
Apr 2-4	Photonics In Switching Topical Meeting	OSA	Stockholm, Sweden
Apr 17-18	Photomask Japan	SPIE	Kawasaki City, Japan
Apr 20-25	AeroSense Aerospace/Defense Sensing and Controls	SPIE	Orlando, Florida USA
Apr/May	Third International Conference On Optical Fiber Submarine Systems	OSA	tba
May 4	Diagnostic Techniques for Semiconductor Materials and Devices	SPIE	Montreal, Canada
May 6-8	Electronics Industries Forum Of New England	OSA	Boston, MA
May 15-16	Microlens Arrays (13th EOS/TM)	EOS	Teddington, United Kingdom
May 15-18	Expo Comm Wireless Korea '97	OSA	Seoul, Korea
May 18-23	Conference On Lasers and Electro-Optics (CLEO'97)	OSA	Baltimore, Maryland
May 18-23	Quantum Electronics and Laser Science Conference (QELS'97)	OSA	Baltimore, Maryland
May 19-23	Sviaz Expo Comm Moscow '97	OSA	Moscow, Russia
May 20-23	Correlation Optics	EOS	Chernovtsy, Ukrainia
May 26-28	Conference On Polarization Effects In Lasers and Spectroscopy	OSA	Toronto, Canada
Jun 2-5	Euro American Workshop Optoelectronic Information Processing	EOS	Barcelona, Spain
Jun 4	Pattern Recognition in Practice V	IAPR	Vlieland, Netherlands
Jun 8-12	3RD Med. Workshop On Novel Optical Materials and Apps. (NOMA)	OSA	Cetraro, Italy
Jun 9-13	International Workshop On Adaptive Optics For Industry and Medicine	OSA	Shatura, Russia
Jun 14-19	9th CIMTEC	EOS	Florence, Italy
Jun 15-19	Asme Electronic Packaging Conference&Exhibition (INTERPACK '97)	OSA	Honolulu, Hawaii
Jun 16	Meeting on Optical Interconnections	EOS	Edinburg, United Kingdom
Jun 16-20	Lasers '97 Exhibition and Conference	OSA	Munich, Germany
Jun 16-20	EOS Annual Meeting '97 co-located with Laser Munich 97	EOS	Munich, Germany
Jun 16-20	- European Symposium on Environmental Sensing III	EOS	Munich, Germany
Jun 16-20	- Europea Symp. on Lasers and Optics for research and Manufacturing	EOS	Munich, Germany
Jun 16-20	- European Symposium on Microelectronics Manufacturing I	EOS	Munich, Germany
Jun 17-18	Non-Astronomical Adaptive Optics Topical Meeting	OSA	Munich, Germany
Jun?19-22	Fith International Topical Meeting on Education and Training in Optics	EOS	Delft, The Netherlands
Jun 23-17	ISMA '97 - International Sym. on Microelectronics and Assembly	SPIE	Singapore
Jun 24-25	Advances in Acousto-Optics (15th EOS/TM)	EOS	St Petersburg, Russia
Jul 1-3	Displacement Measurements (14th EOS/TM)	EOS	Nantes, France
Jul 2-4	Applications Of High-Performance Computers In Engineering (HPC 97)	OSA	Santiago, Spain
Jul 7-9	Diffractive Optics (12th EOS/TM)	EOS	Savonlinna, Finland
Jul 7-10	Technologies and Combustion For A Clean Environment	OSA	Lisbon, Portugal
Jul 7-10	Airborne Remote Sensing Conference and Exhibition	OSA	Copenhagen, Denmark
Jul 8-11	Solid-State Lasers: Materials and Applications (SSLMA)	OSA	Tianjin, PRC
Jul 8-12	Materials for Nonlinear Optics (11th EOS/TM)	EOS	Capri, Italy
Jul 9-11	Optical Guided Waves and Applications	AOS	Canberra, ACT
Jul 14-17	CLEO/Pacific Rim	OSA	Chiba, Japan
Jul 21-23	Optical Amplifiers and Their Applications Topical Meeting	OSA	Victoria, Canada
Jul 27-1	SPIE Annual Meeting	SPIE	San Diego, California USA
Aug 26-30	Symposium On Optical Information Science and Technology	OSA	Moscow, Russia
Sep 5-9	Biomedical Optics Europe V	EOS	San Remo, Italy
Sep 6-8	COLOQ'97	EOS	Strasbourg, France
Sep 9-12	ROMOPTO'97	EOS	Bucharest, Romania
Sep 17-19	Photomask Technology and Management	SPIE	Santa Clara, California USA
Sep 21-25	European Symposium on Satellite Remote Sensing IV	EOS	London, United Kingdom
Sep 22-24	Photonics East and Electronic Imaging International	SPIE	Boston, Massachusetts USA
Sep 22-25	Integrated Optics and Optical Fiber Communications (IOOC '97)	OSA	Edinburgh, United Kingdom
Sep 22-25	European Conference On Optical Communication (ECOC'97)	OSA	Edinburgh, United Kingdom
Sep 29-30	Micromaching and Microfabrication	SPIE	Austin, Texas USA
Oct 1-3	Microelectronic Manufacturing	SPIE	Austin, Texas USA
Oct 12-17	OSA'97 Annual Meeting: Focus on the Life Sciences	OSA	Long Beach, California
Oct 12-17	Interdisciplinary Laser Science Conference (ILS-XIII)	OSA	Long Beach, California
Oct 15-17	Applied Imagery Pattern Recognition Workshop	SPIE	Washington, DC
Oct 15-17	Organic Thin Films For Photonics Applications Topical Meeting	OSA	Long Beach, California
Oct 17-18	Lasers In Dermatology: Bio-Optics and Treatment Of Human Skin	OSA	Long Beach, California

Meetings Calendar at a Glance

Oct 25-31	**FALL TOPICAL MEETINGS**	OSA	Williamsburg, Virginia
Oct 25-31	**- 12th International Conference on Optical Fiber Sensors**	OSA	Williamsburg, Virginia
Oct 25-31	**- Bragg Gratings, Photosensitivity, and Poling in Glass Waveguides**	OSA	Williamsburg, Virginia
Oct 25-31	**- Glass and Optical Materials Division (GOMD) Meeting**	OSA	Williamsburg, Virginia
Oct 27-31	**Joint Magneto-Optical Recording International Symposium (MORIS)**	OSA	Yamagata, Japan
Oct 27-31	**International Symposium On Optical Memory (ISOM '97)**	OSA	Yamagata, Japan
Dec 10	**AOS Bi-Annual Conference**	AOS	Adelaide, SA
Date	**Meeting 1998**	**Contact**	**Location**
Feb 22-27	**Optical Fiber Communication Conference (OFC '98)**	OSA	San Jose, California
Mar 23-27	**Symposium on Advanced Networks and Imaging Technologies II**	EOS	United Kingdom
Mar 30-3	**Integrated Photonics Research**	OSA	Victoria, Canada
Apr 1-3	**Nonlinear Guided Waves and Their Applications**	OSA	Victoria, Canada
May 3-8	**Conference On Lasers and Electro-Optics (CLEO '98)**	OSA	San Francisco, California
May 3-8	**International Quantum Electronics Conference (IQEC '98)**	OSA	San Francisco, California
Jun 8-12	**European Symposium on Environmental Sensing IV**	EOS	Lyon, France
Sep 7-11	**Biomedical Optics Europe VI**	EOS	Scandinavia
Sep 13-18	**CLEO/Europe**	OSA	Glasgow, Scotland
Sep 13-18	**European Quantum Electronics Conference (EQEC '98)**	OSA	Glasgow, Scotland
Sep 21-25	**European Symposium on Satellite Remote Sensing V**	EOS	Taormina, Italy
Oct ?-?	**Photonics Europe'98**	EOS	Paris, France
Oct ?-?	**- Symp. on Optics and optoelectronics for Public Safety III**	EOS	Paris, France
Oct ?-?	**- Symp. on Lasers, Optics and Vision for Productivity in Man. III**	EOS	Paris, France
Oct 4-9	**OSA Annual Meeting**	OSA	Baltimore, Maryland
Oct 4-9	**Interdisciplinary Laser Science Conference (ILS-XIV)**	OSA	Baltimore, Maryland
Oct 11-15	**European Symposium on Optics and Optoelectronics for Public Safety**	EOS	Wiesbaden, Germany
Oct 14-17	**Intelligent Systems and Advanced Manufacturing**	SPIE	Pittsburgh, USA
Nov 2-7	**Voice, Video, and Data Communications**	SPIE	Texas USA
Date	**Meeting 1999**	**Contact**	**Location**
Feb 21-26	**International Conference On Integrated Optics (IOOC '99)**	OSA	San Diego, California
Feb 21-26	**Optical Fiber Communication Conference (OFC '99)**	OSA	San Diego, California
May 23-28	**Conference On Lasers and Electro-Optics (CLEO '99)**	OSA	Baltimore, Maryland
May 23-28	**Quantum Electronics and Laser Science Conference (QELS '99)**	OSA	Baltimore, Maryland
Sep 26-1	**OSA Annual Meeting**	OSA	Santa Clara, California
Sep 26-1	**Interdisciplinary Laser Science Conference (ILS-XV)**	OSA	Santa Clara, California
Date	**Meeting 2000**	**Contact**	**Location**
Mar 5-10	**Optical Fiber Communication Conference (OFC 2000)**	OSA	Baltimore, Maryland
May 7-12	**Conference On Lasers and Electro-Optics (CLEO 2000)**	OSA	San Francisco, California
May 7-12	**Quantum Electronics and Laser Science Conference (QELS 2000)**	OSA	San Francisco, California
Date	**Meeting 2001**	**Contact**	**Location**
Feb 18-23	**Optical Fiber Communication (OFC 2001)**	OSA	San Francisco, California
May 6-11	**Conference On Lasers and Electro-Optics (CLEO 2001)**	OSA	Baltimore, Maryland
May 6-11	**Quantum Electronics and Laser Science Conference (QELS 2001)**	OSA	Baltimore, Maryland

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Quasi-Molecules in Cavity Quantum Electrodynamics

Barry Sanders
School of Mathematics, Physics, Computing and Electronics
Macquarie University, Sydney, NSW 2109

We propose a new technique to probe the radiation properties of a single atom in a high-finesse cavity.

1. Introduction

Quantum electrodynamics (QED) is the study of the interaction between electromagnetic fields and charged particles. It has long been recognised that the quantum vacuum, a background of virtual photons whose ephemeral existence is guaranteed by the Heisenberg Uncertainty Principle, is responsible for experimentally observable effects. Spontaneous emission of radiation, the Lamb shift and corrections to the $g = 2$ gyromagnetic factor for the electron are each consequences of quantum noise in the electromagnetic field.

QED is often cited as the most successful theory in physics, agreeing with experiment to an astounding 1 part in 10^{10} or better. Although QED might eventually be replaced by another theory someday, its great success gives us confidence that all electrodynamic phenomena, no matter how complicated, can be well explained in terms of QED theory.

Cavity Quantum Electrodynamics (CQED) [1], the study of radiation from sources in confined spaces, or, more precisely, in an optical cavity or resonator, is a proper subset of QED. Unlike QED, though, CQED has not achieved the great agreement between theory and experiments, but better understanding and analysis of CQED systems as well as greater experimental control of atomic beams is catapulting this field to the forefront of tomorrow's research.

Many exciting projects are being undertaken including, but not limited to, quantum field state engineering [2], microlasers [3], quantum logic gates [4] and extensions to condensed matter systems [5]. Excluding the last example, these experiments involve atomic beams passing through high-finesse optical resonators, and the latter case is realised as an exciton-cavity system with quantum wells in a monolithic semiconductor.

2. Quasi-molecules

In CQED the spectrum of the radiation field is modified by the presence of the resonator. For a nearly lossless cavity with one mode and strong dipole coupling between the cavity field and the atom, spontaneous emission is oscillatory rather than exponential over time. This oscillatory behaviour is due to the reversibility of spontaneous emission. The emitted photon is more likely to be reabsorbed by the atom than to be irretrievably lost to the universe.

This description oversimplifies the process, of course, and the electronic state of the atom and cavity mode are actually in a quantum superposition state of sharing the photon's energy. This entanglement, or quantum correlation (between the internal electronic state of the atom and the state of the cavity field) removes the separate identities of the atom and field and replaces the two entities by a single quantum beast, a beast which behaves as a rather large and peculiar quasi-molecule, or one-dimensional atom [6]. This quasi-molecule has its own unique spectrum and radiation properties. A major objective in CQED now is to make this beast, to get to know it and to play with it.

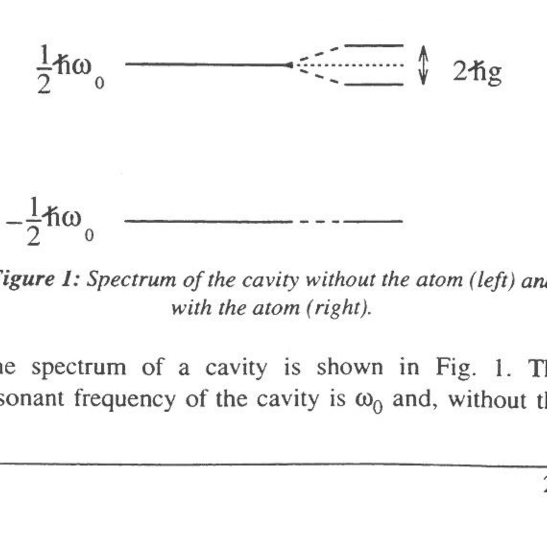

***Figure 1:** Spectrum of the cavity without the atom (left) and with the atom (right).*

The spectrum of a cavity is shown in Fig. 1. The resonant frequency of the cavity is ω_0 and, without the

atom, the cavity's energy levels are $n+½$ times the photon energy, where n is the number of photons. The presence of the atom modifies this spectrum by splitting all but the ground-state energy into couplets, and Fig. 1 depicts the "Jaynes-Cummings ladder" of so-called dressed states. The splitting is proportional to the dipole coupling strength g.

The square roots of integers in the energy splitting terms are direct consequences of the electromagnetic field's granularity and are very important in CQED; signatures of these square roots are also very hard to observe experimentally. The problem with observing these square roots and using them in applications is that the quasi-molecule is not dynamically stable. We don't have a way to glue the atom in place within the resonator; the atom tends to be moving or falling, and, as the coupling strength g between the atom and field depends on the atomic position $\boldsymbol{r}$ within the field mode, the quasi-molecule has a spectrum which varies with time as the atomic position varies.

3. Generating a Quasi-molecule

A quasi-molecule can be created by directing an extremely sparse atomic beam through the resonator with the atoms moving transverse to the cavity axis. The beam would have to be rarefied enough to ensure that two-atom and multi-atom effects are negligible in experiments. A typical atomic beam uses sodium with coupling between the hyperfine component of the D_2 line and a high-finesse confocal resonator. If the atoms are sufficiently slow, then there is some time-scale over which the coupling strength can be treated as constant, and the quasi-molecule has a fixed spectrum over this time-scale.

The trouble is that even if experiments are conducted over a short time-scale during which the atom is effectively frozen, its position $\boldsymbol{r}$ is uncontrollable, and therefore we don't know exactly what the coupling strength $g(\boldsymbol{r})$ is. Without control over the atomic position, the spectrum of the quasi-molecule is described, not by a fixed g, but by a distribution $P(g(\boldsymbol{r}))$, and this distribution leads to an inhomogeneous broadening of the spectral lines [7,8].

This inhomogeneous broadening is shown in Fig. 2. The Jaynes-Cummings ladder, truncated beyond two-quanta entangled-state resonances, is depicted for $g = g_{max}$, where g_{max} is the maximum achievable coupling strength for the atom in the cavity, and, as all coupling strengths from 0 to g_{max} can occur, the inhomogeneous width is bounded by g_{max}.

Our proposal to overcoming inhomogeneous broadening borrows from spectral hole-burning concepts and employs photon coincidence measurements. This new technique, photon coincidence spectroscopy (or photon correlation spectroscopy) [7,8] is based on (i) multichromatic excitation of the atom-resonator system to multi-quanta entangled states and (ii) multiphoton coincidence detection of the cavity output field to yield information about the decay of the multi-quanta entangled states.

In the variation presented in Fig. 2, a bichromatic driving field excites the quasi-molecule (by driving the atom directly as it passes through the cavity) to a subensemble of the population with coupling strength g_f selected by a laser with fixed frequency ω_f and amplitude $\mathcal{E}_f$. A second field, the scanning (or probe) field, with scanning frequency ω_s and amplitude $\mathcal{E}_s$, is used to probe for two-quanta excited state resonances.

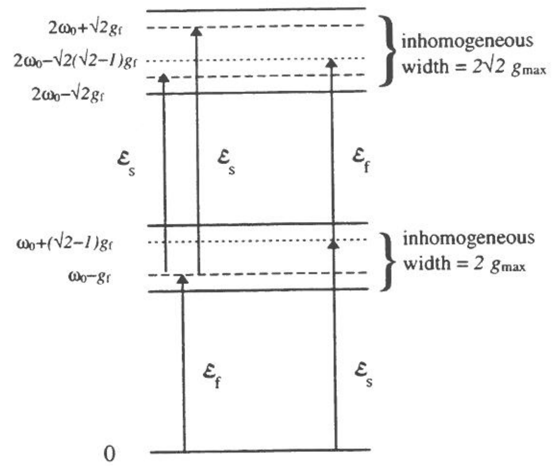

Figure 2: *Excitation of two-quanta entangled state resonances in the presence of inhomogeneous broadening [9].*

Three resonances arise as the scanning frequency is sampled, two due to excitation by ω_f to the subensemble $g=g_f$ and a third due to excitation by ω_s to the subensemble with $g=(\sqrt{2}-1)g_f$. The three peaks arise for $\omega_s = \omega_0 + \chi\, g/k$ for $\chi = \pm(\sqrt{2}-1)$ and $\chi = \sqrt{2}+1$ and yield a signature of the characteristic $2\sqrt{n}g$ splitting for the Jaynes-Cummings system [9].

4. Detecting the Entangles States

Our method of detecting these two-quanta entangled states is borrowed from particle physics where unstable particle resonances are detecting by correlating decay products, in this case photon pair emission from the cavity. We have shown that the photon pair coincidence rate, within a coincidence window corresponding to the cavity decay time T, can yield unmistakable signatures of single-atom operation by probing the multi-quanta resonances of the Jaynes-Cummings ladder. The three spectral peaks, shown in Fig. 3 for feasible parameters and after applying the subtraction process described

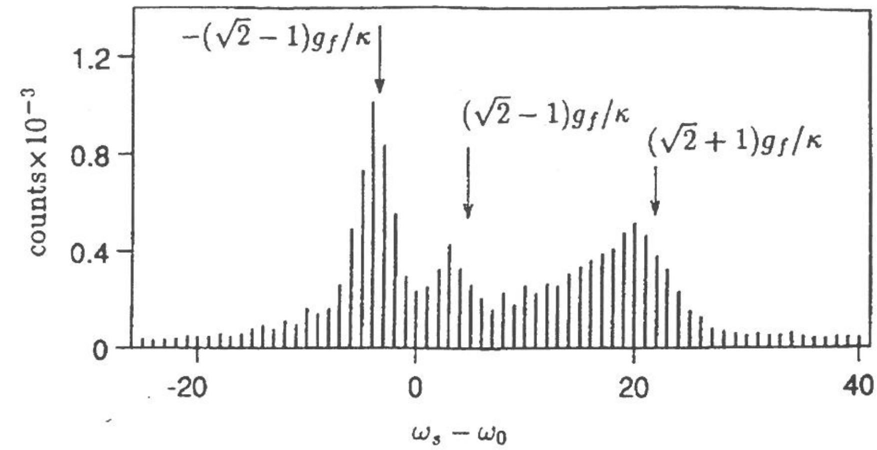

Figure 3: Three (simulated) two photon coincidence spectral peaks shown here are signatures of single-atom operation obtained by probing the multi-quanta resonances of the Jaynes-Cummings system.

below, appear as greatly enhanced photon pair emission rates from the cavity for particular values of the scanning field frequency.

Without subtraction, the two-photon coincidence spectrum is dominated by an inhomogeneously broadened peak located at the cavity resonance frequency due to scanning-field two-photon resonances.

Spectral hole-burning does not overcome this problem: the solution is to perform the experiment twice, first with both the fixed- and scanning-fields on, then with only the scanning field on. The two-photon coincidence rate obtained without the fixed field on is subtracted from the former, and all three peaks are then visible [9,10]. Thus, the elimination of inhomogeneous broadening in the two-photon spectrum requires both the hole-burning method and this background subtraction technique.

The experiments would be challenging but feasible. Photon-pair coincidence detection has been used to study optical bistability and photon statistics in CQED [10], and our proposal adopts this technique for 50 to 100 frequency channels.

5. Conclusion

The simulations are conducted for realistic parameter choices and indicate the feasibility of our proposal. The time-scale for accumulating data would be about an hour rather than minutes, but is possible, and we look forward to the day when these experiments are performed. These experiments would be an important step towards understanding and probing the quasi-molecule, allowing us to achieve the next stage of exploiting its potential, be it as atoms passing through cavities or as excitons in semiconductor quantum well structures!

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[10]. G. Rempe *et al,* Physical Review Letters **67,** 1727-30 (1991).

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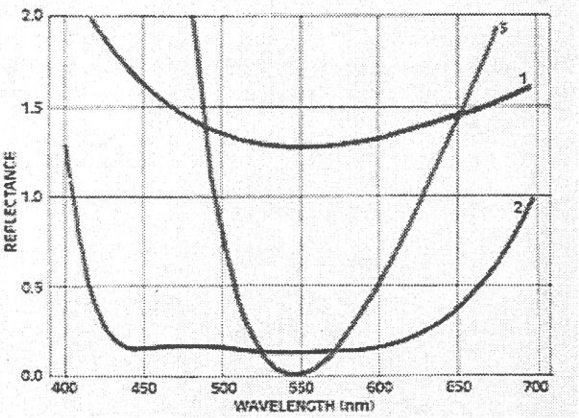

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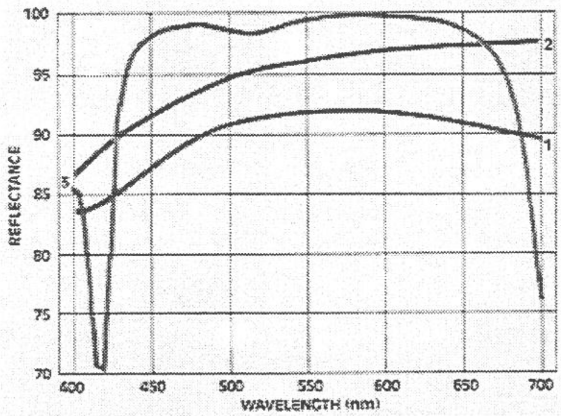

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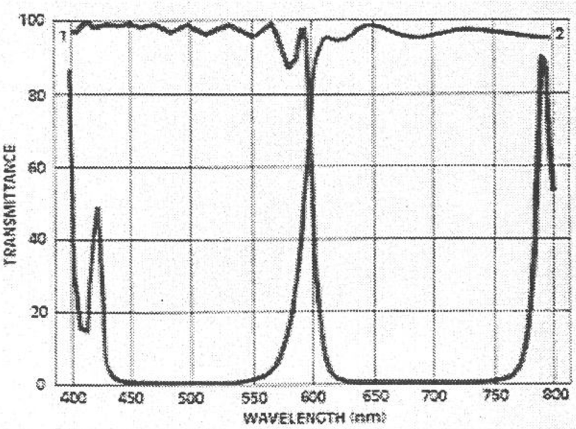

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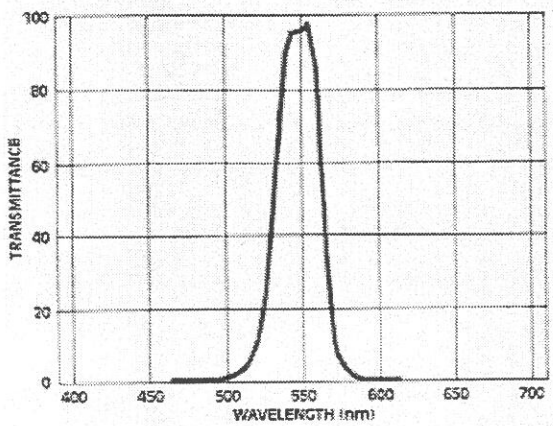

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Technical Note

Coping with Laser Power Fluctuations

Duncan Butler
CSIRO Division of Telecommunications and Industrial Physics, PO Box 218 Lindfield NSW 2070
(previously School of Physics, The University of Melbourne, Parkville VIC 3052)

Editor's note: This is the first of a new section which will appear occasionally in the AOS News. These technical notes aim to inform the reader about common optical problems. We hope they will be of practical use, particularly to the large student component of the AOS membership.

Two methods of dealing with laser power fluctuations are discussed, one based on active feedback and the other on the ratio of powers from two parts of the beam.

1. Introduction

The laser is a remarkable light source. The high radiance level and spectral purity of laser light are just two of the reasons why lasers are at the heart of so many applications in optics.

In practise, however, the behaviour of a laser can be far from ideal. The coherence length, which may be large compared to the wavelength, is not so large that it can be ignored in, say, interferometry. Although the wavelength is usually constant to better than 1 part in 10^6, it is not stable enough for high accuracy length measurement. The irradiance profile of a single line is usually only Gaussian to first order, and the total laser output is complicated by the presence of satellite beams, scatter, and the plasma discharge itself. On top of this the total beam power can fluctuate by as much as several percent.

Here we look at the problem of dealing with the fluctuations in the output power of a laser, and two possible solutions.

2. Laser Power Noise

A typical gas laser exhibits fluctuations in the beam power of the order of one percent of the total output. The source of the noise is usually fluctuations in the length of the tube caused by vibration or thermal expansion. Hence, water cooled lasers are generally a little noisier than uncooled lasers, such as the common HeNe. Diode lasers are much quieter due to their solid state nature, and in this case the level of noise is determined by the quality of the power supply.

Although the presence of noise is usually of no importance, there are times when this is not the case. In the comparison of detector responsivities [1], for instance, two detectors are used to measure, consecutively, the power in a laser beam. Obviously the accuracy of the comparison is compromised if the beam power changes during the experiment. Beam stability is also required when the beam profile must be measured using certain techniques. If the wavefront is to be mapped using point by point measurements (ie a scanning pinhole), or if measurements must be of great accuracy, laser fluctuations can be very destructive. On the other hand, if the measurement uses a long integration time, such as a film exposure, fluctuations may present no problem.

3. Total Beam Power

Keeping the total beam power of a laser constant is relatively straightforward. Indeed, some gas lasers can be operated in 'light mode' where the output of the tube is modulated to obtain some degree of stability. External stabilisation can be achieved by using a power monitor and some method of controlling the laser power in an active feedback loop.

A power monitor is easily made using a glass beam splitter and a photodiode (see Fig. 1). A wedged beam splitter is preferred because the secondary reflection from the rear face can be separated from the first, and hence interference between these two beams can be avoided. The angular separation of the two reflected beams is approximately 3α, where α is the wedge angle, usually about 1°.

The laser power can be controlled using an optoelectronic element which rotates the plane of polarisation of light. The degree of rotation is proportional to the voltage applied. A polarisation analyser placed after this element transmits light of only one polarisation, so that by varying the plane of

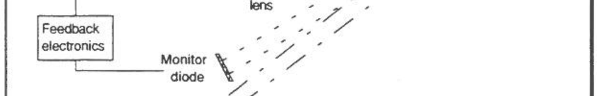

Figure 1: *Producing a stable optical beam using an electro-optic feedback loop (here the limiting aperture is larger than the laser beam).*

polarisation, the total throughput of the system is altered. Some electronics provide a feedback loop to keep the optical power at the monitor constant. The beam power in a 647.1 nm Krypton laser line as a function of time is shown in Fig. 2. The first ten minutes show the beam power with no stabilisation, and the second ten after the feedback loop is enabled. The standard deviation of the power fluctuations fell from 1.7% to 0.005%. (This is in part determined by the integration time, 0.5s, and the detector and amplifier noise).

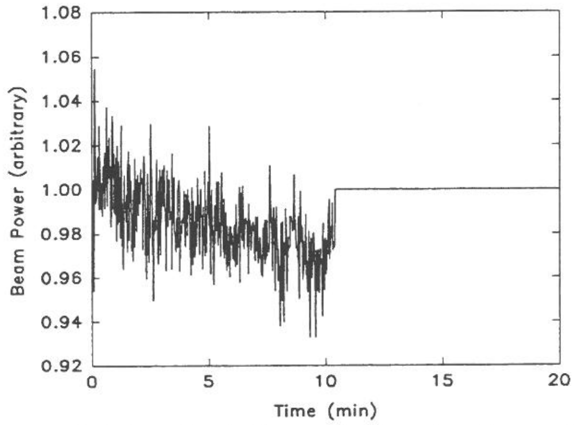

Figure 2: Effect of switching on feedback loop (at ≈ 10 minutes) on the noise in the total beam power.

The system described here has only a few difficulties in practice. The monitor detector must be large enough to receive all of the beam, otherwise small shifts in the laser direction are translated into power fluctuations. Care must be taken with inter-reflections between components; under certain conditions these can lead to the measured power being dependent on some possibly unstable path difference in the optics. As well, back reflections entering the laser cavity can increase the noise to the point where the servo mechanism can no longer cope.

A high quality commercial laser power stabiliser costs around $8,000 (AUS). A cheaper alternative is to purchase an electro-optic modulator, polariser and monitor diode, and then construct a stabiliser following a published circuit diagram [2]. A recent article in *Applied Optics* [3] discusses the optimum arrangement of electronics in this situation.

4. Stable Power and Unstable Profile

If the laser output is considered to be 'stable', it should have an irradiance profile which does not vary with time. However, the method discussed in section 3 makes use of the total beam power (the integral of the beam profile), and this does not necessarily imply a stable laser wavefront. The response of the servo system to shifting beam direction or changing mode structure is simply to hold the total power constant: changes in structure are ignored provided the integral remains the same.

The presence of a spatial filter in Fig. 1 goes some of the way to smoothing the beam profile, so that the total power should be related to the beam amplitude in a straightforward and unchanging way. However, in practice some fluctuations persist, possibly due to the presence of directional variations in the beam.

The consequences of these fluctuations can be significant. Imagine a straight edge inserted into the stable part of the beam in Fig.1. This edge projects a diffraction pattern with a well known fringe structure. Attempts to measure this pattern with, say, a scanning pinhole will encounter a significant amount of noise even when the beam is well stabilised before the edge. That is, the directional changes in the beam are translated into irradiance variations in the diffraction pattern. Of course, the stabiliser provides a significant improvement over an unstabilised laser. However, the magnitude of the improvement is determined by the stability of the wavefront, and this is itself a complicated function of the laser, the geometry of the optics, and mechanical vibration.

5. Unstable Wavefronts

To see that a beam from a laser has a shifting wavefront consider the following simple experiment (Fig.3). The output from a laser is divided into two beams, both of which are incident on detectors which are masked by pinholes.

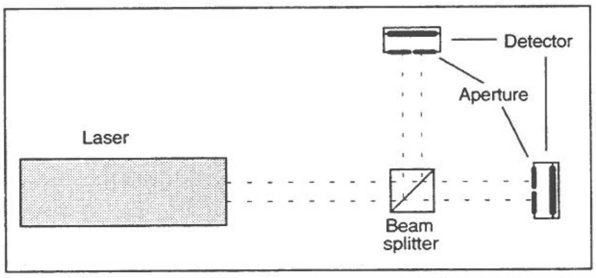

Figure 3: Observation of beam wavefront fluctuations in a HeNe laser.

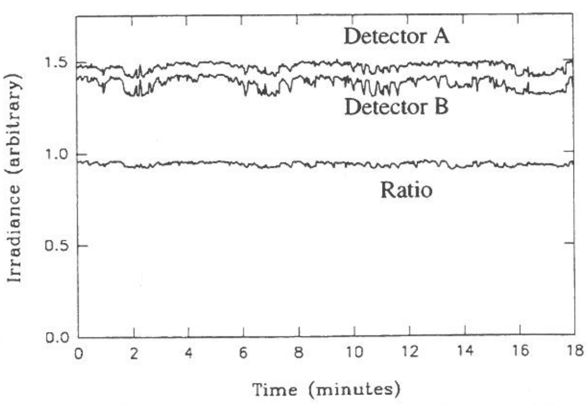

Figure 4: Signals from two detectors (as shown in Fig. 3) masked with pinholes looking at the same laser beam divided by a beam-splitter. The ratio is not constant with time.

One might expect that the signals from each detector will be proportional. However, data from such an experiment, shown in Fig. 4., indicate that this is not the case. Directional and modal variations in the beam produce different quantities of light at each pinhole, and the signals from the two detectors are not well correlated (although clearly a small correlation exists).

It is worth noting that when the pinholes are removed the ratio of signals is constant. Thus the difference between the signals cannot be ascribed to mismatched integration times or detector responses.

6. Stabilising the Wavefront

As previously noted, a spatial filter can improve the wavefront stability but is not the complete solution. We found that better spatial filtering could be achieved by using a length of single-mode optical fibre. The improvement appears to be due to the elimination of directional variations; the beam profile emerging from a single-mode fibre is truly independent of the input beam. In addition, a beam splitter can be incorporated into a length of fibre (together known as a *directional coupler*), so that the whole apparatus can be made insensitive to vibration and thermal expansion.

One possible arrangement is depicted in Fig. 5. Laser light is coupled into a fibre using an objective lens. A directional coupler directs 10% of this light into a monitor diode, and the remainder emerges from the other arm to be used in an experiment.

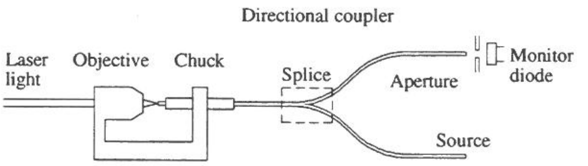

Figure 5: *Removing laser fluctuations using optical fibre to produce firstly a constant beam profile.*

An electro-optic modulator can be placed in front of the laser and used to keep the signal at the monitor, and therefore also at the source, constant. However, for the application for which this technique was developed, the total beam power was not important. (The application was the measurement of the irradiance distribution emerging from a fibre, using a scanning pinhole of sub-wavelength dimension [4]). Here a feedback system was not required, and we chose instead to ratio measurements of the irradiance to the monitor signal.

A ratio technique requires either synchronous detection, or measurement faster than the changes in beam power. The later option was used with each detector read consecutively using an analogue to digital converter in a personal computer. Thirty of these readings were interlaced and the average taken to obtain the signal from the monitor and the detector at each point (these detectors were each masked with a 500 μm pinhole). The result is shown in Fig. 6. The signal ratio is more stable in time than the corresponding ratio in Fig. 4.

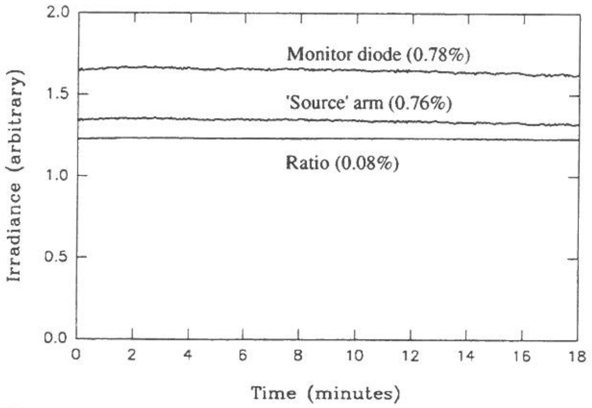

Figure 6: *Ratio of detector signals for the monitor and a detector on the 'source' arm of the directional coupler (Fig. 5). The RMS noise is shown for each signal.*

The cost of a ratio technique is much less than that of active stabilisation. Directional couplers are of the order of $200, and the remaining components can be purchased for similar amounts (if they are not already available in the lab). The electronics for the ratio technique are discussed in detail in reference [3].

6. Conclusion.

Dealing with laser beam noise can be tricky if the beam profile is changing with time. For some applications only the total power is important, but if the irradiance is required then some form of spatial filtering should be used to generate a constant profile. We find that passing the beam through a single-mode optical fibre is a good solution to this problem. Once the beam shape is stable, active feedback can be used to keep the total power constant, or a ratio technique used to correct irradiance measurements made with the beam.

The effectiveness of these solutions will depend on a multitude of factors, including the initial laser noise, the mechanical and thermal stability of the optics, and the quality of the detectors and electronics used. Indeed, in many instances solid state lasers may represent an easier alternative to active beam stabilisation or ratio techniques.

Acknowledgement

The author wishes to thank Prof. Keith Nugent for his ideas concerning the ratio method presented here.

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[1]. For example, N.P. Fox, Metrologia, **28**, p197 (1991).
[2]. US National Bureau of Standards, Technical Note **987** (1979)
[3]. P.C.D. Hobbs, Appl. Opt. **36**, p903 (1997)
[4]. D.J.Butler, K.A.Nugent and A.Roberts, *J.Appl.Phys.*, **75** (6), p2753, (1994)

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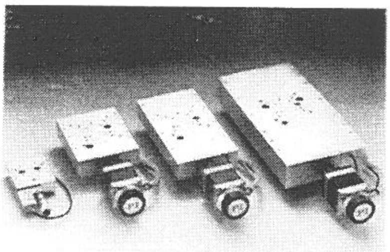

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from RENISHAW

Renishaw, the manufacturer of 2D imaging Raman microscopes and Raman spectroscopy systems have announced that it has been granted key patents for its technology by the European and U.S. Patent Offices.

They relate to Renishaw's use of a holographic filter at a low angle of incidence as a beamsplitter.

This has the dual purposes of injecting the illuminating laser light into the optical path, and rejecting scattered light of the laser wavelength from the resulting Raman spectrum.

With further patents covering direct 2D imaging using a tunable filter, and for their 'easy confocal' technology, these innovative technologies give Renishaw's customers many unprecedented advantages in terms of high performance, high throughput and ease of use.

from Levy Hill Laboratories

Levy Hill Laboratories have just announced the shipment of their 100th MkVI radiometer/photometer.

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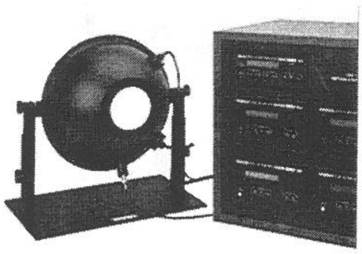

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PO Box 1685 Strawberry Hills NSW 2012
tel: (02) 9319 0122
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ICONEWSLETTER

Commission Internationale d'Optique ◆ International Commission for Optics ◆ January 1997

From the ICO-17 Congress

Every three years, ICO holds a Congress. The ICO Congress consists of a business part, known as the ICO General Meeting, and an International Scientific Conference part. The 17th Congress of ICO was held at the Riviera Hotel at Taejon, South Korea. The event attracted 538 participants from 33 countries, who together authored over 450 communications. Unfortunately, the authors of a number of other accepted communications were unable to make it to the meeting. The 167 oral communications, including 25 invited talks, were held in four parallel sessions. Five plenary papers highlighted some remarkable aspects of progress in optical science:

- L. Hesselink and coworkers, U.S.: "Holographic digital data storage systems,"
- T. Kamiya, Japan: "Progress in ultrafast optoelectronics,"
- B.Ya. Zel'dovich and coworkers, Russia and U.S.: "Spin-orbit interaction of a photon: mutual influence of polarization and propagation,"
- G.C. Righini, Italy: "Glass integrated optics: advances and perspectives,"
- D. Maystre and coworkers, France: "Theoretical study of photonic band gap structures,"

In addition, three ICO Prize winners delivered their Prize lectures:

- A.K. Rebane, Switzerland, 1993 ICO Prize winner: "Time-and-space-domain holography in frequency-selective spectral hole burning materials,"
- E. Desurvire, U.S. and France, 1994 ICO Prize winner: "Erbium-doped fiber amplifiers for a new era of optical communications," and
- T. F. Heinz, U.S., 1995 ICO Prize winner: "Surface studies with laser techniques."

The newly elected ICO Bureau at Taejon, August 1996. Left to right: A.T. Friberg, M.C. Hutley, S.S. Lee, P. Chavel, A. Consortini, R. Dandliker, T. Asakura, F. Merkle, K. Chalasinska-Macukow, G. G. Mu, J. Ojeda- Castaneda, and A. H. Guenther. Not pictured: R. R. Shannon. Copies of the ICO triennial report, "Toward ICO-17," may be obtained from the ICO secretariat.

ICO-17 was organized by the Optical Society of Korea and by KAIST, the Korean Advanced Institute for Science and Technology. The conference chairs were Sang-Sung Lee of KAIST, vice-president of ICO, and Anna Consortini of Universita di Firenze, Italy, president of ICO.

The ICO General Meeting consists of delegates from each member territory, who have a number of votes determined using the guidelines of the International Union of Pure and Applied Physics. The decisions approved at the General Meeting in Taejon include the following:

- The ICO expressed support for the initiative of the "Coalition for Optics" (CFO) (since the general meeting, the "Coalition for Optics," changed its name to the "Coalition for Photonics and Optics (CPO)") by endorsing it's mission to "promote the interests of the optics community," and by accepting the invitation of CPO to send an observer to share information about CPO with interested organizations outside the U.S. and coordinate their initial *Continued on next page*

1996 Galileo Galilei Award Winner: Daniel Malacara

The ICO Galileo Galilei Award for 1996 has been given to Daniel Malacara (Mexico) for his numerous contributions to the advancements of optics, in particular in the field of interferometry, for his contributions to the dissemination of optical knowledge through outstanding scientific articles, books, and conferences, and for his important role in the development of major centers of research in optics in Mexico.

Daniel Malacara

Born in Leon, Guanajuato, Mexico in 1937, Malacara graduated from the National University of Mexico and from the University of Rochester. In 1965 he joined the Institute of Astronomy of the National University of Mexico, where he founded the Department of Optics, the first one in the country.

He has been a promoter and leader in the creation of several optics institutions in his country. In 1972 he collaborated with Guillermo Haro in the creation of the Instituto Nacional de Astrofisica, Optica y Electronica in Tonantzintla, Pue. Mexico, where he became the first technical director and professor. In 1979 he returned to the National University of Mexico, to work with Arcadio Poveda in a project for the establishment of the Centro de Investigaciones en Optica, Leon, Gto. In 1980 the new institution was officially created and he became its first general director, for two consecutive periods, from 1980-1989. In 1987 he was the promoter and one of the co-founders of the Mexican Academy of Optics, of which he was elected the first president.

The design and construction of optical instruments have always been part of his activities. He supervised during the construction of the Ritchey-Chretien 2.1 m diameter telescope at Cananea, Sonora, Mexico, and the 0.8 m diameter telescope in Baja California, Mexico, as well as the development of the first Helium-Neon and Argon lasers made in Mexico, in 1965.

Malacara has authored or edited several optics books (five in English and six in Spanish). Most famous among these is *Optical Shop Testing*, which has been translated into Russian, Chinese, and German.

His scientific production, published in over 100 papers, include the fundamental analysis of the Ronchi test, the invention of several holographic interferometers for optical testing, contribution to the analysis of interferograms *Continued on last page*

ICO Territorial Committees: News, Organization, History

The Chinese Optical Society ICO Territorial Committee

The Chinese Optical Society (COS) became an ICO Territorial Committee, *i.e.*, an ICO member, in 1987. Its present membership classification is eight units and implies four votes in the General Meeting. COS was refounded in 1979 and is affiliated with the China Association for Science and Technology as a member society. It has established 16 Topical Committees for the following fields: Fundamental optics, optical engineering, optical materials, lasers, infrared radiation and photoelectric elements and devices, optical literature and references, high-speed photography and photonics, spectroscopy, color optics, optical thin films, holography and optical information processing, fiber optics and integrated optics, optical measurements, medical optics, opto-electronic technology, and laser processing. The main journals published by COS are: *Acta Optica Sinica* (monthly), the *Chinese Journal of Lasers A* (monthly, in Chinese), the *Chinese Journal of Lasers B* (bimonthly, in English), the *Journal of Infrared and Millimeter Waves* (bimonthly), *Spectroscopy and Spectral Analysis* (bimonthly), and the *Chinese Journal of Laser Medicine and Surgery* (monthly).

COS operates by "sessions" and has at present reached its fourth session. In this session, there are two honorary presidents, one president, and four vice-presidents. Jici Yan and Daheng Wang from the Chinese Academy of Sciences are the honorary presidents, Guoguang Mu from the Nankai University is the president, Fuxi Gan and Zhizhan Xu from the Chinese Academy of Sciences, Bingkun Zhou from Tsinghua University, Prof. Jingyao Hao from the North China Optoelectronic Industries Corporation are the vice-presidents.

Guoguang Mu served as vice-president of ICO in 1993-1996 and is presently serving a second term in that capacity. COS has a favorable experience of cooperation with ICO. ICO acted as a sponsor of the Second International Conference on Opto-electronic Science and Engineering, Beijing, 1994 and endorsed the International Conference on Holography and Optical Information Processing, ICHIOP '96 held in Nanjing in 1996. ICO and COS will jointly hold the ICO Topical Meeting on "Optics for the Information Infrastructure" in Tianjin in 1998. The COS, as an ICO Territorial Committee, is looking forward to this opportunity of welcoming colleagues from all over the world.

New Bureau for the Mexican ICO Territorial Committee

The Academia Mexicana de Optica, AMO, is serving as the ICO Territorial Committee in Mexico. Its president for 1996 and 1997 is J. Ojeda-Castaneda of Universidad de las Americas. The president -elect, who is also ex officio in charge of ICO relations, is Gustavo E. Torres-Cisneros, prol. Tampico s/n, Apartado Postal 215-A, Salamanca, Gto, 36730 Mexico, fax +52 464 7 24 00, amo@salamanca.ugto.mx.

ICO-17 Congress

Continued from previous page

representation within CPO. Since the general meeting, the "Coalition for Optics," changed its name to the Coalition for Photonics and Optics (CPO)." ICO will also promote the recognition of optics, in particular its recognition as a discipline. The ICO will soon explore ways to improve the place and visibility of optics within the International Council of Scientific Unions.

- Cuba and Ghana were transferred from associate membership to full membership in ICO, the membership of Ukraine was confirmed, and Turkey was admitted as a new member. As a consequence, ICO has now 44 member territories and no associate members.
- The next ICO Congress, ICO-18, will be held in San Francisco, Calif., August 2-6, 1999, with a satellite meeting in Mexico.
- The annual subscription unit will be held constant at U.S.$150 per membership share. The total income from members will therefore remain approximately U.S.$25000 per year. The other sources of income being significantly lower, ICO will continue to rely on the voluntary services of many opticists throughout the world for its programs.
- A slight change was made to the ICO Statutes to introduce a position of associate secretary in the Bureau and modified ICO Rules and Codes of Practice were adopted. The latter document includes procedures for membership application and for ICO participation in meetings and schools. It is available from the ICO secretariat.
- The 1996-1999 ICO Bureau was elected. The results of the votes are as follows: President: T. Asakura (Japan); Past-President: A. Consortini (Italy); Secretary: P. Chavel (France); Associate Secretary: A. T. Friberg (Finland); Treasurer: R. R. Shannon (U.S.); Vice-Presidents: K. Chalasinska-Macukow (Poland), R. Dandliker (Switzerland), A. H. Guenther (U.S.), M. C. Hutley (UK), S. S. Lee (Korea), F. Merkle (Germany), G. G. Mu (China), and J. Ojeda-Castaneda (Mexico).

Adaptive Optics for Industry and Medicine Workshop to be held in Russia

An ICO co-sponsored event, the International Workshop on Adaptive Optics for Industry in Medicine will be held June 9-13, 1997, in Shatura, Moscow region, Russia. The workshop co-chairs are J. C. Dainty (Imperial College, UK), F. Merkle (Carl Zeiss, Germany) and V. Panchenko (NICTL, Russia).

Adaptive optics is usually known as a technology for astronomical applications. However, because of the widespread use of lasers for medical and industrial applications, adaptive optical methods and elements are increasingly being applied to light beam control in various areas. This workshop, the first of its kind, is specifically directed at potential non-astronomical applications of adaptive optics, which include among others intra-and extracavity control of laser beams, retinoscopy, light-of-sight optical communication, fringe stabilization, underwater applications, and microscopy. The program committee will invite leading scientists in this field to give lectures on the latest achievements in the field. The workshop will cover the following main problems: What is the success of adaptive optics in industry and medicine and can it best be used? It is co-sponsored by OSA, ICO, EOS, SPIE, Russian Basic Research Foundation, Ministry of Science of Russia, the Administration of Shatura, Technolaser (Russia), and the U.S. Army Research Laboratories.

The topics to be considered include intracavity and extracavity active and adaptive optics for lasers and laser technology; nonlinear and non-conventional adaptive systems; adaptive interferometry novel laser cavity; adaptive optics in medicine adaptive picture reconstruction; low cost systems; correctors and wave front sensors. All participants of this workshop are expected to present an oral or poster paper as well as contribute to discussion. The abstract deadline is January 15, 1997.

For information about this workshop please contact A. Kudryashov, PL/LIMI, 3550 Aberdeen Ave. SE, Kirtland AFB, NM 87117-5776, USA; fax)+1-505-846-2045; koudriea@plk.af.mil

Forthcoming Events with ICO Participation

February 9-13, 1997
10th Meeting on Optical Engineering in Israel
Jerusalem, Israel. Contact: R. Stankevich, Assoc. Engineers and Architects in Israel, P.O. Box 3082, Tel Aviv 61030 Israel; fax) +972 3 5244618.

March 16-21, 1997
OC '97, Topical Meeting on Optics in Computing
Lake Tahoe, Nevada, USA; Contact: Optical Society of America Conference Services, 2010 Massachusetts Ave., NW, Washington DC 20036-1023; fax) +1 202/223-1096; http://www.osa.org.

April 2-4, 1997
ECIO '97, Eur. Conf. on Integrated Optics
Stockholm, Sweden. Contact: ECIO '97, Institute of Optical Research, S-100 44 Stockholm; fax) +46 8 789 6672; ECIO97@optics.kth.se.

June 9-13, 1997
Intl Workshop on Adaptive Optics for Industry and Medicine,
Shatura near Moscow; Contact: Adaptive Optics, NICTL, Gubkina 3, B-333 Moscow, 117971 Russia; fax) +7 095 135 54 30; adopt@laser.nictl.msk.su.

July 7-9, 1997
EOS Topical Meeting on Diffractive Optics
Savonlinna, Finland. Contact: Prof. J. Turunen, Dept of Physics, Univ. Joensuu, P.O. Box 111, 80101 Joensuu, Finland; fax) +358 13 251 3290; eosdo-97@ilmari.joensuu.fi.

August 19–22 1997
Education and Training in Optics
Delft, the Netherlands. ICO Fiftieth Anniversary Topical Meeting, organized in association with SPIE. Contact: Prof. H.J. Frankena, Technische Univ., Lorentzweg 1, 2628CJ Delft, Netherlands; fax) +31 15 278 81 05; edu97@optics.tu.tudelft.nl; http://www.tn.tudelft.nl/optica/optica.html.

August 26-30, 1997
OIST'97, Optical Information Science and Technology
Moscow, Russia. Contact: M.V. Politov, Inst. for Optical Neural Technologies, 44/2 Vavilov Street, Moscow 117333, Russia, fax (7) 095 925 5972 fax box K-03, e-mail iont@glas.apc.org

September 9-12, 1997
RomOpto'97
Bucharest, Romania; Contact : Prof. V. Vlad, Inst. Atomic Physics, Lasers Dept, P.O.Box MG-36, Magurele Bucharest, fax +401 420 9391, vlad@roifa.ifa.ro.

First Semester 1998
6th Optilas and III Reunion IberoAmericana de Optica
Bogota, Columbia; Contact: Prof. A. Guzman, Univ. Nacional de Colombia, Bogota; fax) +57 1 2225716; angela@ciencias.campus.unal.edu.co.

August 3-6, 1998
Optics for the Information Infrastructure, ICO Topical Meeting
Tianjin, China. Contact : Prof. G.G. Mu, Nankai Univ., 94 Weijin Road, Tianjin 300071, China; fax (86) 22 350 2974; imo@sun.nankai.edu.cn.

September 1998
Optika'98
Budapest, Hungary; Contact: OPAKFI, Fo u. 68, 1027 Budapest; fax) +36 1 202 0452.

August 2-6, 1999
ICO-18
Congress of the International Commission for Optics "Optics for the New Millenium," San Francisco, Calif., U.S.

ICO Fiftieth Anniversary Topical Meeting to be Devoted to Optics Education and Training

The fifth International Topical Meeting on Education and Training in Optics will be held at Delft University of Technology, Delft, the Netherlands, August 19-22, 1997, in celebration of the fiftieth anniversary of ICO. The meeting will be chaired by Dr C.H.F. Velzel of Philips Laboratories, Eindhoven and S.S. Ballard and G. Toraldo di Francia, two of the founders and former Presidents of ICO, will be honorary guests. The meeting will address issues concerning optical education at academic institutes as well as training within industry. Sessions are being planned on the following topics: training and laboratory equipment for demonstrations; training in industry; education in geometrical optics; education in quantum optics; software for optics. Other sessions will be added to the list at a later stage of program preparation. Original contributions are solicited on the above and related topics. They should include the title, the list of authors, the address, telephone, fax and e-mail address for correspondence, the preferred form of presentation (oral or poster), a 250 words abstract, and a 50 to 100 words biography of at least one author. Submissions should be sent in four copies by February 15, 1997 to Education and Training in Optics, attn. Prof. H.J. Frankena, TU Delft, Dept of Applied Physics, Optics Research Group, Lorentzweg 1, 2628 CJ Delft, the Netherlands. Fax and plain ASCII text e-mail submissions are welcome (fax +31 15 278 8105, abstracts@optica.tn.tudelft.nl). More information can be found at http://www.tn.tudelft.nl/optica/optica.html or obtained from edu97@optica.tn.tudelft.nl.

International Commission for Optics

International Commission for Optics. Bureau members: President: A. Consortini; Past-President: J.P. Dainty; Treasurer: R.R. Shannon; Vice-Presidents: T. Asakura, K. Chal-asin' ska-Macukow, S.S. Lee, F. Merkle, G.G. Mu, G.T. Sincerbox, C.H.F. Velzel, M.J. Yzuel; Secretary: P. Chavel.

International Commission for Optics, secretariat: B.P. 147, 91403 Orsay cedex, France, phone (33)1 69 41 68 44, fax (33)1 69 41 31 92, e-mail: Pierre.Chavel@iota.u-psud.fr

Optical Society of America, 2010 Massachusetts Ave., NW, Washington, DC 20036; 202/223-8130; fax 202/223-1096; info@osa.org.

Traveling Lecturer Program

ICO has established a Traveling Lecturer Program to promote lectures on modern aspects of optics in interested territories by scientists of international reputation with good lecturing skills. The program is aimed at developing nations, but is not necessarily restricted to them. As a rule, it is expected that the lecturer's local expenses will be met by the host institution and that ICO's contribution will be towards the travel costs. For the triennium 1996-1999, the ICO budget includes an amount of U.S.$5000 for the Traveling Lecturer Program. While an ICO Traveling Lecture may be given during a trip where the Traveling Lecturer is also an invited speaker at a conference, or a visiting scientist at a research institution for some period, the funds will be granted only for the presentation of a series of lectures on some active subfield of optics in one or preferably several laboratories in one (or several) foreign countries. This form should normally be submitted by the host (or one of the hosts).

Applications should be filed at the earliest possible time when plans start to be clear and sent to the ICO treasurer, Robert R. Shannon, CIO, P.O. Box 32576, Tucson AZ 85751- 2576, USA, fax)+1 (520) 721-1035; shannon@ccit.arizona.edu.

Name of traveling lecturer: ______________________________

Address, fax, e-mail (as applicable): ______________________________

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Detailed route: institutions to be visited, person responsible for hosting lecturer at every institution, tentative dates, lectures titles:

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Name and capacity of person submitting application ______________________________

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Address, fax, e-mail (as applicable): ______________________________

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1996 ICO Galileo Galilei Winner

Continued from first page

with Zernike polynomials, the invention of various configurations for shearing interferometers and numerous original contributions to the fields of geometrical optics and lens design. Malacara has supervised the thesis work of over 30 students.

He is a Fellow both of the Optical Society of America and The International Society for Optical Engineering (SPIE). He served as a Vice-President of ICO in 1987-1990 and in 1988 he became a member of the Board of Governors of SPIE. He contributed extensively to meeting organization and served as a Topical Editor for Applied Optics from 1989 to 1992. He has received from the Mexican Academy of Sciences in 1983, the Scientific Research Prize, and the National Prize for Technology, from the Mexican Government, in 1986. He was also granted the Rudolf and Hilda Kingslake Chair by the University of Rochester in 1989 and also received in 1994 the A. E. Conrady Award for Scientific Achievement by the International Society for Optical Engineers.

The Galileo Galilei Award of ICO was established in 1993 to recognize outstanding contributions to the field of optics achieved under comparatively unfavorable circumstances regarding the economic and social conditions and the access to scientific facilities and sources of information. It consists of the Galileo Galilei Medal, donated by the Societa Italiana di Ottica e Fotonica, funding of registration and approved local expenses at an ICO Meeting where the winner will give a presentation based on his achievements, and appropriate measures of ICO to support the future activities of the award winner. The ICO Galileo Galilei Award Subcommittee for 1994- 1996 consisted of H. H. Arsenault (Canada), T. Asakura (Japan), G. G. Mu (China), J. Perina (Czech Republic) and M. J. Yzuel (Spain), Chair.

Erratum

ICO Prize: The address of the ICO Prize Committee chair was inaccurate in the October 1996 Newsletter. Please send applications to: K. Chalasinska Macukow, chair, ICO Prize Committee, Warsaw Univ., Institute of Geophysics, Pasterua 7, 02-293 Warsaw, Poland; fax) +48 22 222387; kmacukow@mimuw.edu.pl.

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A New Diode Pumped, Q-Switched and Frequency Doubled Nd:YAG Laser

The T40-Y70-532Q is a diode-pumped, q-switched Nd:YAG laser externally frequency doubled using NCPM LBO. This laser, is designed as an alternative for traditional arc-lamp pumped Nd:YAG lasers currently used in materials processing applications. Average output power exceeds 3W at 532nm in the 7-lOkHz PRF range Pulse energy at lkHz exceeds .75mJ in a 70ns pulsewidth. The laser system is built upon Spectra-Physics' patented FCbar platform, recently recognised in the laser industry as the defacto standard for high power diode pumped solid state laser design. This highly efficient system allows the 20W bars to be derated by >25% for significant gains in diode bar lifetime. The FCbar modules are located in the T40 power supply, which provides total thermal management for the diode bars The T40 operates from standard 110V or 220V single phase outlet. The system is fully air-cooled; no closed loop water system. The Y70-532Q laser head is a rugged, field proven resonator ideally suited for demanding OEM applications.

Hytek- High-Speed Laser Diode Driver for High Current Digital Modulation

Hytek Microsystems has introduced a high-speed, high-current, laser diode driver for digital modulation of laser diodes. Applications of the HY-6110 include laboratory research and satellite-to-satellite communications requiring high power. By incorporating the technique of backmatching, the HY-6110 laser diode driver enables the laser diode to be driven through a 50 ohm coaxial transmission line with the driver located up to a meter away from the diode.

The HY-6110 features a GaAsFET current switch that drives a laser diode with modulation currents of up to 200mA peak-to-peak, along with a single-ended ECL input. Two programmable current sources allow the user to select the desired bias (zero to 40mA) and modulation (zero to 200mA) currents, on a 500MHz bandwidth. If desired, Hytek can package the HY-6110 laser diode driver with a thermoelectric cooler, providing a complete system for operating a high-speed, high-current, semiconductor laser diode.

Oriel's Fibre Optics

Need to carry light to hard to reach areas? For the most extensive line of fibre optics light guides, you can depend on Oriel Instruments. Oriel offer single and multi-branch fibre bundles that consist of many closely packed fibres that collect and transfer light from sources or samples; Liquid Light Guides that have excellent UV transmission; single fibres with cores from 200 to 1000,um preserve brightness and are economical, and Multi-track Fibres that are best suited for two dimensional detectors, such as CCDs.

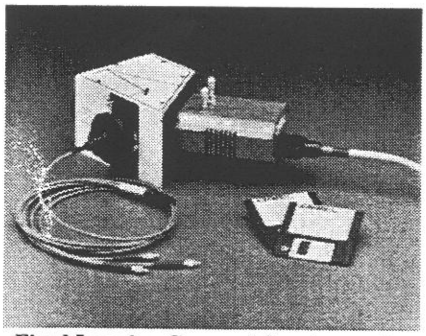
In addition, Oriel offers Fibre Optic Holders and Positioners that range from simple low cost rod mounted holders to sophisticated X, Y, Z Positioners, and UV-IR Fibre Optic Illuminators consisting of integrated systems or modular components.

Spectral Analysis of Optical Filters Using Ocean Optics Spectrometers

October 1996 - Ocean Optics has developed a low-cost spectrophotometric accessory for fast, convenient absorbance/transmission measurements of optical filters.

Ocean Optics' In-line Filter Holder/Shutter accepts 1" round or 2" x 2" square optical filters, up to 1/4" (6mm) in thickness, and has a manual light-block wheel for taking dark readings. The assembly provides a convenient place to put filters into optical setups, or acts as an effective device to measure filters.

The In-line Filter Holder can be used for UV, VIS or Shortwave-NIR experiments. The filter holder retails for A$790.00. The l cm pathlength filter holder assembly includes a pair of 5mm diameter focusing collimating lenses to maximise light throughput. Plastic supports hold SMA terminated fibres steady during use.



Fixed Imaging Compact Spectrographs

Looking for compact, economical, efficient spectrographs? Oriel's FICSTM - Fixed Imaging Compact Spectrographs - family of four, all with ion-etched holographic concave gratings, is the answer.

Oriel's FICSTM family provides spectral resolution with precise imaging of the input slit in the flat output field. Each spectrograph features a corrected output focal plane that is between 23.3 and 25.6mm long in the spectral direction, depending on the model you choose. Each FICSTM has a focal plane matched to Oriel's popular InstaSpec™ ICCDI CCD, and PDA Multichannel Detection Systems.

If you need efficiency, you'll find it in the FICSTM family, large concave gratings mean high throughput. This large grating design gives you highly efficient f/2.1 optical performance. The low f/# was chosen as a close match to the ca. F/2.2 emergent cone from fused silica fibres. No f/# matching is required to prevent overspill, and the fibre ends can act as the input slit.

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AUSTRALIAN OPTICAL SOCIETY

1997

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First ______ *Second* ______ *Third* ______

1 astronomical optics	*8 optical design*	*15 nonlinear optics*
2 atmospheric optics	*9 optical physics*	*16 teaching*
3 communications and fibres	*10 radiometry, photometry & colour*	*17 holography*
4 electro-optics	*11 spectroscopy*	*18 (.......................................)*
5 fabrication and testing	*12 thin films*	*19 (.......................................)*
6 information processing	*13 vision*	*20 (.......................................)*
7 lasers	*14 quantum optics*	

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