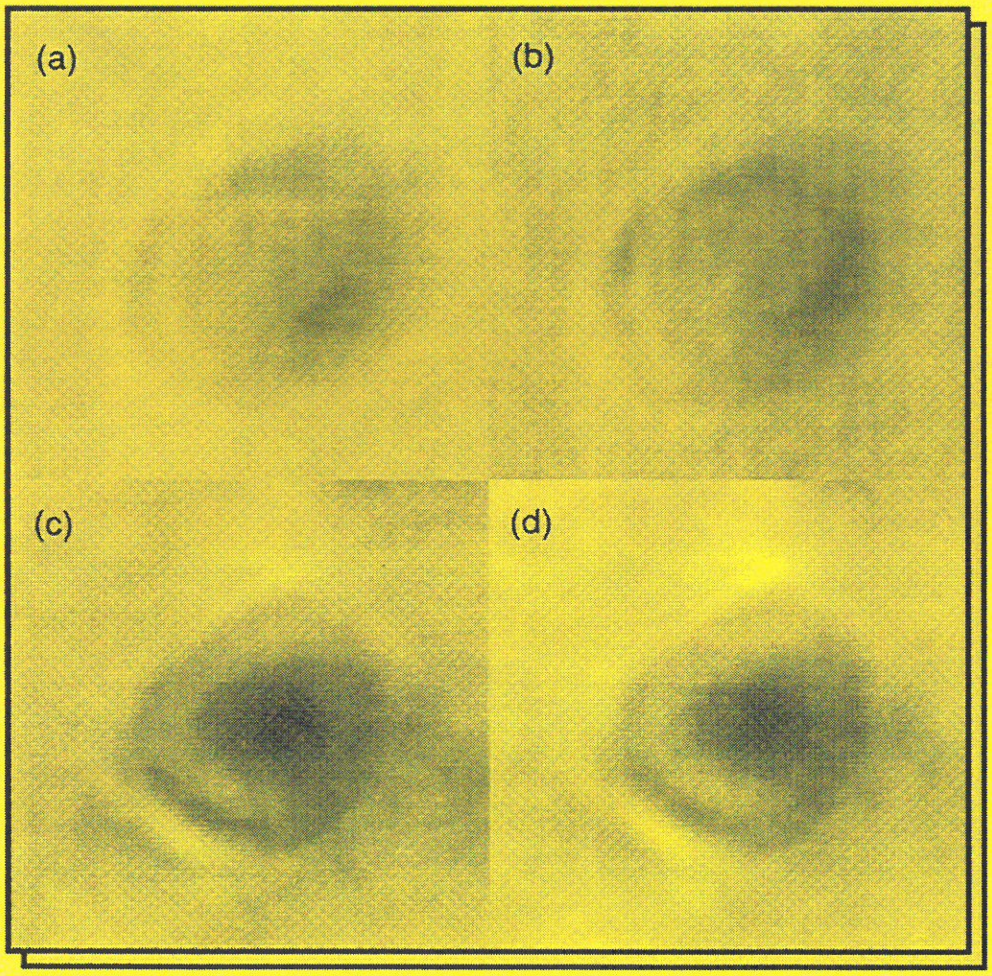
Australian Optical Society

NEWS



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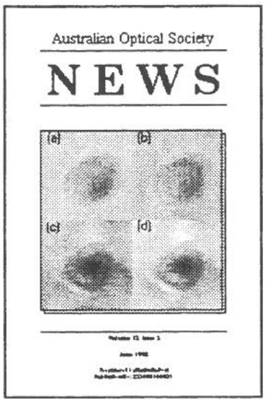
AOS NEWS



COVER:
Images of a polystyrene bead embedded in a turbid medium. The bead is 22 µm in diameter.

A conventional microscope image is shown in (a). By using annular lenses to reduce the number of scattered photons reaching the detector, the image contrast is improved (c).

Images (b) and (d) are the same as (a) and (c), except that polarises were used to further suppress scattered photons.

Research into imaging in turbid media is directed at the medical field, where it is relevant to non-invasive imaging with non-ionising radiation. See p15.

SUBMISSION OF COPY:
Contributions on any topic of interest to the Australian optics community are solicited, and should be sent to the editor, or a member of the editorial board. 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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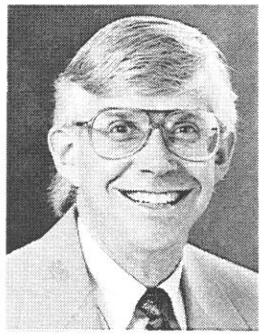
President's Report

Optics experts ... but what about our vision?

This is the last issue of *AOS News* that will appear during my two-year term of Presidency. How time flies! In July 1996 I took over the task so excellently prepared for me by Chris Walsh with a mood of self-confidence that, in retrospect, may have been far from justified.



What I did not anticipate realistically at the outset were the rapidly changing conditions in which the Australian Optical Society now operates. Things have evolved dramatically during the last two years everywhere we look - community expectations of science and research, fluctuating financial markets, political norms and standards, the dwindling profile of Australia's manufacturing industry, workplace conditions and employer/employee relationships, and so on. The relentless march of economic rationalism has tended to marginalise expert technical advice and often to bypass innovation on the local scene. Critical decisions seem to be guided only by parameters that can readily be entered into an accountant's spreadsheet and gauged against a perceived international marketplace, without evaluating genuine productivity or encouraging national self-sufficiency.

These are widespread, global concerns, of course. In the specific case of optics, we in the AOS need to consider whether we have a chance to promote optical technology as a vital element in Australia's future and whether it is sensible to urge the need for greater independence from international suppliers.

Optics has so many commercially important applications - in modern telecommunications, in medical diagnostics and treatment, in surveillance and sensing (both industrial and military), in processing and machining of materials, to name a few - that it cannot be ignored strategically. But is it necessary to maintain a strong scientific and technological capability in optics here in Australia or should we take the "easier" approach of importing most of the advanced optical systems (for instance, supermarket checkout and automatic teller machines) that we need?

I should make it clear that I believe in the need to have a viable local optics industry, supported by strong R&D. However, I am not confident that we are going to get what we need. We have seen a decline in many local optical fabrication capabilities that were born of necessity during World War II and that flourished in the subsequent quarter-century. It is now relatively simple to purchase virtually any optical component from the catalogues of various international suppliers or to have a set of prescription lenses designed by computer with key materials delivered from the other side of the world. Those of us active in optics research must recognise our continual dependence on optical materials, components and instruments from overseas suppliers, that would simply not otherwise be available from local manufacturers. We measure our research outcomes by international standards and rarely stop to think how dependent on imported technology we have become.

Within AOS circles for many years, there has been a persistent call for us to support the local optics industry and to create fresh career opportunities for optical technologists. It remains as perilous as ever to neglect this call, even though it may be difficult to answer in the current economic and managerial climate.

It is easy to overlook our dependence on the basic craftsmanship of optics as we strive to advance our individual areas of interest. Likewise, it is easy to become preoccupied with the international conference scene and with our (highly valuable) affiliations with other scientific and professional societies such as the Optical Society of America, SPIE and the Australian Institute of Physics. At the same time, we should not overlook the important role that the AOS has to play in communicating with political lobby groups such as FASTS and with formal liaison bodies such as the International Commission for Optics. (I confess that a recent lapse of corporate memory within the AOS Council very nearly terminated our relations with the latter body, but hopefully that has now been remedied.)

I am dissatisfied with the above message because it poses more questions than it answers. Perhaps that is simply a sign of the times, where a clear vision for the future is hard to come by ...

Meanwhile, as we ponder such weighty matters, I hope that many AOS members will be able to attend our Annual General Meeting in Sydney on 24 July, together with the accompanying mini-symposium on "Current Topics in Optics" (see advertisements elsewhere in this issue).

- Brian Orr

ACOLS 98

Australasian Conference on Optics, Lasers & Spectroscopy

14th–17th December, 1998

University of Canterbury,
Christchurch, New Zealand

Conference Chair: Professor Wes Sandle, Department of Physics, University of Otago, Dunedin, New Zealand.

For current information:

Web: http://www.physics.otago.ac.nz/~acols98
Email: acols98@physics.otago.ac.nz

Keynote speakers:

Professor Carl Wieman of JILA will give the Frew Lecture.

The invited speakers will include:

Janet Fender, OSA
Allister Ferguson, Strathclyde
Chris Foot, Oxford
Crispin Gardiner, Victoria Uni.
Peter Hannaford, CSIRO
Dwayne Heard, Leeds
Wonho Jhe, Seoul
Jeff Kimble, Caltech
Warren Lawrance, Flinders
Stephen Leone, JILA
Keith Nugent, Melbourne
Ulrich Schreiber, Munich
Wilson Sibbett, St Andrews
Dan Walls, Auckland

AUSTRALIAN OPTICAL SOCIETY MINI-SYMPOSIUM

"CURRENT TOPICS IN OPTICS"

and Annual General Meeting 1998

Afternoon of Friday 24 July, 1998
The Mini-Symposium will commence at 3 p.m., preceded at 2.15 pm by an optional tour of Australian Photonics CRC facilities

Australian Photonics Cooperative Research Centre,
Optical Fibre Technology Centre (OFTC),
Australian Technology Park, Eveleigh (near University of Sydney)
Australian Photonics CRC Meeting Room,
National Innovation Centre (see detailed directions below)

The Australian Optical Society has organised a short, topical symposium on the same afternoon as its 1998 Annual General Meeting (see accompanying notice and agenda). OFTC (the Sydney University wing of the Australian Photonics CRC) has kindly agreed to make its meeting rooms available and to conduct an optional tour of its technological facilities before the Mini-Symposium commences in mid-afternoon. We hope that this event will attract a wide-ranging audience, both from the Sydney area and from farther afield. Three leading opticists from the Sydney area have agreed to talk about their optical research interests, from basics to frontiers.

The Programme for the afternoon is:

2.15 pm	Optional tour of OFTC facilities (meet Dr Peter Krug at Australian Photonics CRC Meeting Room, National Innovation Centre)
3.00 pm	Welcome & introduction (Professor Brian Orr, AOS President)
3.10 pm	***"Optical devices for characterisation of thin films"***, Mr Chris Freund (CSIRO Telecommunications & Industrial Physics) Winner of 1998 AOS Technical Optics Award
3.45 pm	**Annual General Meeting** of the Australian Optical Society (see accompanying notice)
4.05 pm	Refreshments
4.30 pm	***"Optics for the Communications Revolution"***, Dr Peter Krug (Optical Fibre Technology Centre, Australian Photonics Cooperative Research Centre)
5.05 pm	***"Lasers produce heat as well as light"***, Dr Judith Dawes (Macquarie University)
5.40 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 of cars to the Australian Technology Park.

How to get there:

By car - Enter the Australian Technology Park via the gate at the corner of Garden and Boundary Streets, Redfern
By train - Proceed to the south end of Platform 10 at Redfern Station, from which there is a direct entrance to the Australian Technology Park. The National Innovation Centre is the large building (but not the huge one!) towards the east end of the site. The Australian Photonics CRC Meeting Room is on the middle of the three floors of that building.

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 3.45 p.m. on Friday 24 July, 1997
in the Australian Photonics CRC Meeting Room at the National Innovation Centre,
Australian Technology Park, Eveleigh (near University of Sydney - detailed directions on p5).

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 1998

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 24 July 1998 and at any adjournment thereof.

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ SIGNED

this _ _ _ _ _ _ day of _ _ _ _ _ _ _ _ _ _ _ _ _ _

in the presence of: _ [witness]

OPTICS GRAPEVINE

News from the World of Optics

ACOLS 98

Australian Conference on Optics, Lasers and Spectroscopy
University of Canterbury
Christchurch, New Zealand
14-17 December, 1998
(details p4)

OSA Journals Online

For the first time, all of the OSA journals are available online. *Applied Optics*, *JOSA A*, *JOSA B*, *Optics Letters*, and the all-electronic journal *Optics Express*, are all accessible through the OSA web page: www.osa.org.

Browsing of the tables of contents and abstracts is freely available. However, in some cases access to the full-text articles and searching features is restricted to online paid subscribers. The cost of subscription to *JOSA A*, for example, is US$30 for OSA members (or, if you wish to maintain your print subscription to *JOSA A*, for an additional US$8). The articles are Adobe Acrobat files which contain full equations and graphics, and can be viewed with the free utility, Adobe Acrobat Reader.

Ron Bracewell awarded an Order of Australia

In the Queen's Birthday Honour List Professor Ron Bracewell was awarded an AO. Many of you will know Ron as being "Mr Fourier Transform". Ron was a member of staff of CSIRO Radiophysics in the late 40s and early 50s before moving to California and Stanford University. He retired a few years ago to an Emeritus Professorship.

New editor required!

If you are interested in the job, please contact Duncan Butler, CSIRO-T.I.P., PO Box 218 Lindfield 2070. E-mail: Duncan.Butler@tip.csiro.au

Adolph Lomb Medal goes to Ben Eggleton

Ben Eggleton, a recent University of Sydney post-graduate physics student, is the 1998 recipient of the Adolph Lomb Medal of the Optical Society of America. It is presented to "... a person who has made a noteworthy contribution to optics, ... (and) which must be published before the age of 30". The citation reads

"... for the first observations of nonlinear optical pulse propagation in photonic band gap materials, including solitons and modulational instabilities in fiber Bragg gratings as well as optical switching in long-period gratings."

The experiments showing nonlinear optical pulse propagation in photonic band gap materials were done while Ben was a student at The University of Sydney. This work was a collaboration between the School of Physics, the Australian Photonics CRC, and (then) AT&T Bell Laboratories (now Bell Laboratories, Lucent Technologies). It was described in Issue 1 of Volume 10 of *AOS News* (January 1996).

After finishing his Ph.D. at the University of Sydney in late 1996, Ben took up a post-doctoral postion at Bell Laboratories, Lucent Technologies. He has now accepted a permanent position there.

- Martijn de Sterke

Dates for your Diary :

24 JUL :	**AOS Annual General Meeting**
24 JUL :	**AOS Mini-symposium**
14 DEC:	**ACOLS**

Details of these events can be found in this issue.

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

CRC PROGRAM TO CONTINUE GOVERNMENT PLEDGES SUPPORT

Australia's peak council for scientists and technologists today (Wednesday) applauded the announcement by the Minister for Industry, Science and Tourism, John Moore, that the Government would continue funding the Cooperative Research Centre (CRC) program.

Professor Peter Cullen, President of the Federation of Australian Scientific and Technological Societies (FASTS), he was delighted that the Government had recognised the strengths of this unique Australian program. "Australia needs to encourage industries and research organisations to work closely together, and that's just what the CRC program does best," Professor Cullen said. "It's part of a long term investment in revitalising Australian industry, and stocking it up with the best ideas from Australian scientists."

The CRC program had been the subject of a review led by Don Mercer and John Stocker. In today's response to this review, Mr Moore indicated that the Government had adopted its key recommendations. Professor Cullen said it was entirely appropriate for the Government to review such a new and innovative program. "It has taken some time for industry and research groups to learn to work together. There is no other program like this in the world, and we had to work out the difficulties as we went along. "It has created a new culture: scientists thinking like entrepreneurs, and entrepreneurs thinking like researchers."

He supported the ideas that CRC's should have greater emphasis on international links, and said that he would look forward to seeing the detail in the Government's re-focussing.

REPORT PREDICTS OPTICS REVOLUTION

SAN FRANCISCO — A new report by a committee of the National Research Council has predicted that harnessing the properties of light will lead to technology revolution having a pervasive impact on life in the next century.

This dramatic vision, and recommendations to help the nation's research community maximize the potential of optical science and engineering, was to be previewed here today (May 6) by Charles V. Shank, director of the Department of Energy's Lawrence Berkeley National Laboratory, at the Conference on Lasers and Electro-Optics and the International Quantum Electronics Conference (CLEO/IQEC).

Shank was chair of the Research Council's Committee on Optical Science and Engineering, a distinguished group of academic and industry leaders which spent three years undertaking a comprehensive assessment of the field of optics — its progress over the last decade, its vision of the future, and its technological opportunities. The result, Harnessing Light: Optical Science and Engineering for the 21st Century, will be available from National Academy Press in mid-May.

Dr. Shank, in summarizing the report's conclusions, described optics as a critical enabler for technology that promises to revolutionize the fields of communications, medicine, energy efficiency, defense, manufacturing, and the frontiers of science into the next century. Since the development of the first laser in 1960, optics has impacted the global economy in countless ways, in fiber-optic communications, manufacturing, and imaging.

"There are about 5,000 optics-related companies with a financial impact of more than $50 billion annually," he said. "But that number is insignificant compared to what optics has spawned as an enabler. An investment of a few hundred million dollars in optical-fiber technology has leveraged a trillion-dollar worldwide communications revolution."

And that is only the beginning. The report envisions major advances in telecommunications, in disease diagnosis and therapy, in electric lighting efficiency, in semiconductor manufacturing, and in defense surveillance and guidance systems, to name a few.

These developments will change the world in ways that are hard to imagine, Shank said, but to realize the vision will take a reordering of research priorities, more coordination among agencies and industries engaged in optical science, and federal leadership in focusing efforts of the research community.

"Optics is an extraordinarily strong and dynamic field," Dr. Shank said. "In a few important areas, however, action is needed to overcome barriers that might slow the present pace of rapid progress – to break down the barriers to individual home access to high-speed fiber-optic communications, for example, or to take full advantage of the potential of non-invasive optical methods for medical monitoring and diagnosis."

Some of the key areas identified by the report for particular focus of optics research in the coming years are:

• Information technology and telecommunications: Around the world, optical fiber is being installed at a rate of 1,000 meters every second, comparable to the speed of a Mach 2 aircraft. By the year 2005, about 600,000 kilometers of fiber optic cable will cross the oceans, enough to encircle the Earth 15 times. It will eventually be feasible to extend these networks all the way to the end-user in individual homes, resulting in high-speed data and video transmission more ubiquitous than the telephone. But many research and manufacturing capabilities will have to advance a hundred-fold to achieve this vision.

The report recommends that Congress "challenge industry and the federal regulatory agencies to ensure the rapid development and deployment of a broadband fiber-to-the-home information infrastructure."

• Health care and the life sciences: Building on present capabilities for laser surgery and non-invasive diagnostic methods, optics can help realize the potential for laboratory and clinical health care methodologies. In the future, for example, people could have personal health monitors that can evaluate the optical properties of their blood and tissue. But, according to the report, fundamental science that would lead to such innovations is presently incomplete, and the disease-oriented structure of the National Institutes of Health (NIH) "does not encourage the growth of biomedical optical technology programs."

The report suggests mechanisms to encourage increased public and private investment in the development of non-invasive optical monitoring of basic body chemistries, as well as a stronger focus in this area by the NIH.

• Optical sensing, lighting, and energy: Lighting accounts for almost 20 percent of total annual electricity use. New lamps and light sources could reduce consumer electricity bills in the United States by tens of billions of dollars a year, according to the report. These lighting efficiencies can reduce greenhouse gas emissions and, along with advanced solar cells, reduce the energy it takes to illuminate the world.

The committee recommended that various public and private agencies coordinate efforts to create a single program for lighting efficiency, with the goal of reducing America's consumption of electricity for lighting by a factor of two over the next decade, thus saving $10 billion to $20 billion a year in energy costs.

- National defense: Optics continue to play an indispensable role in defense programs and promise even greater capabilities in the areas of weapons targeting and detection of biological and chemical warfare agents.

The report suggests that the Department of Defense needs to make a greater investment in research areas of photonics, sensors, and high-powered tunable lasers to gain maximum defense competitive advantage, and in low-cost manufacturing of precision components.

The report recommends a larger effort in the development of ultraprecise optical lithography in industrial manufacturing, possibly through a government-led consortium. It also urges that the National Institute of Standards and Technology become a leader in the development of international optics standards.

The committee encourages multiple agencies to support optics as a cross-cutting initiative, similar to recent efforts in high-performance computing. And it recommends that the National Science Foundation develop an agency-wide initiative to support multidisciplinary research and education in optics.

"We expect the field of optics to become a discipline," the report concludes, "as computer science has over the past few decades, and to become recognized as such in educational institutions around the world."

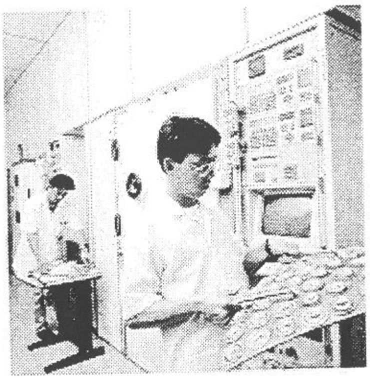
The study was funded by the Department of Defense, the National Science Foundation, and the National Institute of Standards and Technology. The National Research Council is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering. It is a private, non-profit institution that provides science advice under a congressional charter. The study was overseen by the NRC's Board on Physics and Astronomy and the National Materials Advisory Board.

Other members of the committee include Aram Mooradian, Vice Chair; David Attwood, Lawrence Berkeley National Laboratory; Gary Bjorklund, Optical Networks, Inc.; Robert Byer, Stanford; Michael Campbell, Lawrence Livermore National Laboratory; Steven Chu, Stanford; Thomas Deutsch, Massachusetts General Hospital; Elsa Garmire, Dartmouth; Alastair Glass, Lucent Technologies; John Greivenkamp, University of Arizona; and Arthur Guenther, Sandia National Laboratories.

Also, Thomas S. Hartwick, TRW (retired); Robin Hochstrasser, University of Pennsylvania; Erich Ippen, MIT; Kristina Johnson, University of Colorado; Dennis Killinger, University of South Florida; Herwig Kogelnik, Lucent Technologies; Robert Shannon, University of Arizona; Glenn T. Sincerbox, University of Arizona; Brian Thompson, University of Rochester; and Eli Yablonovitch, UCLA. Thomas Baer, Biometric Imaging Systems, was a special consultant. The National Research Council staff, headed by Don Shapero, director of the Board on Physics and Astronomy, included Robert Schafrik, Dan Morgan, and Sandra Hyland.

Harnessing Light;:Optical Science and Engineering for the 21st Century can be ordered through the National Academy Press, 2101 Constitution Avenue, NW, Lockbox 285, Washington, D.C. 20055, or by calling 800-624-6242.

Advanced Thin Films



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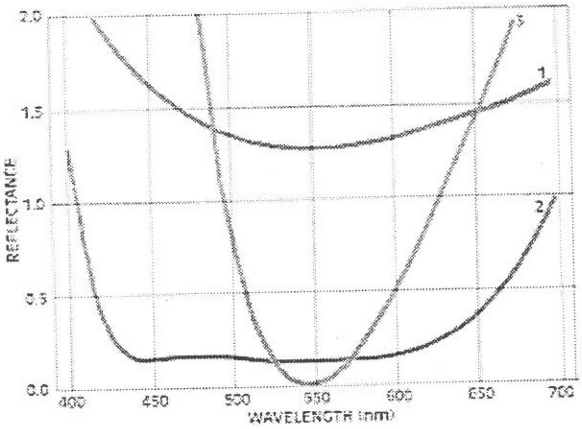

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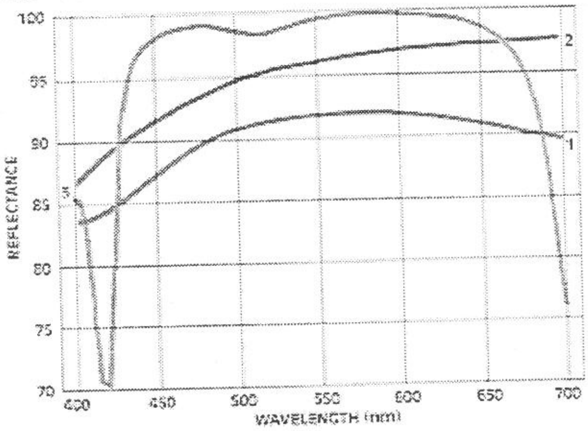

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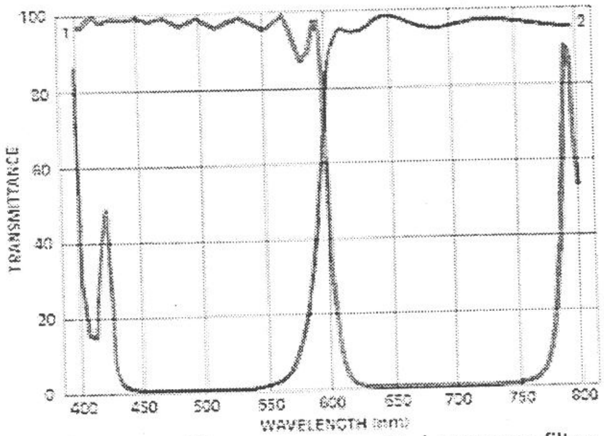

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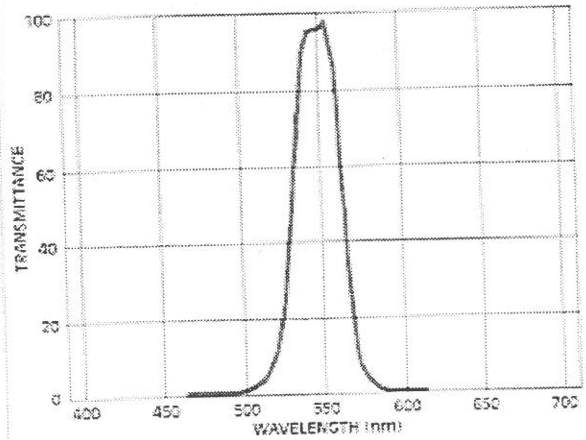

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Conference Review : Advanced Solid State Lasers 1998

Justin L. Blows
Center for Lasers and Applications, School of Mathematics, Physics, Computers and Electronics, Macquarie University 2109, Australia.

The 1998 meeting of Advanced Solid-State Lasers was held at the Coeur d'Alene Resort, Coeur d'Alene Idaho between February 2-4. It was evident that solid-state lasers, fuelled by the availability of compact and efficient diode pump sources, are coming very close to meeting the demands of high power applications such as material processing and remote sensing. Additionally, there were reports on periodically poled KTP, new self-frequency doubling crystals and a myriad of OPO systems.

The emphasis of the meeting was the engineering of high output powers at wavelengths typically near 1 µm, and the nonlinear frequency-conversion (frequency doubling and summing, optical parametric oscillation or Raman shifting) to obtain a frequency useful for a target application. The vast majority of laser devices presented were optically pumped by diode-laser arrays. Small devices (~10 W) were end-pumped by a fiber-coupled diode-laser array. Larger devices (>100 W) were side-pumped. The diode-arrays were typically collimated along their fast axes with fiber lenses, when used in a side pumping configuration.

Some of the more interesting paper are summarised bellow. The inertial confinement fusion program at the Lawrence Livermore National Laboratory USA, is developing a 10 Hz repetition rate replacement (with the current 100 J/pulse prototype dubbed "Mercury") for the current flashlamp pumped system, "Nova". Nova is limited to a single pulse every few hours, due to the severe thermal load. To achieve higher repetition rates in the Mercury system, Marshall et al. have replaced flash-lamps with kW diode arrays (reducing the thermal load) and substituted Yb:S-FAP for the traditional Neodymium doped crystals. Ytterbium (Yb) has a low quantum defect and hence produces two thirds less waste heat. Due to its longer lifetime, Yb also represents a more economical use of the relatively expensive diode pump light.

Machan et al. from TRW corp., have developed a high average power, pulsed Nd:YAG laser for machining applications. A Nd:YAG zig-zag slab design was implemented, side-pumped by SDL stacked quasi-continuous-wave diode-laser-arrays. A 1.5 times unstable resonator was used in conjunction with a variable reflectance mirror to produce 3600 W of 2-4 times diffraction limited output.

Using a 0.4 mm thin disk of Yb:YAG cooled to -70oC, Karszweski et al. from Universität Stuttgart, Institut für Strahlwerkzeuge, obtained 97 W of TEM_{00} output power for 245 W of pump light from fiber coupled diode-arrays. This impressive result from a longitudinally pumped laser is due to the longitudinal cooling, which greatly reduces the effects of the thermal lensing which usually limits longitudinal designs.

Grubb from SDL corp., presented single mode Yb fiber lasers, clad in a multimode fiber. Using this strategy, where the pump light is launched into the cladding around the central fiber laser, high efficiencies were obtained. For 60 W of diode pump light (915 nm) 40 W of diffraction limited output (1117 nm) was generated. There were negligible thermal effects, due to the very long absorption depth. It is expected that nonlinear effects within the single mode fiber will limit scaling to several tens of Watts.

There was particularly strong interest in the generation of high power visible (2nd harmonic of the ~1 µm Nd laser line) and UV (4th and 5th harmonics). These wavelengths, particularly the UV ones, are useful for industrial machining applications. Chang *et al.* from the Lawrence Livermore National Laboratory USA, developed a side-pumped Nd:YAG rod laser, using compound parabolic concentrators, a new technique to laser engineering, in order to collect and deliver diode-array output to the rods. The laser, which is reminiscent of a V6 engine, delivered 451 W of 1064 nm output. When Q-Switched at 13 kHz and extracavity doubled with LBO, 182 W of 532 nm was generated with 60 ns pulses. This device was intended for industrial applications, making the device lifetime an important issue. After operation for over 1000 hours, the authors noted negligible power losses.

Honea *et al.* from the Lawrence Livermore National Laboratory USA, developed a diode-array-stack end-pumped Nd:YAG laser. The diode-array-stack consisted of 38 bars mounted on mircochannel cooler packages. The diode output was collected and delivered using a lens duct. This device generated 140 W of 532 nm output (KTP doubled 1064 nm) when AO Q-switched at 10-30 KHz. The output was multimode (M2 = 51) with a 11% conversion efficiency from diode-pump to 532 nm output.

Finch *et al.* from the USHIO Institute of Technology, USA, have developed a high-power, high-repetition rate, diode-pumped, deep UV laser system. It is based around a master oscillator, power amplifier configuration utilising side-pumped Nd:YLF slabs. This system gave 29 W of 20 ns Q-switched pulses at 5 KHz. The output was doubled in LBO, then doubled and summed in CLBO to produce the 4 th and 5 th harmonics. This system gave 6.6 W of 262 nm, and 2 W of 209 nm output.

There is continuing interest in periodically poled nonlinear materials. Pasiskevicius et al. have periodically poled flux grown KTP, for quasi-phasematching. Quasi-phasematching enables the largest nonlinear tensor component to be used, allowing more efficient frequency conversion than for the equivalent birefringent phasematched crystal. The advantage of KTP is that thicker samples can be poled compared with Lithium Niobate. Furthermore, denser gratings can be fabricated. The authors found that periodically poled KTP was 4 times more efficient at doubling 1064 nm laser output than type II phasematched KTP.

The self-frequency doubling laser crystals, Yb:GdCOB (Martrou *et al.* of Chime Appliquée de l'Etat Solid, France), Nd:YCOB (Chai *et al.* of CREOL, USA) and Yb:GdCOB (Chai *et al.*) have been demonstrated. These crystals, which are grown by the Czechralski technique, are negative biaxial crystals with very good optical properties. Nd:YCOB gave ~400 W of 1060 nm fundamental output for 1 W of Ti:Saphire pump. 57 mW of continuous wave 530 nm output was produced when the crystal was phasematched for self-frequency doubling. These crystals are diode-pumpable. Nd:YCOB is pumped at 812 nm.

There were several diode-pumped ultrafast lasers presented. Loesel et al. from Ultrafast Laser Physics, Institute of Quantum Electronics, Swiss Federal Institute of Technology, presented a Nd:glass diode-laser array end-pumped slab laser, producing 1 W of 175 fs modelocked pulses at 117 MHz. A semiconductor saturable absorber mirror was used to achieve modelocking.

My collaborators, Judith Dawes (also my supervisor) from Macquarie University, Takashige Omatsu from Chiba University, Japan, and myself, presented a paper on thermal lensing measurements in planar Nd:YAG crystals end-pumped with a beam brought to a line focus. Thermal lensing has been found to be severe in laser-diode array end-pumped systems, with focal lengths of around ~0.1m being typical (~10 W absorbed pump). This strong thermal lensing must be accounted for in the laser cavity design. The paper outlined a technique for measuring the aberrated thermal lens profile, holographic lateral shear interferometry, and discussed the numerous thermal advantaged in using such a planar end-pumped laser design.

I wish to thank the Australian Optical Society for giving me this wonderful opportunity. The conference was very informative, and I was pleased to meet so many well-informed people with whom I spoke.

High Resolution Imaging Through Tissue-like Turbid Media

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Imaging through a tissue-like turbid medium has important medical applications, including the early diagnoses of small tumours. Imaging trough a turbid medium is one of the major research programs currently being undertaken in the Optoelectronic Imaging Group at Victoria University. In this article, a new technique for obtaining high-resolution images of an object embedded within a turbid medium is described [1-4]. A pair of polarised, annular objectives are employed to discriminate against the propagation path difference between scattered and unscattered photons.

1. Introduction

In recent years there has been a substantial increase in research into imaging with non-ionising radiation (eg. laser emission) [5]. Researchers are currently trying to develop techniques and theoretical models to help in the imaging of very small tumours embedded in thick layers of human tissue for medical applications (eg. optical tomography and skin biopsies). Human tissue is highly diffusive and acts as a highly scattering random medium (HSRM), which creates problems in detecting the necessary light to form a useful image on the scale required. This is due to the nature of the detected illumination photons once they have propagated through a HSRM.

The detected illumination photons consist of unscattered (ballistic), weakly scattered (snake), and multiply scattered (diffuse) components (Fig. 1). The unscattered component, 1(a), travels in a straight line along the illumination path in a scattering medium and carries information of objects embedded in or behind a HSRM. The weakly scattered component, 1(b), consists of photons that propagate along zigzag paths slightly off the straight line path, and the multiply scattered component, 1(c), consists of photons randomly scattered at various angles in the HSRM. These multiply scattered photons are the source of image blurring and resolution deterioration that make it difficult to obtain the necessary information needed for high contrast and high resolution imaging. The degradation of the image quality can become so severe in a HSRM that the embedded object is completely hidden from view.

The distinction between the weakly and multiply scattered photons is somewhat arbitrary. However, we will assume that the weakly scattered photons and the unscattered photons are those necessary to create an informative unblurred image.

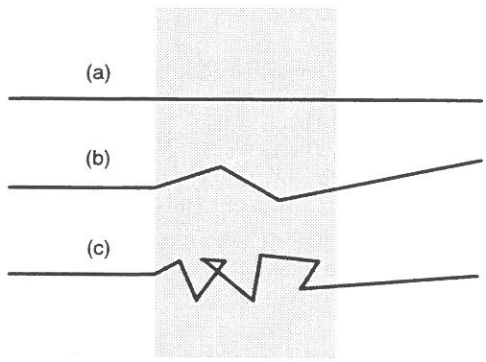

Figure 1: *Classification of photons propagating within a HSRM. For clarity, the three components are depicted separately: (a) ballistic photons; (b) snake photons; (c) multiply scattered photons.*

There are physical differences between unscattered and scattered photons which are outlined in Table 1. The magnitude of the effects depends on the number of scattering events experienced by an individual photon. All these effects provide a means of distinguishing between the different types of photon. Thus, methods for detecting unscattered and weakly scattered photons, while suppressing multiply scattered photons, can be used when imaging an object embedded in a HSRM.

Unscattered photons	Scattered photons
early arrival time	late arrival time
same coherence	low coherence
same polarisation	depolarised
same direction	different direction

Table 1: *Physical difference between unscattered and scattered photons after propagating through a HSRM.*

A number of approaches have been proposed to obtain useful images through significant depths of a HSRM. Several gating methods are currently available to selectively suppress the scattered photons based on the properties in Table 1. These are time-gating [6], which relies on the utilisation of an ultrashort pulsed beam, coherence-gating [7] which relies on the degree of coherence of photons, polarisation-gating [8] which relies on the polarisation-state of the photons, and angle-gating [1-4] which relies on the path deviation of the scattered photons.

Although all of these gating mechanisms can be employed in any imaging system, the efficiency of these methods depends on a particular imaging system. Transillumination imaging systems, which use a parallel beam probe, can give images of millimetre resolution [5]. To obtain an image of micrometer resolution, a microscope objective is necessary. In this case, time-gating, coherence-gating and polarisation-gating may become less efficient due to the large range of illumination angles. However, angle-gating is still a useful method. The rest of this article is concerned with angle-gating in a microscopic system.

2. Principle of angle-gating

Figure 2 shows the principle of angle-gating in a transmission optical microscope. Here the beam is shown in grey-scale where the darker regions include more unscattered photons. When one employs a pair of circular objectives in a transmission microscopic imaging system (Fig. 2a), there is no physical way to separate the scattered photons in the angle domain of the second objective. If however one places a central obstruction to form an annular objective in the illumination path which confines the illumination photons into a small angular region (Fig. 2b), one can separate the scattered and unscattered photons from each other since the scattered photons propagate along different angles from the unscattered photons. A ballistic photon peak can exist near the edge of the second objective [4]. This ballistic peak in the angle-domain can be used for imaging if one employs a second central obstruction to form an annular objective in the collection path (Fig. 2c). This collection obstruction should be large enough to suppress the scattered photons but allow the ballistic photons to be detected. A polarisation-gating technique (Fig. 2d) can be simultaneously employed to further suppress the scattered photons which are scattered back to the same direction of the ballistic photons.

3. Polarising annular objectives

In Fig. 3, a schematic diagram of our scanning optical microscope which uses two polarising annular objectives is depicted.

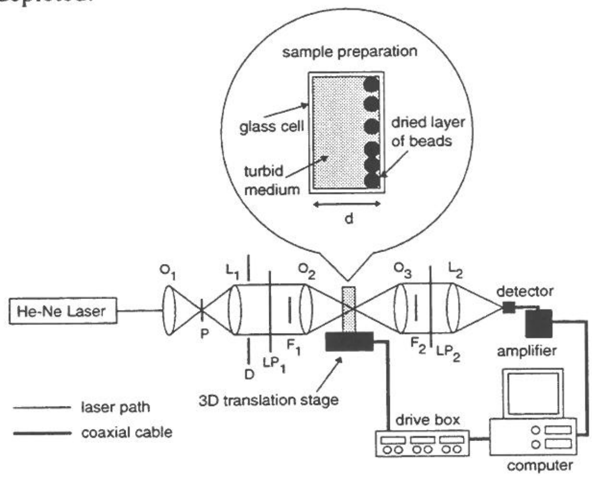

Figure 3: *Schematic diagram of the experimental microscopic imaging system with angle- and polarisation-gating mechanisms. O's: objectives, L's: lenses, D: diaphragm, LP's: polarisers, F's: central obstructions and P: pinhole.*

A He-Ne laser was used as the light source. The beam was expanded and collimated by an objectives O_1 and a lens L_1. The illumination and collection objectives (O_2 and O_3) formed a symmetric focal system around a HSRM since the objectives had an identical numerical aperture. Scattered and unscattered photons collected via objective O_3 were focussed via a lens L_2 onto a large area detector which recorded a time-averaged signal.

Annular objectives were achieved by placing central circular obstructions in the illumination (F_1) and detection (F_2) beam paths. The parameter ε is used to characterise the central obstruction size, and is defined as the ratio of central obstruction radius to the radius of the objectives aperture. A polariser LP_1 was placed such that it

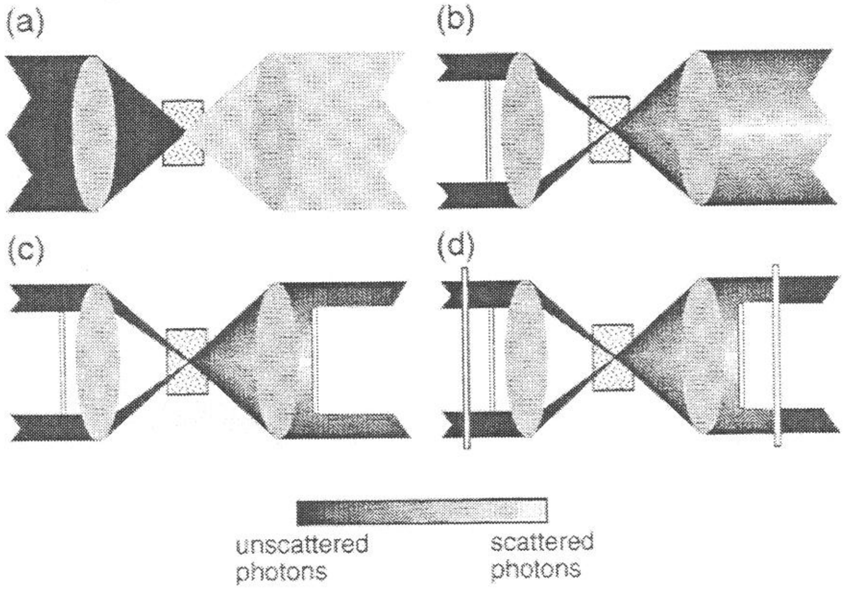

Figure 2: *Schematic diagram for the principle of angle-gating in a transmission microscopic imaging system when employing, (a) a matching pair of circular objectives, (b) an illumination annular objective and a collection circular objective, (c) a matching pair of annular objectives and (d) a matching pair of annular objectives employing polarisation-gating.*

produced a linear polarised illumination beam, while the polariser LP_2 acted as an analyser in front of the detector. As a measure for determining how successful the angle-gating and polarisation-gating methods are we define the degree of polarisation,

$$\gamma = \left(I_p - I_s\right)/\left(I_p + I_s\right), \tag{1}$$

where I_p and I_s are the signals strengths detected with the analyser parallel and perpendicular to the direction of LP_1, respectively. The incident power from the laser was attenuated such that the illumination power at the focus for a pair of circular objectives was equivalent to the power at the focus for a pair of annular objectives. In this way, a comparison of the image quality can be obtained when circular and annular objectives are employed. For an illumination annular objective with $\varepsilon \approx 0.93$, the power in the focal spot was approximately 110 μW. The resulting irradiance is below the tissue damage threshold, and should be safe for a biological specimen.

4. Sample preparation

Two HSRM were prepared, each of which was placed in a glass cell with a lateral dimension of 2 cm × 1 cm. The first sample (hereafter called sample1) consisted of polystyrene microspheres (diameter = 0.48 μm) suspended in 5 ml of water with a particle volume concentration of 2.5%. The scattering mean-free-path was approximately 19.2 μm (anisotropy value, g = 0.81) according to Mie Theory [9]. The second sample (hereafter called sample2) consisted of standard semi-skimmed milk. Milk was chosen as a turbid medium since it has been used for simulating human tissue [8]. The diameter of the scattering particles in the milk suspension was estimated to be in the range of 0.05-0.3 μm [8]. The experimentally measured scattering mean-free-path was ~30 μm, while the anisotropy value was assumed to be < 0.4 [8]. The thickness, *d*, of the glass cells for sample1 and sample2 was 120 μm and 300 μm, with optical thickness for the samples (average number of scattering events experienced by an individual photon), *n*, of approximately 6.3 and 10, respectively. These *n* values are typical for biological tissues under the microscopic condition.

The prepared samples were mounted on a 3D translation stage and then placed in the overlapping focal region of the two objectives (O_2 and O_3). The overlapping focus of the two objectives were equally spaced in the centre of the turbid medium.

5. Imaging with polarising annular objectives

The γ value for an empty cell was measured to be 0.999, and hence depolarisation caused by the objectives and other optical components can be ignored. The suppression of diffusing photons by polarising annular objectives can be seen from the measured dependence of γ on the radius ε for the two samples (Fig. 4). It is clearly seen from this figure that γ increases appreciably when ε changes from zero to unity. The difference in γ results from an increase in *n* for sample2. The difference of the γ value between the circular ($\varepsilon = 0$) and the annular ($\varepsilon \approx 0.93$) objectives was 0.23 and 0.18 for the two samples, respectively. This result clearly shows that if two thin polarising annular objectives are used the diffusing photons can be efficiently suppressed.

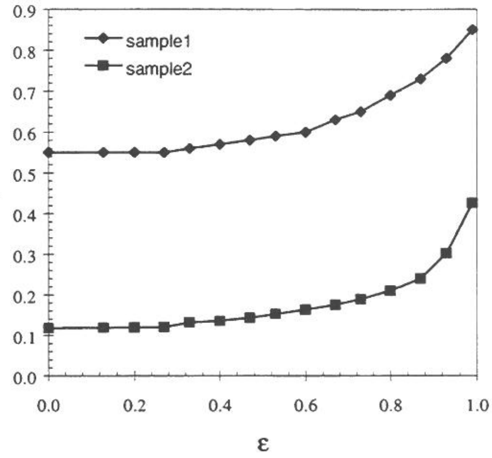

Figure 4: *Dependence of the degree of polarisation, γ, on the radius of the central obstruction of a matching pair of annular objectives, ε. The numerical aperture for objectives O_2 and O_3 is 0.6.*

For evaluating the image quality when polarised annular objectives were used a cluster layer of 22 μm polystyrene microspheres was dried onto the inside back surface of the glass cell before it was filled with the turbid media (Fig. 3). Such an object can be considered an approximate model of tumours embedded in a tissue-like turbid medium. The overlapping focus of the two objectives was placed on the surface of the dried bead layer on the HSRM side. The sample was raster scanned to build up an image of a 22 μm polystyrene microsphere. The numerical aperture of objectives O_2 and O_3 was 0.25.

Figure 5 shows images of one 22 μm bead embedded in sample1 under different conditions. These images are slightly non-circular in shape since the cluster layer had a non-uniform thickness. In Fig. 5(a), two circular objectives are used. Figure 5(b) displays the image when two parallel polarisers are included with the circular objectives. It is seen that the introduction of the polarisers produces a slight improvement in image detail. Both Figs. 5(a) and 5(b) reveal a reversion of image contrast near the centre of the bead where a dark region should be displayed, which may be misleading in interpreting the image. Figure 5(c) shows the image obtained for two annular objectives, revealing that the image resolution is improved significantly and that a correct image contrast in the centre of the bead is obtained. A further improvement in the image contrast near the surface of the bead can be seen in Fig. 5(d) when parallel polarisers are included. In this experiment the reversed contrast in Figs 5(a) and 5(b) is caused by the multiply scattered photons collected by a circular objective. These photons are significantly removed by an annular objective.

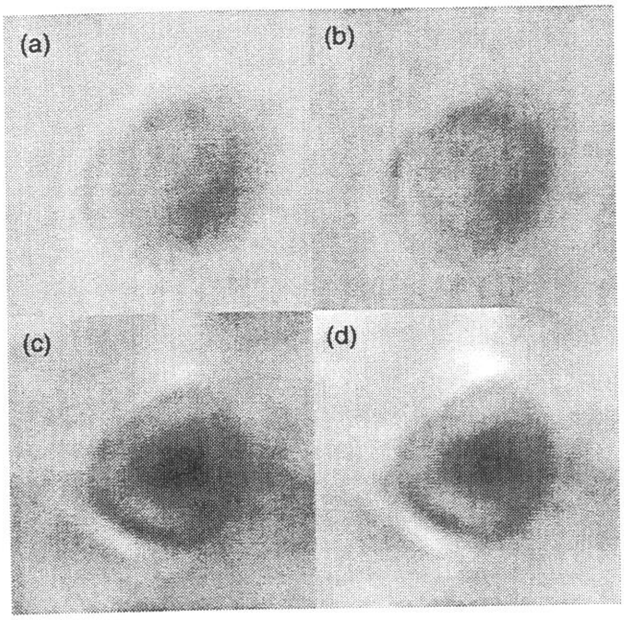

Figure 5: *Images of a 22 μm polystyrene bead embedded in sample1. (a) circular objectives (ε = 0) without polarisers, (b) circular objectives (ε = 0) with polarisers, (c) annular objectives (ε ≈ 0.93) without polarisers and (d) annular objectives (ε ≈ 0.93) with polarisers.*

To demonstrate the ability of annular objectives to select ballistic photons in a more tissue-like sample, a cluster layer was imaged through sample2 using circular (Fig. 6a) and annular objectives (Fig. 6b). The images indicate that an annular objective can be used effectively to image through a HSRM which contains different particle sizes. In addition, employing a pair of annular objectives gives increased resolution and correct image contrast when compared with circular objectives [1].

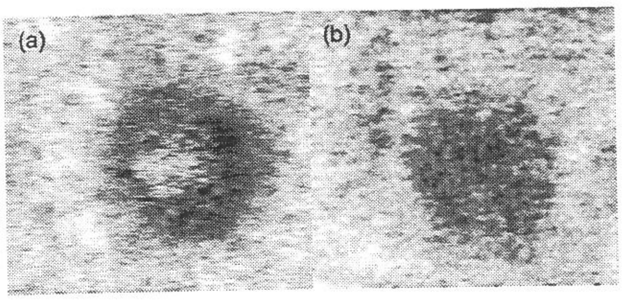

Figure 6: *Images of a 22 μm polystyrene bead embedded in sample2. (a) circular objectives (ε = 0) with polarisers and (b) circular objectives (ε ≈ 0.93) with polarisers.*

6. Summary

Our experimental results (Figs. 5 and 6), based on the angle-gating mechanism [1], have demonstrated that when an object embedded in a turbid medium is imaged with circular objectives the image contrast may be reversed. Using polarising annular objectives can suppress diffusing photons and produce an image which exhibits a correctly enhanced contrast and tens-of-micrometer resolution, which is 50 times higher than that obtained in transillumination imaging [8].

It is clear that the principle of angle-gating can also be applied to a reflection microscope, in which case the angle-gating method can be practically important in skin biopsies. The effect of suppressing scattered photons can be further enhanced if a differential polarisation-gating method is included [10].

Research work on imaging through a HSRM commenced at VUT in 1996, supported by an Australian Research Council Large Grant. In addition to the experimental development [1, 2, 10], we have also developed a novel Monte-Carlo computer program [3, 4, 11] which gives multi-dimensional distributions of photon migration in a HSRM. With this program, image formation in a HSRM can be modelled. In the near future, both the experimental and theoretical work on imaging through a HSRM will be turned towards real tissue media. In particular, 2-photon excitation will be investigated not only for detecting small tumours but also for treating them in photodynamics therapy.

References

[1]. S. P. Schilders, X. S. Gan and M. Gu, "Microscopic imaging through a turbid medium using annular objectives for angle-gating", *Applied Optics* (1998)- in press.

[2]. S. P. Schilders, X. S. Gan and M. Gu, "Efficient suppression of diffusing photons using polarising annular objectives for microscopic imaging through turbid media", *Bioimaging* (1998) - in press.

[3]. X. Gan, S. Schilders and M. Gu, "Image formation in a turbid medium under a microscope", *J. Opt. Soc. Am. A* (1998) - in press.

[4]. X. Gan, S. Schilders and M. Gu, "Combination of annular aperture and polarisation-gating methods for efficient microscopic imaging through a turbid medium: Theoretical Analysis", *Microscopy and Microanalysis*, 3: 495-503 (1997).

[5]. B. Tromberg, A. Yodh, E. Sevick and D. Pine, "Diffusing photons in turbid media: Introduction to the feature", *Applied optics*, 36: 9 (1997).

[6]. E. B. de Haller, "Time-resolved transillumination and optical tomography", *Journal of Biomedical Optics*, 1(1): 7-17 (1996).

[7]. J. F. de Boer, T. E. Miller, M. J. C. van Gemert and J. S. Nelson, "Two-dimensional birefringence imaging in biological tissue by polarisation-sensitive optical coherence tomography", *Optics Letters*, 22: 934-936 (1997).

[8]. S. P. Morgan, M. P. Khong and M. G. Somekh, "Effect of polarisation state and scatter concentration on optical

imaging through turbid media", *Applied Optics*, 36:1560-1565 (1997).
[9]. C. F. Bohern and D. R. Huffman, "Absorption and scattering of light by small particles", J. Wiley and Sons: New York (1983).
[10]. S. P. Schilders, X. S. Gan and M. Gu, "Resolution improvement in microscopic imaging through turbid media based on differential polarisation", *Applied Optics* (1998) - in press.
[11]. X. Gan and M. Gu, "Temporal, angular and spatial distribution of photon migration through a highly scattering medium", *Optik* (1998) - in press.

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FASTS release on the 1998 Budget

THE BUDGET OF LOST OPPORTUNITIES

The peak body for scientists and technologists in Australia said today (Wednesday) that it was disappointed in the Budget brought down last night. Professor Peter Cullen, President of the Federation of Australian Scientific and Technological Societies (FASTS), said that once again Australia seemed to be missing opportunities.

"By dithering we are likely to continue to miss the boat in the biotechnology revolution in the same way as we missed the boat in information technology in the 80s and 90s. The Government seems bereft of ideas. Competitive success in the next century will be won by countries which follow the knowledge-based path, to generate real and enduring employment. This requires a strong science base and smart programs to link industry with science. This needs strong leadership from Government."

Professor Cullen said the Government had clawed back considerable funds from the university sector and by winding down the tax R&D incentive to industry. This was on the grounds that it wanted to target its investments more strategically.

"But we are still waiting. There is nothing in this Budget to stimulate innovation and new technology," he said. He noted that the START scheme — an incentive for industry R&D — appeared to be failing, and urged the Government to develop new and better ways of stimulating the innovation process. He said that the foundations for innovation lie in higher education and basic research, and these areas continued to be eroded.

"The parlous state of the universities has not been addressed despite widespread concerns over the last year," he said. "The level of public funding appears to have decreased by over seven per cent as the cost burden is shifted to students and their parents."

Basic research funding through the ARC has collapsed, with a drop from $445 million to $383 million over two years.

"These cuts appear to be in the funding of research infrastructure and the funding of collaborative research. Such cuts are very short sighted," he said.

"On the bright side, we welcome the Government's strong support for the CRC program and that they have restored the cuts they made last year to the National Health and Medical Research Council."

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Stabilised Helium-Neon Lasers for Measurement of Gauge Blocks

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PO Box 218 Lindfield, NSW 2070, Australia

A simple stabiliser for locking the frequency of 543 nm, 612 nm and 633 nm helium-neon lasers to iodine absorption lines is described. When applied to a 543 nm laser, a long term frequency stability of 1.4 x 10^{-12} was observed. One stabiliser can lock three lasers simultaneously with relative frequency uncertainties better than 2 x 10^{-10} (for sample times greater than 1s). When locked, the lasers are primary frequency references that can be used for gauge block measurements.

1. Introduction

It is now standard practice for the laboratories responsible for maintaining a country's standard of length to calibrate gauge blocks interferometrically with one or more lasers. The length of the gauge block is determined from the laser's wavelength. However, vibrations and temperature changes in the laser cavity can cause the frequency and wavelength of a free running laser to drift by 1 part in 10^6. This frequency instability makes it necessary to stabilise the wavelength of the laser to achieve length measurements uncertainties less than 1 μm when measuring a 1 m gauge block.

In general, the lasers used for length measurement are secondary standards and are not stabilised to absolute references such as the absorption lines of a molecule or atom. Secondary standards require periodic calibration against a recognised primary standard to ensure traceability to the definition of the metre. A more preferable situation is to measure the gauge block directly with the primary standard, avoiding the costly process of wavelength calibration. However, most primary wavelength standards are unsuitable for use in an interferometer because they are either too complex or deliver light that is modulated.

One exception will be the frequency doubled Nd:YAG locked to iodine [1-3] which we will use to replace the 543 nm helium neon laser. But as its application to length metrology is still in its infancy it is not yet commonly used. In many laboratories helium neon lasers are used as either secondary standards or as primary standards. But few helium neon lasers provide enough light to both frequency lock the laser to a reference and to measure gauge blocks.

In this paper we report on an inexpensive technique to lock the frequencies of helium neon lasers at 543 nm, 612 nm and 633 nm to iodine ($^{127}I_2$) using an external cell stabiliser. Results of a comparison between two 543 nm lasers stabilised by this method are presented. These results show that the frequency of the laser is known to better than 2 x 10^{-10}. This stability is in good agreement with a previous measurement where the stabiliser was used to lock a 633 nm laser to iodine [4]. The use of the stabiliser to simultaneously lock all three helium-neon lasers is described. In this case, each laser is sequentially locked to an iodine reference with no significant change in short term frequency stability.

2. Description of lasers and the iodine stabiliser

All lasers discussed in this paper are internal mirror lasers that emit light in at least two orthogonally polarised modes. A heater coil, wrapped around the length of the laser, controls the laser frequency by changing the tube's temperature. Maximum tuning rates of 10 MHz/s are typical. Each laser is pre-stabilised by the two mode power balancing technique [5] which can maintain a short term frequency stability of the order of 10^{-10} for sampling times of 30 seconds or less [6]. Disturbing the power balance with an external signal allows the laser's frequency to be tuned throughout the gain envelope. The laser's output is separated into its two longitudinal modes with a polarising beam splitter, and one mode is used to lock the laser to an iodine reference with the external cell stabiliser.

A full description of an earlier form of the external cell stabiliser is given elsewhere [4]. The one used here is similar, with only minor modifications, and operates in the following manner: The saturated absorption spectrum of iodine is detected by modulating the amplitude of a pump beam and detecting the modulation induced on a probe beam when both beams are tuned to the same velocity group of iodine molecules. By saturating the molecules, the pump beam reduces the number available to absorb light at the resonant frequency by an amount dependent on the pump beam intensity. Therefore, when the probe beam is resonant with the same molecules its transmission through the iodine will also depend on the intensity of the pump beam. As a result, any amplitude modulation on the pump is transferred to the probe beam. Signal detection is straightforward because the pump and probe beams are slightly misaligned, and therefore spatially separated at some distance from the cell (see Fig. 1).

Each saturated absorption line is only 2-3 MHz wide — significantly narrower than the 500 MHz wide Doppler broadened iodine lines that are observed at room temperatures with unsaturated absorption techniques. The line width is important because better frequency stabilities are obtained when the laser is locked to narrower features. The saturated absorption maximum occurs when the pump and probe beams are tuned to 40 MHz either side of the centre of the iodine absorption line. At this tuning both beams interact with the same group of iodine molecules (because the beams are counter-propagating) and an acousto-optic modulator shifts the frequency of the pump beam by -80 MHz. The optical components that make up the stabiliser unit have been mounted on a 12 mm thick aluminium plate that is 460 mm long and 280 mm wide. This compact design simplifies alignment and makes the stabiliser portable.

All aspects of the line-locking procedure are controlled by a program, written in Microsoft Visual Basic. The program automatically locks the laser to a reference absorption line, and provides a continuous display of the error signal amplitude once locked. The software also integrates the error signal, programs the lock-in amplifier which detects the modulation signal on the probe beam, and frequency modulates the laser at 3 Hz to a depth of approximately 300 kHz. This frequency modulation enables locking to line centre. Demodulation of the resulting 3 Hz signal is performed by the computer, replacing the second lock-in amplifier used in our earlier system.

A Stanford Research SR510 lock-in amplifier is used to detect the primary signal. The gain, phase and time constant of this amplifier can be changed at any time by the computer to match the needs of the laser being locked. This amplifier has auxiliary output ports, also controlled by the computer, which generate the tuning signals that are used to control the frequency of the laser.

The entire system consists of the laser, its two mode power balance control box, a computer and the external cell iodine stabiliser. None of these items is particularly large or heavy. Therefore, the system can be moved with relative ease to any location where a primary wavelength reference is required.

3. Performance of the Stabiliser with 543 nm Lasers

The performance of the stabiliser when used to lock a 633 nm laser was discussed in a prior report [4]. The frequency uncertainty of the laser was found to be better than 2×10^{-10}, with a long term frequency stability of 4×10^{-11} after a thousand seconds. We expect the stability to be better for the 543 nm laser because there is more light available, and hence the signal-to-noise ratio of the error signal is superior. To investigate the performance of the stabiliser with a 543 nm laser, two identical stabiliser units were constructed and used to lock two 543 nm lasers known as G2 and G3. The outputs from the two lasers were combined with a beam splitter and focussed on to the same photodetector. A counter connected to the detector measured the frequency difference (beat frequency) between the two lasers. Figure 1 shows the experimental layout used. For effective two mode power balance prestabilisation it was necessary for each laser to emit only two longitudinal modes which had stable polarisations.

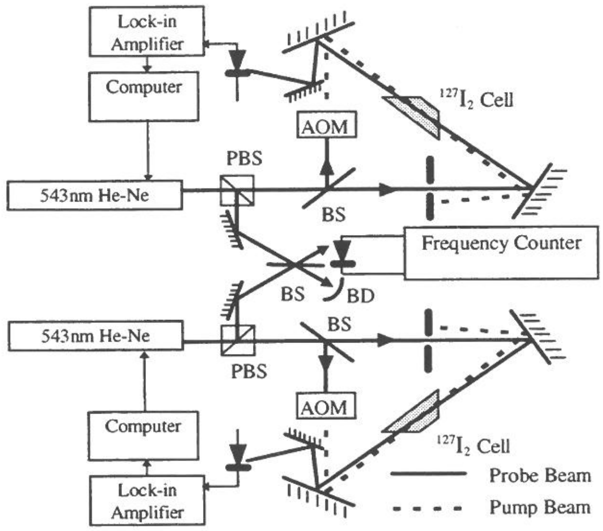

Figure 1: The experimental layout used to measure the frequency difference between two 543 nm helium neon lasers locked to iodine using the external cell stabiliser. Items denoted PBS, are polarizing beam splitters, BS are beam splitters, AOM are acousto-optic modulators, and BD are beam dumps.

Both G2 and G3 were constrained to emit light in only two modes by flexing the tubes with metal collars placed around the output mirrors. The flexing reduces the gain of the tube and makes it possible to extinguish unwanted modes. Permanent magnets were also required to stop the polarisation of the modes from flipping. With these measures, each laser produced single mode powers of approximately 250 µW, with one mode used for line locking and the other for the beat measurement. The frequency difference between the longitudinal modes of each laser was measured with a frequency counter and found to vary by less than 1 kHz over the course of a day. Day to day variations in temperature may cause the lasers to lock to a different mode, resulting in a change in the frequency difference between the line locking mode and the measurement mode. A temperature change of 10°C will produce a relative tube length change of approximately 8×10^{-6} and a subsequent change in the mode spacing of the same order. Therefore, as the temperature of the lasers is controlled to within 10°C, the frequency difference between the longitudinal modes of each laser varies by less than 10 kHz.

With G2 locked to the b5 component of the R(106) transition of 127I2, and G3 locked to the a14 component of the R(12) transition, a frequency difference of 156.37 ± 0.01 MHz was measured. A frequency difference of 156.36 ± 0.04 MHz was measured when G3 was locked to b5 and G2 locked to a14. The expected value [7] is 156.37± 0.03 MHz. Similar agreement between measured and published values were obtained when G2 and G3 were locked to other components of the R(106) and R(12) transitions. These results imply that the lasers are locked close to the peaks of the absorption lines, and hence that the frequency of the laser is the same as that ascribed to the absorption line. To investigate the repeatability, G2 and G3 were locked to b5 and a14, respectively, 20 times over a six day period and a 15 minute beat measurement recorded. The mean value of those measurements was 156.37 MHz and the standard error was 0.01 MHz.

Figure 2 shows the Allan standard deviation [8] of the beat frequency between the two lasers with and without the iodine line locking. Also shown is the Allan standard deviation of a locked 633 nm laser.

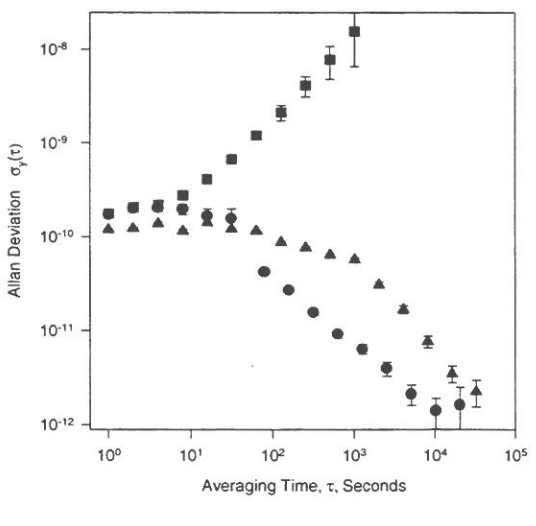

Figure 2. Allan deviation, $\sigma_y(\tau)$ of 543 nm laser (squares and dots) and the 633 nm laser (triangles) as a function of sample time, τ. The squares show the deviation when the iodine stabiliser is not used while the dots show the deviation when the stabiliser is used. All values shown have been divided by √ 2 to indicate the stability of a single laser.

Over the first six seconds the short term stability is limited by the two mode power balance prestabilisation to around 2 x 10^{-10}. After this time the effect of the iodine locking is to improve the frequency stability. The initial period comes about because of the three second time constant used by the computer to integrate the error signal. Such a large time constant is necessary to obtain enough cycles of the three Hz modulation for a suitable signal to noise ratio. A smaller time constant would be possible if the modulation frequency was increased. However, because 3 Hz is the maximum frequency at which the lasers can be modulated, 3 seconds is the minimum integration time that can be used.

The long term stability of 6 x 10^{-12} after a thousand seconds is approximately an order of magnitude better than that obtained with the 633 nm laser [4]. In performing the measurement of the long term stability of the 543 nm lasers, they remained locked for over 4 days. The lasers maintain their lock even if the bench that they are placed on is disturbed or if the ambient temperature changes. This is typical of the system which is relatively insensitive to most normal laboratory activities.

4. Gauge Block Measurement

The stabiliser only requires one of the laser modes for iodine line locking, allowing the second mode to be used for gauge block measurement. At the National Measurement Laboratory, a measurement is performed by frame grabbing an image of the fringes generated by the top of the gauge and the platen at the base, as shown in Fig. 3. The fringe shift between the two patterns is then measured allowing the length of the gauge to be determined. For this process it is the short term stability of the laser and knowledge of the mean frequency that is important. The frequency difference between the modes is known to better than 10 kHz, hence both modes have a relative short term stability better than 2 x 10^{-10}. Two-

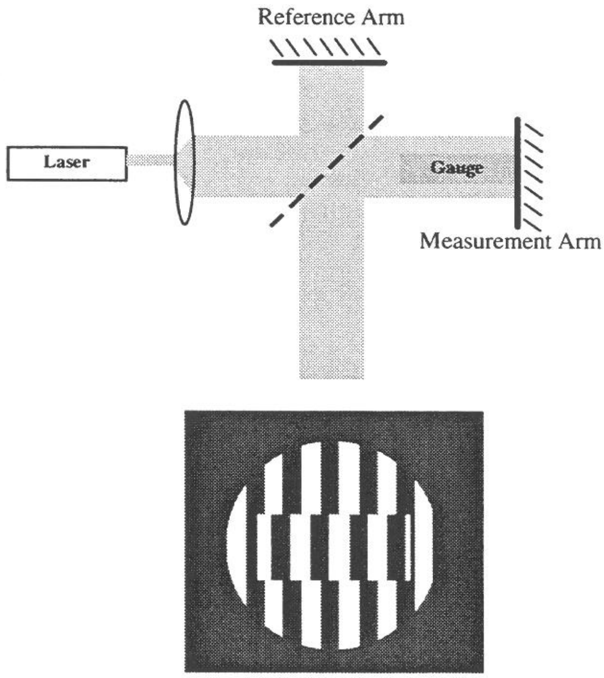

Figure 3: A schematic diagram showing the fringe patterns formed by the top of the gauge and the base (platen).

colour interferometric measurement of 1 m length bars requires a frequency stability and uncertainty of about 10^{-9} (if the relative phase is to be measured to 1% in a practical length of time). Thus, while the stabilisation scheme cannot boast the ultra-high short term frequency stabilities that others can deliver, it is adequate for most gauge calibrations encountered in a measurement laboratory. The real strength of the scheme lies in its simplicity which allows primary standards to be obtained at common wavelengths simply by using different helium neon lasers. The laser can be changed because the optical components used are not wavelength specific.

Recently, we reported a further improvement to the system [9]. It is possible to simultaneously lock three helium neon lasers to iodine references using one stabiliser unit. Each laser is tuned, with a computer generated signal, to the centre of an iodine absorption line by switching it into the stabiliser unit for a 20s period. At the end of this line-locking period, the tuning signal is held constant for the next 40s while the other two lasers are locked, in turn, to their iodine references. The cycle is then repeated. The two mode power balance prestabilisation ensures that each laser does not drift from its iodine reference by more than 100 kHz whenever it is not under the influence of the iodine line locker. The arrangement was investigated by locking G2 in this intermittent manner and measuring the beat frequency between it and G3 which was locked continuously to its reference. No significant change in short term frequency stability was observed from that shown in Fig. 2.

5. Conclusion

We have described a simple external cell stabiliser that can be used to lock the frequency of commonly used helium neon lasers to recognised iodine references. Applied to the 543 nm helium neon laser a short term stability of 2×10^{-10} was obtained, limited by the stability of the two mode power balance prestabiliser. A long term stability of 1.4×10^{-12} after ten thousand seconds was observed. The uncertainty in the frequency was better than 2×10^{-10} for sample times greater than 1 s.

This novel, practical scheme can be used to stabilise three helium neon lasers to iodine transitions at the one time, with one external stabiliser. With this technique, primary wavelength references at 543 nm, 612 nm and 633 nm are generated that have short term (> 1 s) frequency uncertainties of 2×10^{-10} or better, with sufficient power to directly measure gauge blocks or length bars. Consequently, no frequency calibration of the lasers is required. A computer controls all aspects of the line locking including directing the laser beams into the stabiliser, so user input is not required once the system is established. The simplicity of the scheme makes the stabiliser compact, portable and a comparatively inexpensive option.

6. References

[1]. A. Arie, S. Schiller, E. K. Gustafson and R. L. Byer, "Absolute frequency stabilisation of diode-laser-pumped Nd:YAG lasers to hyperfine transitions in molecular iodine", *Opt. Lett.*, **17**, pp. 1204-1206, 1992

[2]. M. L. Eickhoff and J. L. Hall, "Optical frequency standard at 532 nm", *IEEE Trans. Instrum. Meas.*, **44**, pp. 155-158, 1995

[3]. K. Scheider, S. Schiller, J. Mlynek, M. Bode and I. Freitag, "1.1W single frequency 532 nm radiation by second harmonic generation of a miniature Nd:YAG ring laser", *Opt. Lett.*, **21**, pp. 1999-2001, 1996

[4]. E. Jaatinen and N. Brown, "A simple external iodine stabiliser applied to 633 nm, 612 nm and 543 nm He-Ne lasers", *Metrologia*, **32**, pp. 95-101, 1995

[5]. R. Balhorn, H. Kunzmann and F. Lebowsky, "Frequency stabilisation of internal-mirror helium neon lasers", *Appl. Opt.*, **11**, pp. 742-744, 1972

[6]. P. E. Ciddor and R. M. Duffy, "Two-mode frequency-stabilized He-Ne (633 nm) lasers: Studies of short and long term stability", *J. Phys. E*, **16**, pp. 1223-1227, 1983

[7]. T. J. Quinn, "Mise en practique of the definition of the metre (1992)", *Metrologia*, **30**, pp. 523-541, 1994

[8]. D. W. Allan, "Statistics of atomic frequency standards", *Proceed. IEEE*, **54**, pp. 221-231, 1966

[9]. E. Jaatinen and N. Brown, "Sequential frequency locking of three He-Ne lasers with one external iodine stabiliser", *Metrologia*, **34**, pp. 309-312, 1997

"Black holes are where God divided by zero"

"Quantum Mechanics: The dreams stuff is made of"

- Steven Wright

Editorial

In addition to two scientific articles, this issue of *AOS News* features a conference review, a summary of past AOS councils, a report on the AOS membership, and miscellaneous news items from FASTS.

I would like to draw your attention to the mini-symposium to be held at OFTC in Sydney in July (page 5). The Annual General Meeting will take place during the symposium. Last year this event was highly successful, and I'm sure this year will be the same.

The AOS-related optics cenference for this year, ACOLS, is fast approaching. Abstracts are due on the 7th of August, and 'early-bird' registration is due on the 1st of October. For more information see page 4 and/or visit the conference web page.

Duncan Butler

Calling Your Computer Names

One can only guess at the bizarre naming rituals followed by system administrators when it comes to giving the latest piece of whiz-bang hardware a personality.

Physicists, not surprisingly, used up all of their leading lights long ago (**kelvin**, **born**, **maxwell**). And particle physicists spend most of their time searching the subatomic zoo for something different since they ran out of particles in 1994 (**muon**, **tauon**, **lepton***).

Other administrators prefer to put themselves out on a limb: **swifty** is guaranteed to become swiftly obsolete — the namer of **bimbo** was closer to the mark. The name of the legendary sorcerer, **merlin**, is more suggestive of what really is involved in getting one of these machines to work. In a similar vein, **hope** is an apt choice. And one can guess with some confidence as to the thought processes which inspired **laurel** and **hardy**.

(All names are from the member list)

***lepton** is, however, a great name for a cat.

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NEW

The Latest Diode-Pumped Laser Technology From Light Solutions Corporation

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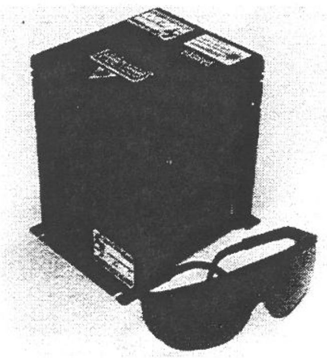
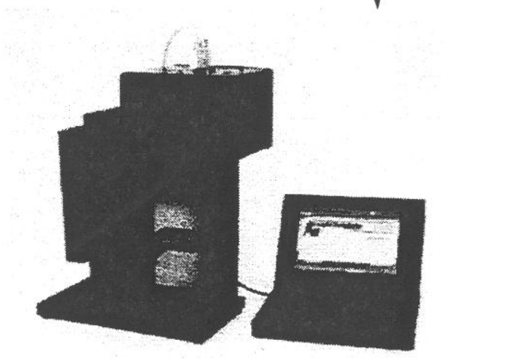


5W TEMoo Orion

The miniature air-cooled Orion is compact enough to "fit in the palm of your hand" and can produce in excess of 5 Watts at 1064nm in either CW or Q-switched format. This powerful little laser has a wide range of industrial marking, military and medical applciations. The rugged, reliable portability of this system has meant that it has already been used on aircplanes and helicopters, robotic arms and all terrain vehicles - anywhere where size and portability is critical.



An air-cooled OEM Orion laser as part of a laser marking system

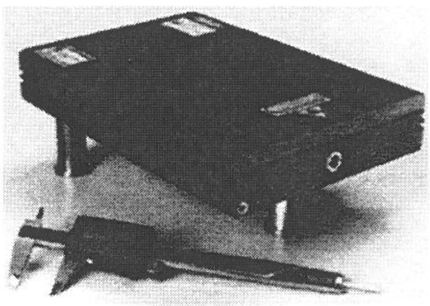
The Lightbook System

The basic 10W *Lightbook* System produces > 10W of TEMoo output ($M^2 = 1.1$) at 1064nm in either CW or Q-switched format. Pulse energies up to 1.5mJ and repetition rates from 1kHz to 100kHz enable many applications requiring high power and excellent beam quality. However the Lightbook is more than just a 10W IR laser - it is a truly modular system that can be upgraded at anytime to a variety of formats, that simply mount on top of the basic head without increasing the footprint of the laser head.

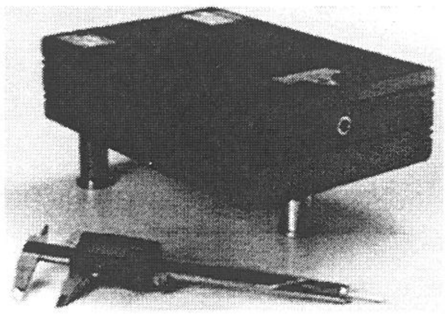
The new *Spectrum* add-on allows the user to switch between 10W @ 1064nm, to 5W @ 532nm to 1W @ 355nm. Other add-ons available include monolithic OPO's for multiwatt output at 1.57, 2.1 or 3.4µm, and the upcoming PPLN OPO for output anywhere in the 1.5-5µm range.

The new *LightAMP* amplifier module added to the Lightbook produces in excess of 20W of TEMoo output power. The cw-pumped LightAMP can also come stand-alone to double the power of most 1064nm lasers including cw, pulsed, Q-switched and mode-locked.

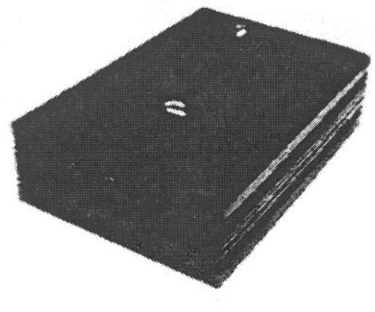
Complete Lightbook System with Laser Head, Driver and new all-solid-state chiller



10W TEMoo Lightbook



20W TEMoo LightAMP



Lightbook Spectrum with 5W @532nm and 1W@ 355nm

1998 MID-YEAR AOS MEMBERSHIP REPORT

Barry Sanders (Honourary Treasurer) and Levente Horvath

Members are aware that the Annual General Meeting is approaching, and so it is worthwhile to review the membership profile of the organisation at this time. We present below the composition of the membership and compare these data to the report of the previous Honourary Treasurer, Dr Esa Jaatinen, published in the *AOS News* December 1996 issue.

As of the First of June 1998, we have 297 members consisting of: 5 Life members, 14 Honourary members, and 278 financial members. Of these financial members, six are corporate members, 254 are regular members and 18 are student members. This represents a drop of 10 members compared with the total of 307 members in total on the 14th of October 1996 presented in the previous report. The drop in membership is largely due to a significant decrease in student members from 42 in October 1996 to just 18 in June 1998 although corporate membership has dropped as well from 14 to 6. Many of the students have stayed on as regular members since graduating, and our regular membership has increased from 231 in October 1996 to 254 in June 1998. The decline in student numbers is due to low numbers of students joining this year. Students often join when they attend conferences, but the conference fee policy towards students at the recent AOS meeting in Adelaide (December 1997) is likely a significant factor in the lower student membership this year.

Many of our 278 financial members are also members of affiliated organisations. Ninety-three are members of the Australian Institute of Physics, 32 in the International Society for Optical Engineering (SPIE) and 100 in the Optical Society of America, with eight of these members of all three of these organisations! New South Wales represents 34% of the financial membership and Victoria the second largest number at 18%. 14% of the membership is based in South Australia, a significant increase from 9% in 1996, due largely to the successful meeting in Adelaide in December. The Australian Capital Territory has the greatest per capita membership with 35 members representing 13% of the financial membership whereas there is just one (valued!) member (0.36%) in the Northern Territory. Tasmania has double the representation of NT: two members; and 8% of the membership is based in Queensland. Four percent of the members are from Western Australia. Overseas, 4% of the members are based in New Zealand, 2% in each of the USA and Asia, and just under 1% (two members) in Europe.

The profile of interests is shown in Table 1. These preferences have changed over time, reflecting changes in membership. The categories "communications and fibres", "nonlinear optics" and "lasers" continue to be quite popular. A peculiar decline in most preferences is due to many members not indicating their preferences on the forms, not due to a decline in interests! However, the diverse range of interests continues and is indicative of the growth and excitement of optical science and technology.

Table 1: Interests of AOS Members

	Category	**1st Preference**		**2nd Preference**		**3rd Preference**	
		10/96	6/98	10/96	6/98	10/96	6/98
1	Astronomical Optics	21	13	11	4	7	5
2	Atmospheric Optics	13	6	4	3	4	1
3	Communications and Fibres	39	31	21	8	14	14
4	Electro-optics	20	10	27	17	18	9
5	Fabrication and Testing	11	7	9	4	11	9
6	Information Processing	7	4	7	6	9	5
7	Lasers	53	35	48	19	36	22
8	Optical Design	16	8	28	23	22	14
9	Optical Physics	18	13	36	26	30	23
10	Radiometry, Photometry & Colour	8	9	17	8	6	4
11	Spectroscopy	16	9	23	18	27	17
12	Thin Films	9	5	8	7	11	7
13	Vision	8	7	5	4	7	5
14	Quantum Optics	20	12	8	7	13	5
15	Nonlinear Optics	19	12	29	23	24	20
16	Teaching	5	6	9	8	24	18
17	Holography	9	6	4	4	9	5
18	-	33	25	12	10	10	7
19	-		-	7	6	1	1
20	-		-	-	-	1	-

ICO NEWSLETTER
Commission Internationale d'Optique ◆ International Commission for Optics ◆ April 1998

THIRD ICTP/ICO WINTER COLLEGE ON OPTICS

HELD IN TRIEST, FEBRUARY 1998

The International Center for Theoretical Physics at Trieste, Italy is a center established by UNESCO with the support of the Italian government to host selected physicists from developing countries; during their stay, they can conduct research, have access to library and laboratory resources, and attend meetings and schools. As part of its program for the support of optics in less favored regions of the world, ICO has been collaborating with ICTP on organizing Winter Colleges in Optics for several years. The third Winter College was held in Trieste, February 9–27, 1998.

It was jointly directed by Prof. T. Asakura (Hokkaido Gakuen Univ., Hokkaido, Japan), Dr. P. Chavel (Laboratoire Charles Fabry de l'Institut d'Optique, CNRS, Orsay, France), Prof. A.T. Friberg (Royal Institute of Technology, Stockholm, Sweden) and Prof. A. Sona (CISE, Milano, Italy). Prof. G. Denardo (ICTP and Univ. of Trieste, Italy) served as the Local Organizer.

Twenty-five lecturers and 80 participants attended the College, which included lectures, laboratory courses, seminars on present research subjects, and communications by the participants. The lectures covered:

- modern microscopy: near field microscopy, interaction of light and matter in the near field, atomic force microscopy, and scanning microscopy;
- nonlinear optics, transmission and the related optical materials: fundamentals of nonlinear optics, solitons in optical fibers and ultra long distance transmission, guided wave optics on silicon, integrated optics in glass, and photorefractive materials;
- physical optics: speckle, scattering, coherence, interferometry and optical shop testing, ultrafast signal manipulation, and diffractive optics; and
- information optics: pattern recognition, holographic memories, and artificial retinae.

The communications by the participants were part of the activities of the ICTP LAMP (Laser, Atomic, and Molecular Physics) network and met a large success. They included 15 minute oral and poster presentations. Eight afternoons were devoted to the experiments, which were held with the help of the Elettra synchrotron facility in Trieste, the CISE research foundation in Milano, Honlet GmbH, Germany, and École Superieure d'Optique, Orsay, France. Every student had an opportunity to participate in four sets of experiments related with nonlinear optics, particle sizing, speckle metrology, and light detection.

The three ICTP/ICO Colleges held so far (1993, 1995, 1998) were successful in bringing together scientists from a particularly large number of countries and promote collaborations. This activity serves one of the priority objectives of ICO: contribute to the international development of research in pure and applied optics with special attention to those parts of the world where conditions are difficult. Plans are being made to continue the series.

ICTP/ICO Colleges are open to scientists from all countries of the world that are members of the UN, UNESCO, IAEA, or UNIDO. The main purpose of the Center is to help research workers from developing countries, but graduate students and post-doctoral scientists from developed countries are also welcome to attend. As the Colleges are conducted in English, participants should have an adequate working knowledge of the language. As a rule, travel and subsistence expenses of the participants should be covered by the home institutions. However, funds are available through ICTP to support participants from developing countries who will be selected by the organizers. Such financial support is available only to those who attend the entire activity. As scarcity of funds does not allow travel to be granted in all cases, every effort should be made by candidates to secure support for their fares (or at least half-fare) from their home country. So far, there have been no registration fees for attending the Colleges.

VISITING LECTURER POSITIONS AVAILABLE AT CAPE COAST UNIVERSITY, GHANA

The Laser and Fibre Optics Centre (LAFOC), located at the Physics Department of the University of Cape Coast, Cape Coast, Ghana, is an affiliated center of the International Centre of Theoretical Physics (ICTP) under the ICTP Office of External Activities. LAFOC is financially supported with funds of SAREC, Sweden. The center focuses primarily on programs for training students at post-graduate level (M.Phil. and Ph.D.) in modern optics, lasers, and fiber optics for biomedical and environmental applications. The facilities at the center are meant to serve as resources for students, lecturers, and visiting scientists from universities or research institutions in the sub-region to enable them to undertake research work. The center also mounts exhibitions and demonstrations for teachers and high school students as well as professionals and industrialists. Since its establishment in 1992, LAFOC has initiated research in the following subjects: light scattering by fluid and powdery samples; holographic and speckle interferometry; fiber sensing; applied spectroscopy for applications in agriculture; and image processing. Aside from these subjects, research areas also extend to theoretical physics and electro-optic devices. In light scattering, the center has been using the technique for particle sizing of powdery substances, fluids, and soil textural classification. Work is being pursued on the computer simulation of bent fibers by making use of a *Continued on last page*

ICO PARTICIPATION IN MEETINGS AND SCHOOLS

There are four categories for ICO participation in meetings and in schools

1. ICO General Meetings
2. Other major ICO events (that may be named ICO Topical Meetings, ICO Regional Meetings, ICO Schools, ICO Colleges)
3. ICO Cosponsored Meetings and Schools
4. ICO Endorsed Meetings and Schools.

For ICO General Meetings and other major ICO events, ICO is normally closely related with the initiative of the Meeting. ICO General Meetings are held every three years and are organized by one of the ICO Territorial Committees following a call for applications issued by ICO. This column describes the procedure and rules applicable to "Cosponsored" and "Endorsed" events.

A. General conditions

1. ICO provides sponsorship and endorsement to international conferences and schools—typically, those with at least 30% of the attendees and at least 50% of the Program Committee from outside the host territory. "Event" in the forthcoming refers to conference or school. A companion document to this one gives the information and guidelines for events directly generated by ICO or in particularly close cooperation with ICO (ICO General Meetings and other major ICO events) and may be obtained from the ICO associate secretary, see address at the end of the Newsletter.

2. ICO participation implies in all cases:

- that the ICO Bureau perceives that the meeting will be of a good scientific quality and that the timing and venue are appropriate;
- that the ICO Territorial Committee of the Territory where the event is to be held approves the project; and
- that the event organizers confirm adherence to the general principle of "free movement of scientists" as defined by the International Council of Scientific Unions (ICSU) in the booklet "Advice to Organizers of International Scientific Conferences." In essence, the host territory must guarantee that a bona fide scientist or engineer of any nationality or citizenship may attend. It is not sufficient to make a guarantee only for persons from territories recognized by the host Territory. Any failure to honor a guarantee is reported by ICO to ICSU through the International Union of Pure and Applied Physics (IUPAP).

3. ICO encourages meetings in all new areas of optics and meetings designed to fill specific needs, including regional development of optics. At the same time, ICO would like to avoid the unnecessary proliferation of conferences.

4. Industrial participation in the Program Committee and in the Organizing Committee is usually required.

B. Special conditions for ICO cosponsored events and for ICO endorsed events:

5. The distinction between the two categories "ICO cosponsored event" and "ICO endorsed event" is outlined in the following points. The ICO Bureau makes the decision but organizers are welcome to propose a category.

6. ICO cosponsored conferences must follow the IUPAP policy on conference fees. For conferences held in 1998, the upper limit is SFr 500 with proceedings included (the figure is increased periodically in line with inflation). For ICO endorsed events, exceptions to that rule may be made.

7. In ICO cosponsored events, ICO must be associated from the beginning and usually no later than 18 months in advance.

8. In ICO cosponsored events, the ICO associate secretary in charge of meetings is *ex officio* a member of the Organizing Committee and should be kept regularly informed of the progress of the organization.

9. In ICO cosponsored events, the ICO Bureau designates one member to represent it in the Program Committee. For ICO endorsed events exceptions to that rule may be made.

10. For ICO cosponsored events, the organizers are always welcome to use the channel of the ICO Territorial Committee mailing list to distribute information.

11. For ICO cosponsored events, the organizers are requested to send free proceedings of the conference to countries where optics development requires special support; a list of some addresses appropriate for that purpose selected by ICO will be provided by ICO; for ICO endorsed events the same action is recommended. The number of copies requested is of the order of 25.

12. All ICO cosponsored and ICO endorsed events are listed in the column "Forthcoming events with ICO participation" in the ICO Newsletter. In addition, organizers of ICO cosponsored events are welcome to provide the ICO secretariat with a 1,000–2,000 words article, if possible with an illustration, for further publicity in the ICO Newsletter. Because the responsibility for the publication rests on it, ICO has the liberty to slightly edit the text to adapt it to the general style and to the space available.

13. The use of the ICO logo in documents concerning ICO cosponsored events is desired; it is permitted in ICO endorsed events.

14. There may be a modest ICO financial participation in ICO cosponsored events in the form of a grant, loan, or participation in the risks. Financial participation is usually in the range U.S. $1,000–2,000. There is usually no ICO financial participation in ICO endorsed events. Note: participation in the financial risks means an immediate loan that can be converted in part or in totality into a grant if the event runs a deficit; ICO accepts to take the first risk, in case of a surplus however, ICO receives a share. Grants may be assigned to specific purposes such as the support of students or the support of participants from less developed countries. Applications for ICO cosponsorship or endorsements are received by the ICO associate secretary. Meetings organizers are requested to use the appropriate forms that can be obtained from the ICO associate secretary and will soon be made available on-line on the ICO Web page (www.ico-optics.org).

The first president of ICO, T. Smith (1883–1969), of the National Physical Laboratory, England, was a specialist of the theory of geometrical optics and a pioneer of ray tracing on calculating machines.

ICTP/TWAS BOOKS AND JOURNALS DONATION PROGRAM

ICO has been collaborating with the International Center for Theoretical Physics (ICTP) for several years now in organizing several winter schools, "colleges" and meetings on optics that were held in Trieste and in other places, and have been met with appreciation. It may be appropriate at this point to publicize the Books and Journals Donation Program that is operated jointly by ICTP and by the Third World Academy of Sciences (TWAS). An organization located in Trieste, Italy and devoted to the development of physics in parts of the world where the development of science requires particular attention, ICTP has established together with TWAS a program for the donation of books, conference proceedings, and journals for the benefit of libraries in regions of the world where the scientific collections are particularly wanting.

If you have books, proceedings of conferences, or back issues of optics (or other) journals that you would be willing to donate, or if you know someone who does, you may want to take part in the program. It is operated as follows: ICTP and TWAS maintain a list of libraries with the publications that they would particularly like to receive. Please send the name of the books, proceedings, or journals that you are considering donating to the address below. For journals, please mention the years and volume numbers. Professor Dalafi will reply to you with a suggestion of places where to ship the journals. Then, please have the shipping made by a surface carrier of your choice and send the original shipping invoice to Professor Dalafi, who will have it reimbursed to you by ICTP. Please note that the original invoice is strictly required and that only surface shipping is acceptable. Recent volumes are in general particularly welcome but collections extending over a long period of time are highly appreciated. Contact: Professor H.R. Dalafi, ICTP, P.O. Box 586, I 34100 Trieste, Italy, +39 40 224 0329; fax +39 40 224 0319; donation @ictp.trieste.it.

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NEWS FROM ICO TERRITORIES

France

Last October in Paris, during Horizons de l'Optique, the biennial meeting of SFO, the French Optical Society elected its new Board. According to the statutes, the Board is also the French Territorial Committee for Optics, *i.e.*, the French member of ICO. The new Board has now started activity on a two year term. Its members are J.M. Maisonneuve (ONERA, Toulouse), president; J.C. Fontanella (Thomson CSF Optronique), past president; J.M. Jonathan (Institut d'Optique/CNRS), vice president; A. Brun (Institut d'Optique), treasurer; G. Corbasson, secretary; J.J. Aubert (CEA CENG DLETI), J. Cornillaud (CILAS), D. Dolfi (Thomson CSF LCR), R. Frey (Ecole Polytechnique/CNRS), S. Huard (ENSP Marseille), D. Laroche (Sfim ODS), J.L. Mercier (Essilor), and G. Rousset (ONERA Chatillon). M. Sirieix (Sagem) is the representative of the Groupement des Industries Françaises de l'Optique and M. Druetta (Univ. Saint Etienne) is the representative of the French Physical Society; and A. Masson is the observer from Club Nanotechnologies.

India

The Officers of the Optical Society of India for 1996–1999 are Dr. O.P. Nijhawan, IRDO Dehradu, president; Prof. N.B. Gupta, IIT New Delhi, vice-president; Dr. Ajay Ghosh, Calcutta Univ., secretary general and ICO contact; Dr. S.N. Sarkar, Calcutta Univ., treasurer.

Japan

The staff of the Japanese Territorial Committee for ICO, Science Council of Japan, has been recently changed. The new representative is Prof. Yoshiki Ichioka, Department of Material and Life Science, Graduate School of Engineering, Osaka University.

Mexico

The ICO has heard with great sadness about the untimely death of Prof. Gustavo E. Torres-Cisneros, on January 25, 1998. Prof. Torres-Cisneros had served for two years as the vice president of the Academia Mexicana de Optica, and as such he was also in charge of ICO relations. On January 1, 1998, he had become the president of AMO for 1998–99. ICO will miss his valuable cooperation in its many contacts with the Mexican optical community. J. Ojeda-Castaneda and X. Sanchez-Mondragon, both former presidents of AMO, are maintaining the contacts.

United States

The new official representative of the U.S. for ICO is Dr. Tamae M. Wong, National Research Council in Washington, D.C. The 1998 United States Advisory Committee for ICO consists of A.H. Guenther, chair; A.A. Sawchuk, chair elect; H.M. Gibbs, C.D. Bowden, and D.W. Chandler, representatives of the American Physical Society; A.E. Willner, D.A.B. Miller, and R.R. Jacobs, representatives of the IEEE Lasers and Electro-Optics Society; J.S. Fender, A.E. Siegman, and T.C. Strand, representatives of OSA; C. Londono, R.A. Sprague, and J.B. Breckinridge, representatives of SPIE-the International Society for Optical Engineering.

Visiting Lecturer Positions Available

Continued from first page

unified matrix formalism. Indeed, candidates from any country can be admitted in the Ph.D. program in physics and work at LAFOC. Candidates from African countries South of Sahara can receive ICTP fellowships to follow the program. Four students are presently working on the Ph.D. program; they come from Ghana, Sudan, Nigeria, and Liberia. At the moment, owing to the limited staff, LAFOC makes use of external lecturers from the U.S. and Senegal. Among the courses taught in the program, the following would particularly benefit from external lecturer support: Optical Electronics and Semiconductor Physics, Quantum Optics, Laser Spectroscopy, Fiber Optics and Photonics Devices, and Quantum Electrodynamics. Visiting lecturers who would like to assist in the program may choose to teach courses or to participate in student supervision. Such visits will be divided in two periods of 6 or 8 weeks. Free accommodation and meals, as well as some reasonable stipend for the period of the visits will be provided. In addition, it is planned to organize an ICO Travelling Lecturer program to complement the stay in Ghana with lectures in other countries in the region. Interested applicants with a doctoral degree in the field and some additional experience in research and higher education should contact Dr. Paul K. Buah Bassuah, LAFOC, Dept. of Physics, Univ. of Cape Coast, Cape Coast, Ghana; +233 42 33773; fax +233 42 43446; lafoc@ncs.com.gh.

In his capacity as the 18th president of ICO, T. Asakura, Hokkaido Gakuen Univ., Japan, chaired the ICO fiftieth anniversary celebration.

Erratum

A photograph of the delegates to the ICO 1 General Meeting (Delft, July 1948) was published in the July 1997 issue of the ICO Newsletter. It was printed as well in the booklet devoted to the celebration of the fiftieth anniversary of ICO, which available on demand from the Secretariat as long as the supply lasts. It has been pointed out that Dr. B. Havelka was mistakenly listed as Dr. J. Hrdlicka in the photography caption. The ICO Secretary wishes to apologize for the error and welcomes any additional information about this photography or, as a matter of fact, about any event related to the history of ICO.

Forthcoming Events with ICO Participation

June 15–16, 1998
ODF '98, Optics Design & Fabrication International Workshop
Tokyo, Japan. Contact: Dr. Kimio Tatsuno, Hitachi Central Research Lab, fax +81 423 27 7673; tatsuno@crl.hitachi. co.jp.

June 17–20, 1998
OC '98, Topical Meeting, Optics in Computing
Brugge, Belgium. Contact: Prof. H. Thienpont, Vrije Universiteit Brussel, ALNA/ TW, Pleinlaan 2, B1050 Brussels; fax +32 2 629 3450; alnatw@vub.ac.be; www.phot. vub.ac.be/oc98/.

August 3–6, 1998
OII '98, Optics for Information Infrastructure, ICO Topical Meeting
Tianjin, China. Contact: Prof. G.G. Mu, Nankai Univ., 94 Weijin Rd, Tianjin, 300071, P.R. China. fax +86 22 2350 2974; imo@sun.nankai.edu.cn.

September 14–17, 1998
OPTIKA '98
Budapest, Hungary. Contact: Dr. G. Lupkovics, OPAKFI H-1027 F6 utca 68, Budapest, Hungary; fax +36 1 202 0452; optik98@ mtesz.hu; www.innostart.hu/optika98/.

September 28–October 2, 1998
III Reunion IberoAmericana de Optica, & 6th Optilas
Cartagena, Colombia. Contact: Prof. A. Guzman, Univ. Nacional de Colombia, Bogota; fax +57 1 316 5669; angela@ ciecias.campus.unal.edu.co.

October 13–16, 1998
OWLS V
Crete, Greece. Contact: Prof. C. Fotakis, FORTH-IESL, P.O. Box 1527, GR 711 10 Iraklion, Greece; fax +30 81 391318, fotakis@iesl.forth.gr.

December 9–12, 1998
ICOL-98, Intl. Conf. Optics & Optoelectronics
Dehradun, India; Contact: Dr. O.P. Nijhawan, IRDE, Raipur, Dehradun-248 008, India; fax +91 135 687161, root@ drirde.ren.nic.in.

July 28–30, 1999
ETOP '99, Sixth Conference on Education and Training in Optics and Photonics, "Teaching Optics for the Information Age," organized in association with SPIE and OSA (collocated with "Light for Life")
Cancun, Mexico. Contact: Dr. J.J. Sánchez-Mondragón, INAOE; fax +52 22 472940, jsanchez@inaoep.mx.

August 2–6, 1999
ICO-18, Triennial Congress of the International Commission for Optics, "Optics for the New Millennium"
San Francisco, Calif., U.S. Contact: ico18@spie.org; www.spie.org/; http:// optics.org/ico-optics/.

The previous issue AOS News carried an obituary for Michael Kidger, a popular figure in optics in Australia and around the world. Articles also appeared in OE Reports (No. 171, March, 1998) and Optics and Photonics News (Vol. 9 No. 4, April 1998). Here I have reproduced a personal perspective from Beattie Steel, one of many prominent AOS members to have known Michael.

The popular courses in optical design run by Kidger Optics continue — the most recent is being held at Sydney University as the AOS News goes to press.

-Ed.

Michael J Kidger: an Australian appreciation

With my shocking memory, I am the wrong person to write this. I am not even sure when I first met Michael. But I cannot forget the effect on me of his paper in the Proceedings of the 1980 Lens Design Conference (Proc. SPIE 237, 348) At this conference, there was a "competition" for the optimization of some given designs.

A range of entries were received and provided a comparison both of different programs and of different designers using the same program. At that time, most programs were for mainframe computers but there was one entry for a PC program, from Michael Kidger, then at Imperial College, London. His program produced as good or better optimized designs as the mainframe programs. Granted, it took a little longer but its success led to a revolution in design programs. PCs were now the way to go.

At that time, I was soon to retire from CSIRO and realized that there was an unfilled demand for optical designs for small local industries that had an idea that incorporated an optical system. This was the type of work in which CSIRO was no longer interested. Australia had a good precision optics industry that could manufacture such designs, so simple optical design would be a good retirement occupation for me.

As soon as I retired I did what I had been unable to afford before, buy a PC to write my own programs and also to use it with a commercial design program that included optimization. I was immediately attracted to Michael's SIGMA program and bought an early version, Michael having now left Imperial College to found his own firm with his wife, Tina. His program also had another attraction, the source code was provided and I ignorantly though I could perhaps modify the program to suit any special needs. I quickly learnt how difficult it is to work on another's source code and did not do this often.

His program produced useful optimized designs for several local industries with innovative ideas. Before that, I had to optimize designs using a simple ray-tracing program and trial-and-error changes. It worked only for very simple systems such as a Cooke triplet for Fourier transformation.

Soon after, Michael came here to give a course on optical design at the University of Melbourne, using his program as a working tool. The course was the first of a several in Australia (but I forget exactly how many). For the most successful, Michael asked my advice and suggested I should give a simple introductory course before his. But there was no interest in my course; you are not interested in a snack before a banquet. But I was given later versions of SIGMA, probably under false pretences, for I had not helped much. While my own program for the (failed) introductory course was very primitive, Michael never made me feel incompetent.

I also advised him on the best location for his course and he was surprised when I told him that the greatest interest was in Adelaide. But I think he was only persuaded to give the course there when I found out for him that there was always a major cricket match in Adelaide at that time, the Australia Day weekend. One course dinner was held in the Don Bradman pavilion.

He was back in Adelaide to represent his company at other meetings (at cricket times?) and, during one visit to Adelaide, I introduced him to the nearby wineries of MacLaren Vale. Another visit I remember was a short demonstration of his latest program at this university (Macquarie). I have not been involved directly in the arrangements for the latest course he was here to give but the large enrolment shows that his standing here remains high.

Tina came with him at least once, when the firm could spare her, and at our house I introduced her inwittingly to the local menace of sandflies, which I had not realized we had in the garden. The result was devastating and I marvel that she still speaks to me.

Tina tells me that Michael had a great fondness for Australia (and not only for optical design and cricket) and he has certainly a major influence on the designers here. We have lost him, but not Kidger Optics, which I trust will continue its role of teaching, program production and design.

W H Steel

RECORD OF THE COUNCIL OF THE AUSTRALIAN OPTICAL SOCIETY

A provisional committee was set up in Melbourne on 14 December 1982. The inaugural meeting of AOS was "Optics in Australia", a 2-day conference held at the National Measurement Laboratory, CSIRO Division of Applied Physics, Lindfield, on 24 and 25 May 1983. It was preceded on 23 May by a scientific discussion meeting "New Frontiers in Optics". A business meeting held during the conference confirmed the committee and office-bearers, as they appear in my list.

Invited papers at the conference were given by:

James C. Wyant (Optical Sciences Center, Tucson, Arizona)
K.N.R. Taylor (University of NSW)
Nobuhiko Ito (National Research Laboratory of Metrology, Ibaraki, Japan)
George Smith (University of Melbourne)
I.M. Bassett (University of Sydney)
John Davis (University of Sydney)
W.E. ["Bill"] James (James Optical) & R.B. Abell (CSIRO Applied Physics)

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	J Munch	J Munch	J Munch	W Walker
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	K Baldwin	W MacGillivray	W MacGillivray	W MacGillivray
	S Rashleigh	S Rashleigh	S Rashleigh	S Rashleigh
	W Walker	W Walker	W Walker	W Walker
	P Chu	P Chu	P Chu	

	(1986-87)	(1985-86)	(1984-85)	(1983-84)
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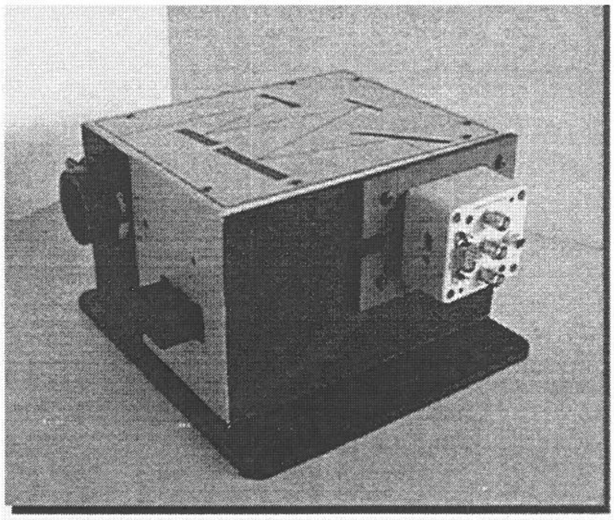

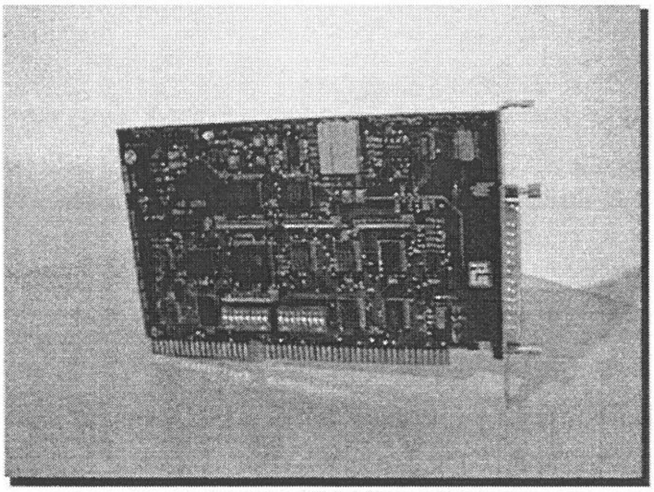

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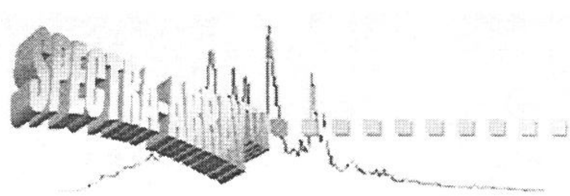

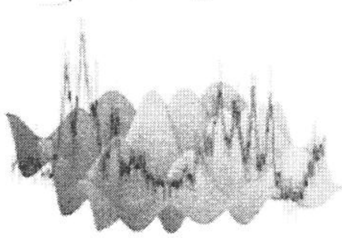

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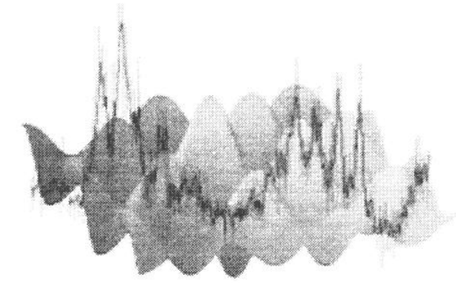

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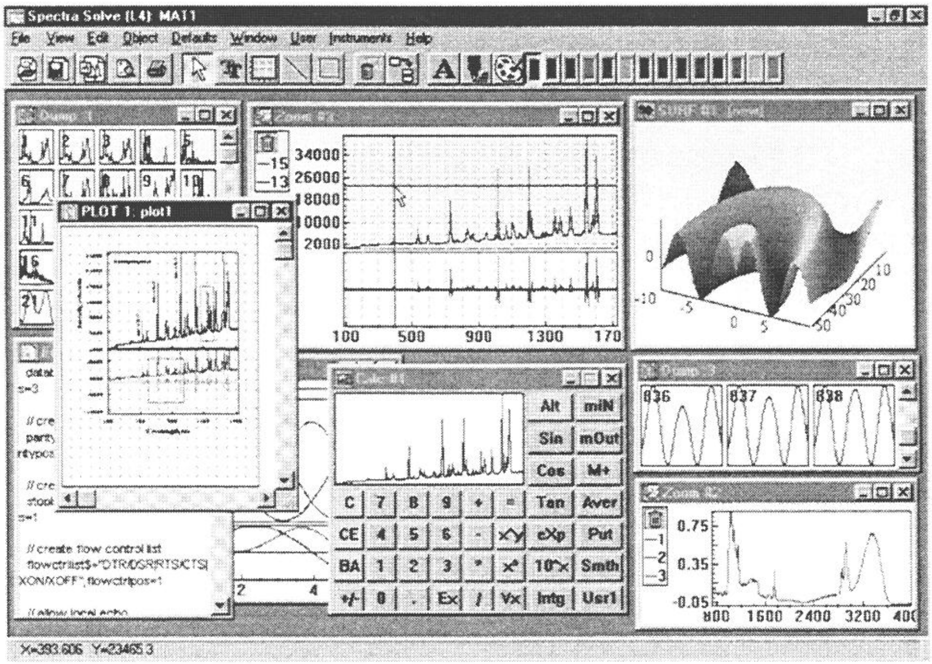

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