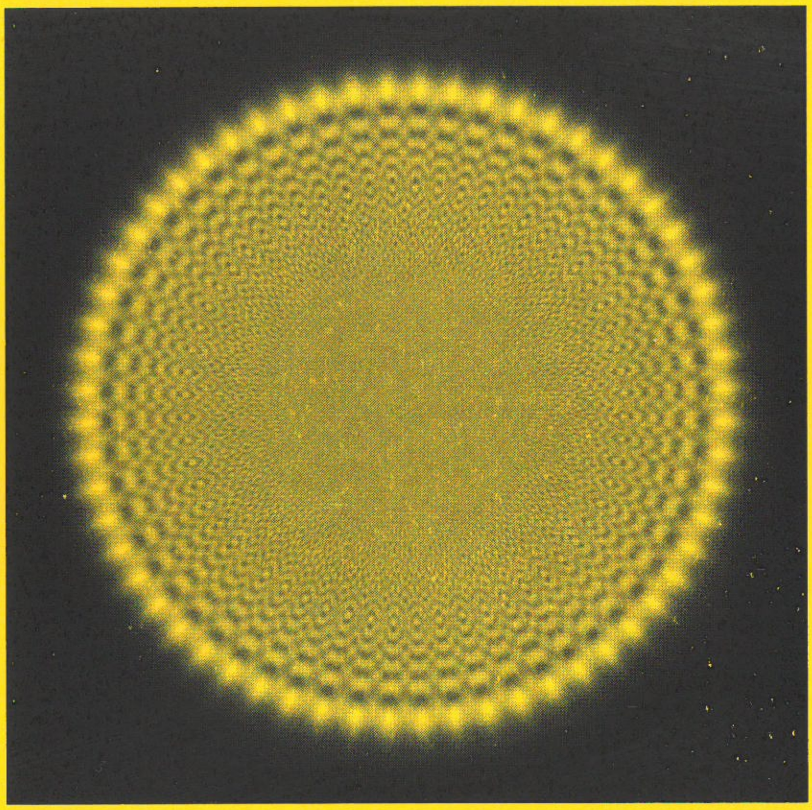
Australian Optical Society

NEWS



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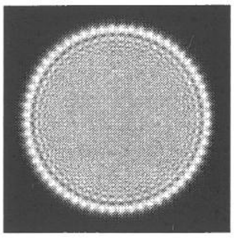
AOS NEWS



COVER:
The cover image shows the diffraction pattern from a toothed circular aperture. An interesting feature of this type of aperture is that the central region of the diffraction pattern is relatively uniform, particularly when compared to an ordinary circular aperture. The article on page 6 by Butler and Forbes discusses the calculation of diffraction patterns from complicated shapes.

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DEADLINE FOR NEXT ISSUE
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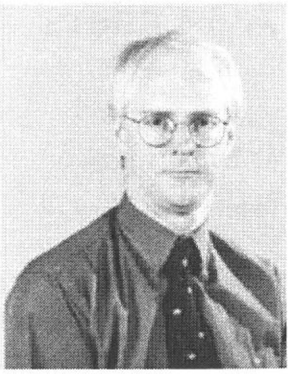
President's Report



In my last column I raised the expectation that there would be increased funding for the Australian Research Council. It is pleasing to see that your President has some prescience (actually, not very much was needed). I even thanked Ken Baldwin ahead of time for his contribution.

From the university perspective, the progressive increase in the large grant scheme will be helpful, but will take some time to take hold. Many of you know that ARC fellowships have, for the past few years, been only partly funded and this has placed great stress on an already struggling education sector. The agreement of the ARC to both increase the number of fellowships and to fund them at individual university salary rates is very sensible, and goes a long way to making government policy more sensible.

But the immediate interest is in the Major National Research Facility (MNRF) Scheme. The deadline for these will be past when you read this and I am not sure how many will be connected with optics. One that I am aware of, however, is the bid for an Australian synchrotron facility, dubbed "Boomerang". There does seem to be a great deal of scientific, industrial and political support for an Australian synchrotron and I would like to acknowledge the work of Mike Murray in Victoria and John Boldeman of ANSTO in promoting this facility. Mike has done sterling work in raising and maintaining industrial interest in the possibilities offered by a synchrotron source. Indeed, a convincing argument can be made that it is impossible for Australia to be a leader in biotechnology without access to such a facility. An interesting auction will likely soon take place between Victoria, NSW and Queensland over which state is to host the facility. As the MNRF scheme, containing $155M over five year, is probably too small to fund a synchrotron, I suspect that we may see this facility appearing as an election give-away. In any case, I believe that a major optics based facility such as a synchrotron will be an excellent outcome for all members of the AOS, including academic, technical and industrial.

A major part of the case for the synchrotron is its potential to create new high-technology industries. I am a strong believer in having scientists and engineers participate in the creation of spin-off companies and this process is now probably acknowledged as being at the core of the innovation system. The development of the photonics industry, as outlined in the previous issue, is a case in point. Acton Lasers, developing out of ANU, and X-Ray Technologies, out of CSIRO, are others. I am myself involved in commercialising imaging technology through a company called Iatia Pty Ltd. All these should become AOS corporate members and all are potentially at the heart of the future of Australia.

But these companies cannot develop without a good education system providing people with the skills they need and there is no question that education remains a problem in Australia. Aside from political point scoring, there is little tangible attention being paid by either political party to providing any improvement. While the government has agreed to fund a considerable number of new places in science, the fine print is only slowly being revealed and once again the constraints and conditions do not appear to be all that encouraging. I think corporate Australia needs to be increasingly vocal about the need for technically qualified people.

Moreover, it is all very well to fund places in tertiary science courses, but at the moment there is little indication that there are enough bright students interested in filling them. We must therefore continue to promote the excitement and rewards offered by a career in science and technology. Perhaps I can finish with the words of our newest life member, Geoff Opat, in a letter he had published in *The Age* in January. "The new Commonwealth contributions to information technology, mathematics and science in schools are a step in the right direction. There is, however, no substitute for good teachers and good curricula. We must now turn our attention to that task".

Keith Nugent
President of the Australian Optical Society

Q: What is the difference between a Ti:sapphire laser and an electric guitar?

A: You can sometimes tune a Ti:sapphire laser.

FASTS and the Innovation Statement

Toss Gascoigne.

The Prime Minister's recent announcement brings $2.9 billion dollars into the science and research sector. FASTS hailed it as a useful first step. We called for a mini-Budget response to science funding in May last year, and the Innovation Statement was released in January - out of the normal Budget cycle.

FASTS has played a very active role in creating the political climate in which the Statement was made. We constantly raised issues and publicised the benefits of increasing the national investment in Science & Technology. Further discussion is included in the report from the FASTS President (see page 20 of this issue).

The table below compares FASTS' "Billion Dollar" list (April 2000), with the recommendations in Dr Batterham's "A Chance to Change", and the final figures in the Innovation Statement (January 2001). All figures in $millions.

Comparing FASTS, Batterham and the Innovation Statement

	FASTS April '00	**Batthm Nov '00**	**Innovat Jan '01**
Double funds to the ARC large grants	500	660	736.4 **4*
Improve laboratories and libraries in universities	500	275	583 **5*
New scheme for major national research facilities	300	400	155
Retraining, HECS relief for science and maths teachers	100	264	130 **6*
Assist libraries with electronic subscriptions to journals	50	5	
Measures to stimulate careers for younger scientists	250	38.6	Yes (in ARC)
Tax credits to stimulate innovative companies	1,250	Uncosted	128
Additional funding for the CRC Program	250	150	227
Priority environmental projects	200		**1*
Boost funding to science agencies (CSIRO, AIMS, etc)	350	**2*	Indirectly
New commercialisation stimulants	100	175	775 *7
Increase funding to awareness programs, specially industry	100	**3*	
University salary levels for NHMRC and ARC fellowships	50	No	Partly through ARC
Overdue university salary increases (scientists' share)	1,000	nil	nil

*1 funded through other initiatives eg salinity
*2 no direct dollars except access to ARC grants, new funds for CRC, commercialisation
*3 affected by (3) above
*4 includes doubling ARC project grants, Federation Fellowships, Doubling ARC postdocs, Improving ARC salaries and establishing centres of excellence in biotechnology and IT
*5 includes infrastructure and expanded RIBG
*6 re-badged as fostering S&T skills in schools
*7 includes expanded R&D Start and COMET, Innovation Access Program, Pre-Seed Fund and New Industries Development program

Summary:
The recommendations in the Batterham report add up to about 75 per cent of what FASTS recommended.

Expenditure in the Innovation Statement is about 58 per cent of what FASTS recommended in its total package. This proportion rises to 76 per cent, when measured against the issues in the FASTS package that the Government chose to address ($2.9 billion of the $3.8 billion FASTS recommended).

Diffraction Losses from Uniformly Illuminated Apertures

Duncan J. Butler[1] and Greg W. Forbes[2]

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The measurement of flux passing through an aperture is central to radiometric measurements such as absolute power standards or measuring the solar constant. Such measurements require an understanding of how light is diffracted by the aperture, since a detector is not guaranteed to receive all the transmitted light unless it is infinite in size. This article reviews a recent theoretical result which allows the integral for the field behind an aperture to be reduced to a singularity-free one-dimensional integral around the aperture rim. This result enables complicated aperture shapes to be analysed. To illustrate the method we calculate the diffraction loss from a toothed aperture

1. Introduction

The measurement of the total flux passing through an aperture has long been a central problem in radiometry. For example, the absolute output of the sun can be determined by measuring the flux though an aperture of known area [1], and the Stefan Boltzman constant [2] can be determined from the flux through an aperture in front of a black body radiator. In both of these cases, for practical reasons, the detector has to be placed some distance behind the aperture, and hence some fraction of the light is lost due to diffraction. The concept is illustrated in Fig.1 which shows a detector placed to measure the flux through an aperture illuminated by a point source. In this case a small fraction (ε, the diffraction loss) escapes the detector even if the detector is underfilled by the beam.

A similar problem arises when the aperture is larger than the detector. This is the case when apertures are used to limit the field of view, rather than to define a beam (Fig 2), for the purpose of reducing background radiation, or enabling the detector to be kept cold or otherwise shielded from its surroundings. In this case the aperture also affects the flux reaching the detector. If we define the diffraction loss as the difference between the flux arriving and that predicted by geometrical optics, then the concept can be applied in this case as well (although the "loss" may in fact be negative – that is, a gain).

For design work and for high accuracy measurements, then, calculation of the diffraction loss can be important. For a general aperture, such calculations usually take the following form. First, one of several diffraction theories is used to calculate the field at the measurement plane, then the flux is determined from the field and compared with the value expected due to geometrical optics. Scalar diffraction theories – both Raleigh-Sommerfeld and Kirchhoff – express the diffracted field as an integral over a surface. In the case of the field behind an aperture, the integral is restricted to cover only the aperture. Nevertheless, field computations are challenging because the integral is two dimensional and the integrands are highly oscillatory. Moreover, the ability to calculate the field may not be enough to calculate the flux. Consider the usual case where a two-dimensional integral over the aperture is required to obtain the irradiance at one point on the detector. If the detector is two-dimensional, then

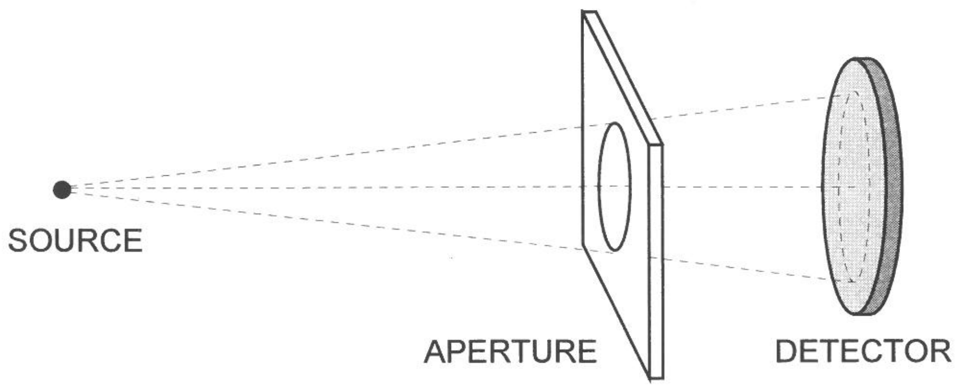

Figure 1: Illustrating diffraction loss from a circular detector placed behind a circular aperture in front of a point source.

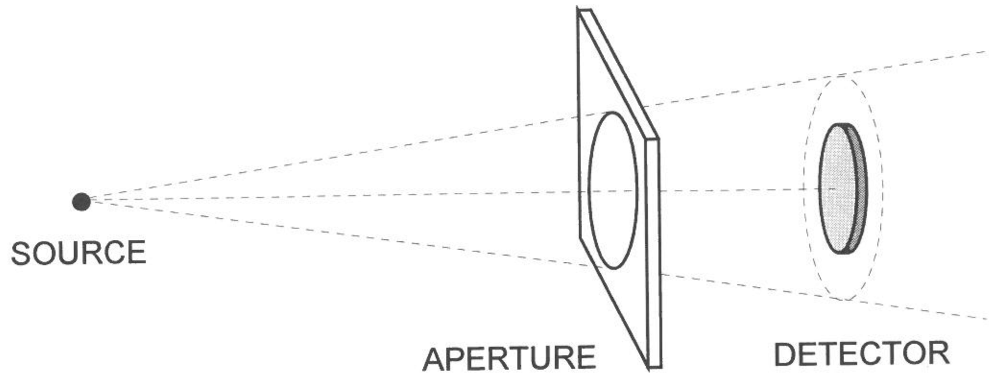

Figure 2: Illustrating diffraction loss when the detector is overfilled. In this case light redirected from the aperture edge can cause the measured flux to differ from that predicted geometrically.

the total flux becomes a four-dimensional integral, and there is an additional integral over wavelength if the source is polychromatic. To make matters worse, if the source cannot be treated as a point or plane wave, then there is another two-dimensional integration over the source, leaving an intractable seven-dimensional integral. Such integrals are prohibitively complex even for advanced computers.

In special cases, symmetry can be used to simplify the flux calculation. Lommel [3] gave his results for the irradiance behind a circular aperture in the nineteenth century (his famous result is commonly used to illustrate wave optics and to discuss resolution in microscopy [4]). Later there appeared asymptotic forms for the flux behind a circular aperture, and these results have since been collected and applied to radiometry by Blevin [5]. However, only a handful of other geometries have been analysed, and none have such simple results for the diffraction loss.

Hence, a recent result which allows scalar diffraction integrals to be reduced to a singularity-free, one-dimensional integral around the aperture rim [6], is of importance for diffraction calculations in radiometry. Although only the first integral in the long series required to obtain the flux is simplified, it is this integral which is the most demanding because it involves oscillatory integrands. In addition, the reduction to a line integral enables apertures of complicated shape to be easily and exactly modelled, without the need to approximate the aperture with a 2D grid.

The reduction of diffraction integrals has been the subject of several previous papers. Reviews can be found in references 7 and 8. In all of these previous results, the line integral contains singularities which complicate its numerical implementation. The new result is valid for diverging, converging, or plane wave illumination, and for plane apertures of any shape. Importantly, the new result is also free from singularities.

In Section 2, the integral reduction technique is summarised. In Section 3 we analyse a toothed aperture which has previously been suggested as a method of reducing diffraction effects in radiometry [9]. Because of its complicated shape, this aperture has only been modelled previously using geometrical optics. We show, quantitatively, that the aperture is successful in reducing diffraction.

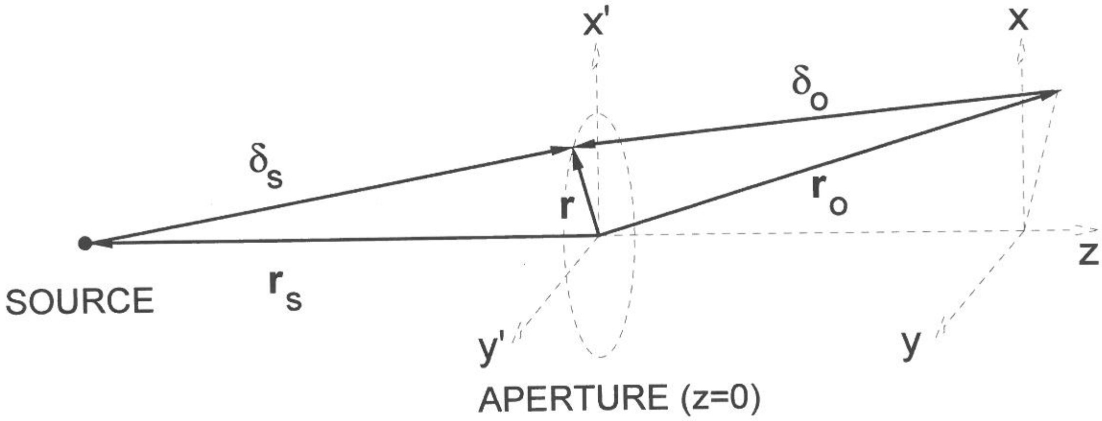

Figure 3: Diffraction geometry for the reduction of the Kirchhoff diffraction integral to an integral around the aperture rim.

2. Reduction of the diffraction integral

The method of integral reduction in reference 6 is reproduced here for one case – Kirchhoff diffraction for a point source, where the aperture is illuminated by a diverging wave (this result and those for Raleigh-Sommerfeld diffraction and converging and plane waves are available in the original paper). The method adopts the Kirchhoff boundary conditions which see the field in the aperture approximated by the incident field and truncated at the aperture edge. Although these boundary conditions are not consistent with Maxwell's equations, the error they introduce is usually too small to be a problem for centimetre-sized apertures and current radiometric accuracies.

The method uses the Poincare Lemma and invokes Stokes's theorem to convert the surface integral to a line integral over the aperture rim. The scalar field u is expressed as a line integral,

$$u = \oint_{\substack{aperture\\rim}} \mathbf{D}(\mathbf{r}).\mathbf{dl}, \quad (1)$$

where

$$\mathbf{D}(\mathbf{r}) = \frac{\delta_o \times \delta_s}{16\pi^2|\delta_o||\delta_s|}\frac{\exp\left[ik\left(|\delta_o|+|\delta_s|\right)\right]}{\left(|\delta_o||\delta_s|-\delta_o.\delta_s\right)} \times \left[1-\frac{4ik|\delta_o||\delta_s|\mathrm{sinc}(kL)\exp(-ikL)}{|\delta_o|+|\delta_s|+|\delta_o-\delta_s|}\right] \quad (2)$$

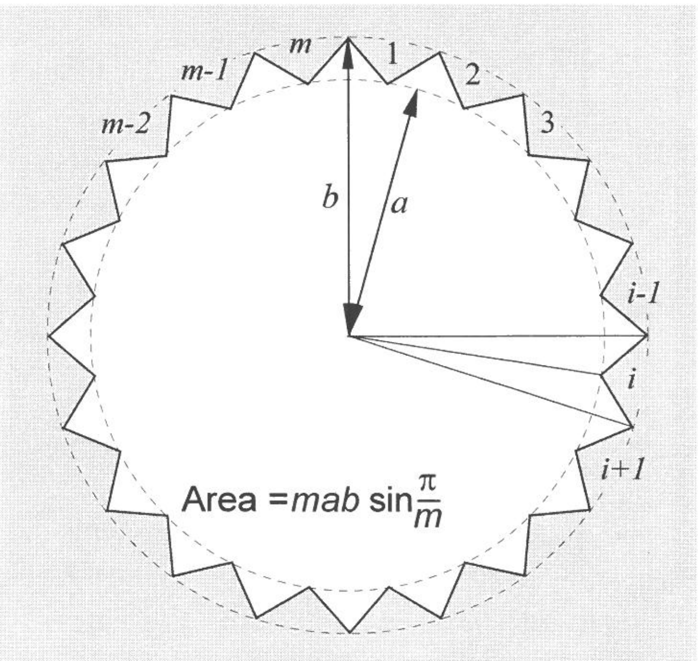

Figure 4: The parameters used to specify a toothed aperture with an inner radius a, outer radius b and m teeth.

$$L = \frac{1}{2}\left(|\delta_o|+|\delta_s|-|\delta_o-\delta_s|\right) \quad (3)$$

Here $k = 2\pi/\lambda$ is the wavenumber and λ is the wavelength. The vectors are shown in Fig. 3, where the origin of the coordinate system is in the aperture. The vector **r** describes the aperture boundary, $\mathbf{r}_O$specifies the point of observation, and $\mathbf{r}_S$ is the location of the source. The vectors $\boldsymbol{\delta}_O$ and $\boldsymbol{\delta}_S$ point from the point of observation and from the source, respectively, to the point on the aperture rim specified by **r**.

The numerical implementation may be improved by factoring out the underlying phase and amplitude (a spherical wave emanating from the source), so we replace **D** by $\hat{\mathbf{D}}$ where

$$\hat{\mathbf{D}}(\mathbf{r}) = \mathbf{D}(\mathbf{r})\,4\pi|\delta_o-\delta_s|\exp\left[-ik\left(|\delta_o-\delta_s|\right)\right]$$

$$= \frac{\delta_o \times \delta_s}{4\pi|\delta_o||\delta_s|}\frac{|\delta_o-\delta_s|}{\left(|\delta_o||\delta_s|-\delta_o.\delta_s\right)} \times \left[\exp(2ikL)-\frac{4ik|\delta_o||\delta_s|\mathrm{sinc}(kL)\exp(ikL)}{|\delta_o|+|\delta_s|+|\delta_o-\delta_s|}\right] \quad (4)$$

Some loss of precision is avoided by evaluating L with the following expression :

$$L = \frac{|\delta_o \times \delta_s|^2}{\left(|\delta_o|+|\delta_s|+|\delta_o-\delta_s|\right)\left(|\delta_o||\delta_s|-\delta_o.\delta_s\right)} \quad (5)$$

Equations (4) and (5) are used to calculate the fields shown in this paper. Since we are also concerned with the energy falling on a detector, we give the formula for the flux here. The total flux, E, crossing a surface, σ, is given by the integral of the flux density, **j**, over the surface: $E = \int \mathbf{j}.\mathbf{d}\sigma$. The flux density of the scalar field represented by a complex amplitude u is given by

$$\mathbf{j} = \tfrac{i}{2k}\left[u^*(\nabla u) - u(\nabla u)^*\right] \quad (6)$$

If we write the field as $u = A\exp(-ik\phi)$, where A and ϕ are the (real) amplitude and phase respectively, we can write the flux density as $\mathbf{j} = |A|^2\nabla\phi$. The total energy crossing a surface perpendicular to the z axis is then

$$E = \int_\sigma |A|^2 \nabla\phi.\hat{\mathbf{z}}\, d\sigma \quad (7)$$

Note that, for non-paraxial scalar fields, the irradiance in not sufficient to determine the energy falling on a detector – the angle the wavefront makes with respect to the detector must also be taken into account. For a paraxial field, $\nabla\phi \approx \hat{\mathbf{z}}$, so that

$$E = \iint_{\sigma} |A|^2 \, d\sigma \qquad (8)$$

and only the irradiance is required to calculate the flux.

3. Diffraction losses from a toothed aperture

To demonstrate the power of this method, we analyse the diffraction loss from a toothed aperture. Such apertures were adopted by Boivin [9] to reduce diffraction effects from view-limiting apertures by causing the light redirected by the aperture edge to fall outside the central region (unlike a circular aperture where diffracted light is redirected throughout the central region). Boivin found experimentally that diffraction losses could be reduced by at least an order of magnitude using this approach. However, detailed analysis has been difficult until now because of the

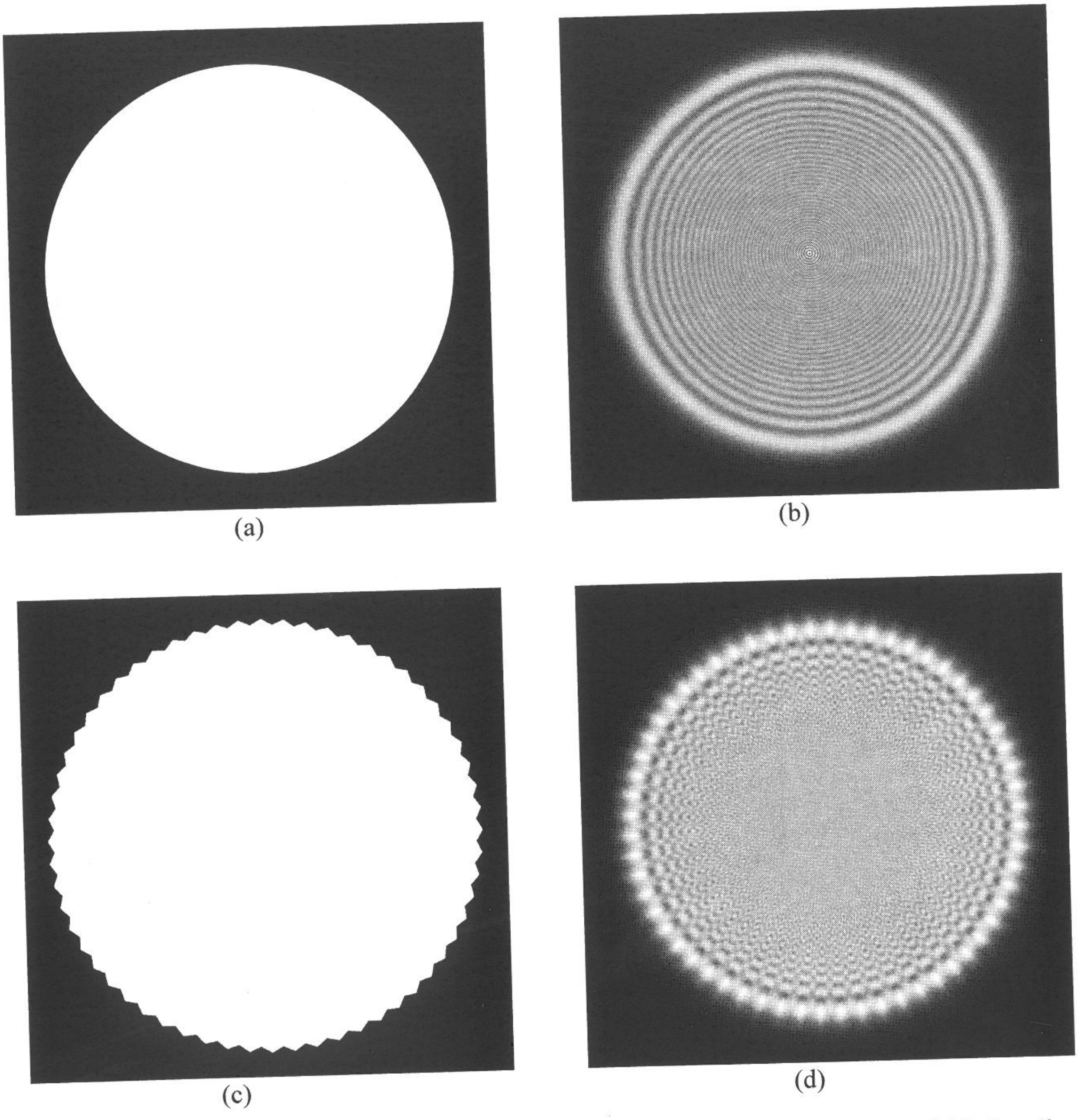

Figure 5: Calculated diffraction patterns from a circular and toothed aperture. Figures (a) and (c) show the aperture shapes, while (b) and (d) show the corresponding irradiance distributions 500 mm behind the aperture. The circular aperture is 3.55 mm in radius, while the toothed aperture has a = 3.50 mm, b = 3.60 mm and m = 60 teeth. The wavelength is 580 nm and the source is 850 mm before the aperture.

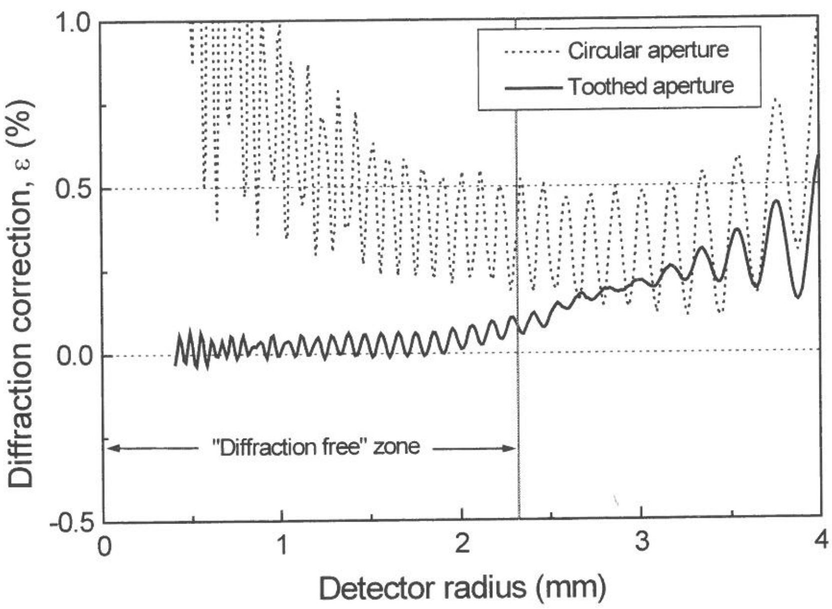

Figure 6: Diffraction correction as a function of detector radius. The "diffraction free" zone, predicted by geometric optics, is indicated. The diffraction effects are reduced by the toothed aperture, and the size of the "diffraction free" region is approximately

complicated aperture shape.

Figure 4 shows the parameters used to specify a toothed aperture. The inner radius is a, the outer radius is b and the number of teeth is m. The aperture has an area equal to $mab\sin(\pi / m)$. According to the simple model presented by Boivin, where light is assumed to be redirected only in directions orthogonal to the aperture edge, the region free from redirected light is approximately circular with a radius of

$$X' = a(1 + z_o / z_s)\cos(\phi + \theta), \quad (9)$$

where $\theta = \pi / m$, $\tan\phi = a\sin\theta / (b - a\cos\theta)$, and z_s and z_o are the distances from the source to the aperture and from the aperture to the detector, respectively.

Irradiance distributions behind a circular aperture and a toothed aperture were calculated using Kirchhoff diffraction theory. The aperture edge was broken into line segments which allow Eqns 4 and 5 to be reduced to a simple form and the line integral to be solved numerically. The irradiance distribution is shown in Fig. 5 for one of the cases discussed in Boivin's original paper (a = 3.50, b = 3.60, m = 60) and for an equivalent circular aperture. As predicted in that paper, the central region of the diffraction pattern from the toothed aperture is more uniform than for the circular aperture.

Unlike the geometrical analysis, however, the analysis presented here can answer the question, how much more uniform? We investigate the diffraction loss of these apertures by comparing the encircled energy with that in the absence of an aperture. The diffraction loss as a function of detector radius is shown in Fig. 6. The net effect of the circular aperture is to redirect more flux into the detector, hence the diffraction "loss" is positive. For the toothed aperture, the loss is much smaller when the detector is smaller than X' = 2.32 mm, in agreement with the simple model.

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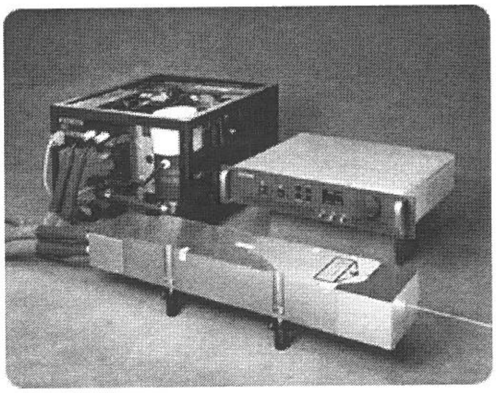
RAYMAX APPLICATIONS - Product Review



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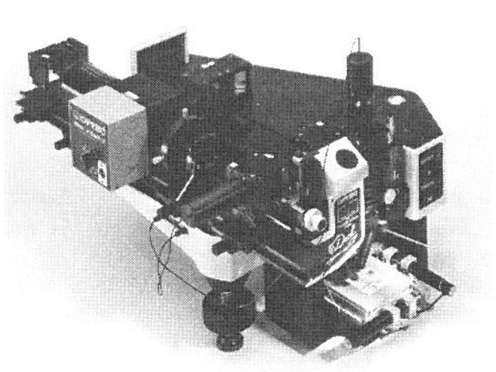

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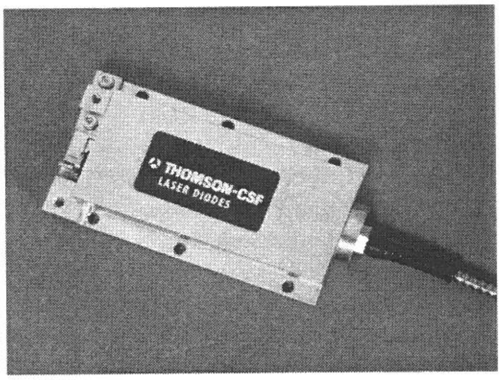

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Email: sales@raymax.com.au, Phone: 02 9979 6746, Fax: 02 99798207.

AOS2000 - Some Reflections

The annual Australian Optical Society conference, last year known as AOS2000, was held in Adelaide as part of the Australian Institute of Physics Congress. As with any major scientific conference, the experience combines a large number of factors, including the social events, scientific presentations, trade exhibitions, personal networking, tourist attractions, administrative details. Anecdotal evidence indicates that AOS2000 managed to combine all of this into a generally positive and worthwhile week. Below are some reflections by a range of different participants at the conference. These include Murray Hamilton, the conference chairperson, discussing issues from an organisational perspective and raising several questions for AOS members to consider for future conferences. A first-time conference attendee, Karl Weber, gives his impressions of the week, which may have influenced his decision to begin a PhD this year in atom optics at Melbourne University Physics Department. Also from Melbourne University, Chris Chantler offers an overview of highlights from the conference.

1 - From the Organiser:

Well, I took on the job of acting as the program committee convenor for AOS2000 reluctantly as it was still less than two decades since I'd last acted in a similar capacity. This was the first time to my knowledge that the Optical Society has decided to make its biennial conference a part of the biennial congress of the Australian Institute of Physics. It promised to be a large meeting, as recent AOS Conferences have been of the same order of magnitude as AIP congresses, and there are not than many people who would normally go to both in one year. Indeed it was large.

The arrangement was that within the AIP congress each participating (sub)conference, such as the AOS conference, would have one plenary speaker who would speak to the whole congress. For the AOS this was Professor Sajeev John from the University of Toronto, who gave the inspiring Coherent Scientific Plenary Lecture on "Photonic bandgap structures and devices". After the morning plenary talks, the various special interest groups were to organise their own conferences more or less as they pleased, though originally this was subject to the constraint of 15-minunte contributed talks and 30-minute invited talks. In the end only about three of these groups stuck to this, which impacted badly on the coordination between parallel sessions. The AOS itself ran two parallel sessions, and in terms of submitted contributions (>160) was by far the largest of the subconferences.

The tradition that the AOS has ex-officio invited speakers from SPIE and the Optical Society of America at its conferences did not sit so well with the idea of the AOS conference being a just subconference in a wider congress, and if the AOS wishes to continue to join with the AIP (which I think would be good for Australian Physics) this will need to be rethought. Probably too much freedom was devolved to the special interest groups, and I also felt that by having only special interest groups represented in the planning, too many smaller areas (acoustics for example) fell through the gaps. This in itself is not primarily a problem for the AOS. But I'm possibly going to be a little self-contradictory in recommending that the AIP congresses be a bit less "organisationally devolved", and that the AOS have greater say in their organisation (if similar arrangements continue). In view of the size of the AOS contribution to the congress, it ought to get more representation in the plenaries for example. Last years' arrangements were more or less a *fait accompli* by the time the AOS got properly involved.

The tours of physics-based industry were organised by yours truly at the behest of Alex Stanco from Lastek. This explains their slant towards the optical industry. The tours appeared to be appreciated by those that participated.

Finally I would like to thank Coherent Scientific for their sponsorship of Prof. John's plenary talk, the companies involved in the tours for their time and their money which made the tours possible, and my fellow program committee members for their time and effort.

Murray Hamilton
University of Adelaide

2 - From a Student:

As an Honours student who attended the AOS conference in Adelaide last year, I was excited to be experiencing for the first time a scientific conference. Many of the AOS presentations were interesting and visually impressive. The use of parallel AOS sessions indicates the strength of the Society. It was helpful that these were conducted under different areas of interest so that the presentation of material did not directly compete with the other session. Personally, I enjoyed the Atom Optics sessions, particularly the talk by Dr. Andrew Wilson from Otago University (N.Z.) on their atom laser and Bose-Einstein work. The large number of poster presentations and of those who took an interest was extremely positive. The two sessions required highlights how important these are for students.

In general, the use of a professional conference organiser appears to have been the biggest concern for those who attended (the cost of registration for supervisors and students was noted by most). In preparing for the conference, the description of requirements for the submitted abstracts were vague and could have been improved by providing a downloadable template from the website. The organisation of accommodation for students also left a lot to be desired.

The most disappointing aspect I thought arose from the conference proceedings was that some interesting afternoon AOS sessions were scheduled alongside the poster presentations. This left presenters in the position of choosing whether or not to attend the talks and possibly missing an observer's useful comments relating to their poster. Other views of students included: not being advised as to which of the different dimensions for poster presentations they were allocated, abstracts not appearing in the summary booklet, and there being no food or drink available in the same room as the poster presentations. As a student who had just finished their undergraduate degree and not yet decided on their choices for next year, I was disappointed with the Careers table. I had hoped this would provide more information on companies that actively sought graduates with a physics education.

Conducting the various affiliated AIP organisations conferences together at the same venue did however allow physicists to engage in other interests outside their immediate research fields. It also provided a good meeting place for students from most of the Australian Universities to discuss their Ph.D. topics. Additionally it generated general communication amongst research groups from the same University. For the socially active students (and supervisors), Adelaide offered good weather and a variety of restaurants at reasonable prices. It was pleasing to be able to relax at an inner city pub and discuss some of the day's topics - even if it was just "Do you think Brett Lee will play in the Test?"

I came away from the week of AOS2000 encouraged that physics research undertaken in Australia is interesting and of a high quality.

Karl Weber
University of Melbourne

3 - From an attending AOS member:

The co-location with the AIP was a significant experiment for our Society to show our common overlap with the Institute. Significant numbers of us attend and are members of both, and it was an opportunity to see the larger Physics community. That created a dilemma for some non-Physics based members and attendance by these was perhaps less than at some recent conferences, and perhaps an apology is due. While the policy of our Society was unchanged with respect to submissions and selection procedures for presentations, there was an increased bureaucratization of submission and registration, with an increased burden on us financially. However, I think the co-location was successful, particularly in enabling students to see a wide range of possible futures and areas of research. I enjoyed parallel sessions of 'Solar, Terrestrial and Space Physics', 'Atomic and Molecular Physics and Quantum Chemistry', and 'AINSE/NUPP'. There were excellent plenaries of wider interest, including that by Prof John Barrow on 'The origin of the Universe', the public lecture by Paul Davies, and the plenary by Prof Janet Conrad on neutrino oscillations, to name a few. I have to say that I thought the most exciting plenaries were 'ours' by Prof. Sajeev John, 'Photonic Band Gap Materials: a new frontier in quantum and non-linear optics', and the AMPQC plenary by Prof Chris Greene 'Photoionization of light atoms and molecules: a window into few-body and many-body dynamics'.

Some were concerned at the full-week nature of the conference – for an AOS conference, it is not common to have a 'day off' in the middle, and some members would commend a 3-day conference with fewer parallel sessions. In general, there were only two parallel AOS sessions for most of the conference [Tuesday, Thursday, Friday]. However, some have noted difficulties with a poster session scheduled at the same time as a talk by the same research groups *(see previous review - Ed.)*. In this sense the AOS Keynote sessions were excellent as then there was only one AOS session. There were members of our society scheduled for AOS poster sessions at the same time as e.g. AMPQC talks, which was unfortunate but rare.

Attendance was very high, partly because of the co-location. The AOS was one of the largest contributions to the total attendance. The conference was extremely successful when measured by numbers, the excellence of presentations, the interactions and the ideas presented. I would therefore especially thank Murray Hamilton for his tireless efforts in chairing the program committee. We had many AOS members invited to speak in other sessions (and hence communities). This is a commendation for the breadth and range of interests of our society. Gerard Milburn, Keith Nugent, Bill MacGillivray, Bipin Dhal and David Paterson were amongst our ambassadors in this context.

Restricting my attention to the AOS sessions, we had some 74 speakers, with some 106 posters distributed in two sessions. I might give personal highlights for the presentation by Jim Gardner on how to measure colour, Deb Kane on optical feedback, Andre Luiten on a phase-coherent link between microwave and optical frequencies, Colin Sheppard on beam propagation, Jose Varghese on applications of new X-ray optics to solve extremely complex protein structures, and Harry Quiney on new approaches to theoretical computations for a wide range of atomic and molecular physics issues. The OSA presentation by Richard Powell (University of Arizona) and the SPIE presentation by Richard Hoover (George C. Marshall Space Flight Center) were up to the usual standard, and showed explicitly the links with our colleagues. Richard Hoover's address on microfossils in meteorites illustrated an amazing amount of optical beauty using an array of SEM and EDS techniques. There were too many good sessions to mention individually. Amongst the students, the quality of oral talks was again very high, and I might particularly cite Mr Winfried Hensinger, Mr Chanh Tran, Ms Nicoletta Dragomir, Mr Ben Buchler and Mr Martin de Jonge amongst many others. There was good attendance from Western Australia, which is sometimes under-represented at our conferences, and the welcome change may be partly due to the co-location.

One of my highlights of the conference was the difficulty judging the AOS student poster prize with so many clear and insightful presentations, especially perhaps from Adelaide university / DSTO, the University of Queensland, and Griffith University. My congratulations to the winners.

Chris Chantler
University of Melbourne

Don't forget...

This year's conference, the 14th Australian Optical Society Conference, is part of

ACOLS 2001

to be held in Brisbane, in December 2001

see page 18 for conference details

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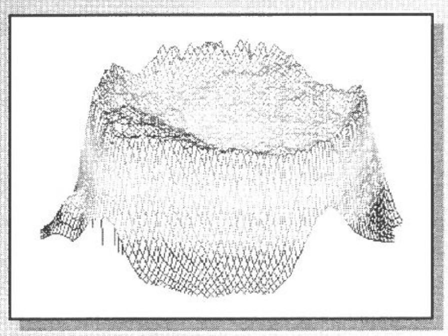

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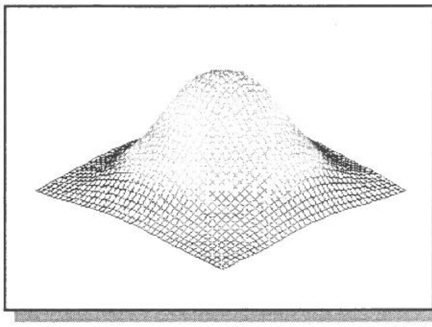

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Australasian Conference on Optics and Laser Spectroscopy

3-6 December, 2001
University of Queensland, Brisbane, Queensland, Australia

ACOLS 2001 is the fifth conference in the ACOLS series, and incorporates the following meetings:

- 14th Australian Optical Society Conference
- 10th Australian Laser Conference
- 20th Australian Spectroscopy Conference

ACOLS 2001 is the region's showcase of research and development in all aspects of optics, lasers, and spectroscopy, and provides a broad forum for discussion of these important areas at the modern facilities of the University of Queensland. Each day will feature general interest plenary speakers of high international standard, followed by parallel oral sessions with both invited and contributed papers. Two poster sessions will also be held in the same venue.

Invited Plenary Speakers

Mark Kasevich, Yale, USA
Atom interferometry (Frew Lecturer)

Eleanor Campbell, University of Göteborg
Collisions of fullerenes

James Harrington, Rutgers University
Infrared optical fibres (SPIE Lecturer)

Deborah Kane, Macquarie University
Integrated semiconductor lasers

Anthony Johnson, New Jersey Institute of Technology
Ultrafast optical phenomena (OSA Lecturer)

Paul Kwiat, University of Illinois
Quantum communication* (Coherent Scientific Lecturer)

Anthony Legon FRS, University of Exeter
Rotational and vibrational spectroscopy

Motoichi Ohtsu, Tokyo Institute of Technology
Microscopy

**to be confirmed*

Courses & Student Prizes

The Optical Society of America (OSA), the International Society for Optical Engineering (SPIE), and the Australian Optical Society will combine to sponsor a short course at ACOLS 2001, with reduced fees for members of these societies.

SPIE and OSA will combine to provide a prize for the best student presentation at ACOLS 2001. The prize is $2500 in travel support to one Societies' managed meeting or conference in 2002.

Technical Exhibition

A technical exhibition is being planned in conjunction with the conference, featuring leading Australasian suppliers of equipment in the field of optics, lasers, and spectroscopy. The exhibition will be held in the Heith Room at the University of Queensland, close to the conference lecture theatres.

Accommodation

Accommodation is available on campus in comfortable budget rate university student colleges at approx. AUD$35 per night for bed and breakfast, or alternatively in nearby hotels.

Deadlines

Call for Papers:	May 2001
Registration Forms available:	July 2001
Submission of Abstracts:	1 September 2001
Registration:	2 November 2001

Registration/Feedback

For more information, or to register your interest in attending ACOLS 2001, visit the conference web page:

http://www.physics.uq.edu.au/acols2001/

SPIE
THE INTERNATIONAL SOCIETY FOR OPTICAL ENGINEERING

SPIE - What's In It For You?

Most AOS members are by now aware that they are entitled to a discount on SPIE membership dues, but many are unaware of what SPIE is, and the benefits of joining.

SPIE was formed in 1955 as the Society for Photo-optical Instrumentation Engineers, and has been dedicated to providing the best possible service to the optical engineering community. SPIE is an international technical society dedicated to promoting the engineering and scientific applications of optical, photonic, imaging and optoelectronic technologies through its education and communications programs, meetings and publications.

SPIE offers...

International Networking

Today SPIE is the largest international professional engineering society serving the practicing engineer and scientist in the field of optics and photonics. The Society serves the global technical and business communities, with over 14,000 individual, 320 corporate, and 3,000 technical group members in more than 75 countries worldwide. Advance professionally through networking and visibility among your peers. Learn from others and gain access to the voices, ideas, and the energy of a global community.

Meetings

Among the many services the Society offers are the sponsorship, planning, and execution of technical conferences, product exhibitions, and symposia. SPIE's technical meetings and symposia are internationally-acclaimed gatherings of engineers and scientists working in optics, optoelectronics, and many related fields. They take place in large and small venues, from specialised topics to cross-disciplinary information exchanges, complete with extensive programs including short courses, workshops, and other special activities.

Publications

A major activity of SPIE is the publication and distribution of archival professional journals, full-manuscript conference proceedings, newsletters, and optics-related texts and monographs. SPIE publications deliver timely, high-quality technical information to the optics, imaging, and photonics communities worldwide. Membership includes a subscription to *OE Reports*, a monthly newspaper that provides news and commentary on cutting-edge technology.

...and More

In addition, SPIE provides numerous services to its members, including on-line electronic databases, electronic bulletin board and networking services, and employment assistance. To further serve the public good, the Society sponsors a number of awards, scholarships, and educational grants every year, and publishes a comprehensive catalogue of educational resources in the optics field, *Optics Education*.

To join SPIE: Complete the online membership form at *www.spie.org/membership_form.html*, print and fax it to SPIE along with a copy of your AOS dues receipt. (Be sure to indicate that you are eligible for the US$20 discount as an AOS member). Any queries can be directed to Mr Paul Giusts at *membership@spie.org*

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FASTS President's Report

FASTS Board Meeting, February 23, 2001

Science and technology have come to the forefront of the national agenda for the first time in more than a decade. Recognition of the pivotal role of innovation in the nation's prosperity has come late, but is no less welcome for that.

The Prime-Minister's Innovation Action Plan will boost the nation's investment in research by three billion dollars over the next five years. By the fifth year, the investment will be an extra one billion dollars per year. As the Prime-Minister said, this is an important 'first step' in Backing Australia's Ability.

There is a sea-change in recognition that intellectual capital is at least as important as labour and capital in ensuring the social, economic and environmental well-being of the nation. Admittedly, Australia has come to this realisation a little later than some other countries, but we have not missed the bus. There are fleets of buses leaving, and we want to drive them! This is the message we gave to the Prime-Minister's Science, Engineering and Innovation Council.

The Innovation Action Plan would not have been possible without the work of FASTS' member societies. The unified voice of scientists and technologists, together with those of business, have been critical in ensuring the implementation of the Chief Scientist's recommendations. Of Robin Batterham's 20 recommendations, 18 have been adopted, and the other two implemented in a modified form. The Batterham report strongly reflected FASTS proposals, as the attached table shows.

We should not under-estimate the impact of 180 scientists from across the country converging on federal parliament last November, delivering the Batterham report. This has helped make investment in science and technology a non-partisan affair, even in (or should I say, especially in) an election year. Your support for the FASTS' Science Meets Parliament Day was critical in getting the message across the line.

The Innovation Action Plan is about more than research dollars. It is about Australia's value system. It is about valuing our scientists and technologists. Status took a heavy knock after the Dawkins' reforms, and in the following years when our universities and research institutions were under-valued. This situation is being reversed. There is a ground-swell of realisation in the community that we must value and reward our intellectual capital. You have helped bring about this sea-change.

When Robin Williams asked the PM on the Science Show what factors had led to his 'conversion' to science and technology, he replied that the presentations to the Prime-Minister's Science, Engineering and Innovation Council had been important. He said that the positive response to the Government's increase in research funds for the National Medical Research Council (NHMRC) had been another important factor. Some FASTS' member societies have sent a positive note to the PM, noting the 'important first step' that has been taken by the Commonwealth Government.

We need the continued support of our member societies for the Innovation Action Plan, to ramp it up and top it up! Michael Lee, Shadow Minister for Education, committed to this last Friday 16 at the Go8 Forum.

The PM will Chair the Implementation Committee for the Innovation Action Plan. This is extremely important, because it means that the Government means business and is not engaged in a 'smoke and mirrors' exercise. FASTS will keep a close watch on this, to maintain a sense of urgency in investment in R&D and to ensure early development of guidelines for the various programs.

Lessons must be learned from implementation of the "doubling" of funds for the NHMRC, announced in May 1999. As the first step in "doubling" the funds, the Commonwealth Government announced enhanced investment of ten million dollars in medical genomics in the 1999 budget. It was not until March 2000 that NHMRC announced its Medical Genomics Program and called for expressions of interest for projects that would help build Australia's biotechnology base, through large-scale DNA sequencing projects. Successful applicants were advised this month!

The pace of technological change is frenetic and international competition will not wait for us to sit in peer review committees for two years in order to distribute ten million dollars! FASTS will be working for rapid implementation of the Innovation Action Plan.

FASTS tries to maintain a careful balance between bleating from the sidelines and being in the mainstream of science policy development. Our membership of the Prime-Minister's Science Engineering and Innovation Council is part of this. Our Executive Director, Toss Gascoigne, ably assisted by Robyn Easton, works hard to ensure we punch above our weight. But nothing could be achieved without the input of volunteers, including Ken Baldwin as Chair of FASTS' Policy Committee, our two Vice-Presidents, Jan Thomas and David Denham, members of the Board, and the Presidents of our member societies.

This year FASTS will be focused on implement the Innovation Action Plan, on how to ramp it up and top it up, and on ensuring this becomes a non-partisan issue that stays on the agenda through any changes in Government over the next five years.

The community, and the Government, has sent a strong message to us that our scientists and technologists are valued. We shall continue, through FASTS, to promote respect for the achievements of our member scientists and technologists.

Sue Serjeantson
President
Federation of Australian Scientific and Technological Societies
March 2001

CONFERENCE ANNOUNCEMENT

Multi-dimensional Microscopy 2001 – MDM2001

The 3rd Asia-Pacific International Symposium on Confocal Microscopy and Related Technologies

November 25-28, 2001, Melbourne, Australia

Multi-dimensional Microscopy (MDM) is a new international conference series with a focus in the Asia-Pacific region. The aim of the MDM conference series is to provide a principal forum for scientists, engineers and research students to exchange topical research and development information and to stimulate discussion on novel applications and concepts. The first meeting of MDM was held in the National University of Singapore in 1999. After the second successful meeting of MDM in Kaohsiung in 2000, MDM2001 (the 3rd Asia-Pacific Symposium on Confocal Microscopy and Related Technologies) will be organised by Swinburne University of Technology at Melbourne, Australia, from November 25 – 28, 2001.

Location

MDM2001 will be held in Eden on the Park (http://www.edenonthepark.com.au/), Melbourne, Australia. This stylish hotel is located at a picturesque site near Melbourne's Albert Park Lake and is close to the Hawthorn campus of Swinburne University of Technology. The Hawthorn campus is located seven kilometres east of the city of Melbourne.

Deadlines

Submission of abstracts:	August 31, 2001
Registration:	November 2, 2001

Topics

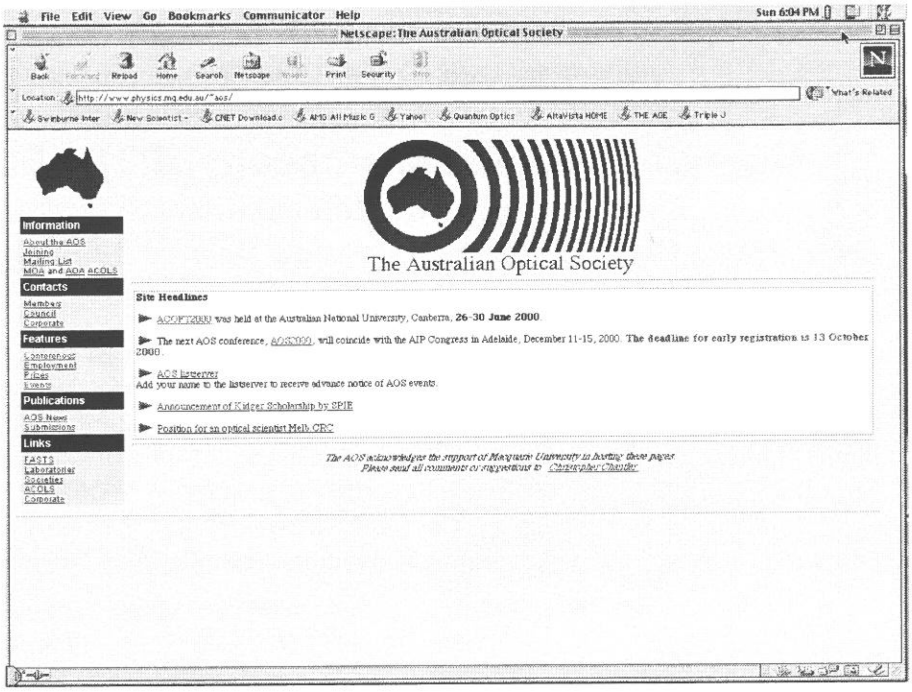
- Confocal microscopy (fluorescence and non-fluorescence)
- Two-photon fluorescence microscopy
- Multi-photon (SHG, THG, CARS) microscopy
- IR and UV microscopy
- Spectroscopy microscopy
- Novel light sources for microscopy
- Instrumentation and theory
- Novel approaches for biological applications (green fluorescent protein)
- Living cell imaging
- Laser tweezers and trapping
- Three-dimensional optical data storage and micro-fabrication
- Optical coherence microscopy
- Laser gene scanners
- Near-field scanning microscopy
- Multiple scattering and imaging through turbid media
- Fluorescence resonance energy transfer microscopy
- Digital signal processing and image reconstruction
- Fluorescence lifetime imaging

Further announcements for MDM2001 (submission, registration, and accommodation) will be available at the following web site:

http//:www.swin.edu.au/optics/cmp/aps2001

Australian Optical Society on the World Wide Web

http://www.physics.mq.edu.au/~aos/



Stay in touch with your own professional society via the world wide web. Find out about:

- Objectives of the AOS
- Affiliated bodies
- Employment opportunities
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- AOS Council members
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There are also many links to websites of interest to AOS members.

http://www.physics.mq.edu.au/~aos/

Fabrication of Three-dimensional Photonic Crystal Structures using Two-photon Photopolymerization

Nina Rimac and Min Gu

Centre for Micro-photonics, School of Biophysical Sciences and Electrical Engineering
Swinburne University of Technology
PO Box 218, Hawthorn, 3122, Australia

The possibility of extending current optoelectronic systems to all-optics systems is an exciting prospect that has come closer to reality with the fabrication of three-dimensional photonic crystals. We describe a method for fabricating three-dimensional photonic crystal structures based on two-photon photopolymerization in a resin with a large two-photon absorption cross-section.

1. Introduction

Photonic crystals (PC) are periodic structures that manipulate light using multiple Bragg diffraction. The ability of PCs to control light of TE and TM modes in all dimensions without loss is the key factor which make it analogous to semiconductors with electrons. An all-optical system would have the advantage of being faster and more compact than current optoelectronic systems. PCs would enable optical circuitry but also integrated efficient lasers, optical channels, splitters, junctions, grating couplers, optical power limiting, optical power stabilization, filters, reflectors, antennas, wavelength division multiplexing (WDM) add-drop multiplexers, dispersion compensators, delay lines and waveguides [1-8].

The number of directions (x, y or z) in which the structure is periodic describes the dimensionality of a crystal structure. An example of one-dimensional (1D) PCs is multiple layer thin films. Two-dimensional (2D) photonic crystals such as a collection of rods have been able to demonstrate lossless acute angle waveguides [9].

If photons of particular energy are prevented from propagating in any direction inside the crystal a photonic band gap (PBG) is formed [8]. The properties of PBGs rely on the configuration of the periodic structures, the dielectric contrast and the ratio of the high and low dielectric constants of the materials involved. Higher ratios show greater scattering effects and are therefore more likely to create a pronounced gap. PCs with micro- and sub-micrometer lattice constants are required to produce a PBG in the visible region [10].

It is desirable that PCs operate in the infrared (IR) and visible spectrum for compatibility with current optical systems that operate in this region. Three-dimensional (3D) PCs have proven to be challenging to manufacture on a small enough scale for use in these spectral regions. Other difficulties include structural instability, configuration limitations and the possibility of controlling localised modifications such as doping and defects in the produced structures.

The first PC to successfully produce a PBG was found by Yablonovite [11]. Holes were drilled into a dielectric medium along the three axes of the diamond lattice [11]. Theorists first predicted a photonic band gap (PBG) with a diamond lattice of spheres. Spheres have been popularly used in practice as a basis of many PC structures due to the ability to control the radius of the spheres and the ease of manufacture due to self-ordering. Sol-gel synthesis of monodisperse suspension of silica spheres in solution [12] and self-ordering in suspensions of latex microparticles packed monodisperse silica submicron spheres [13, 14] are a few examples. Spheres in solution are however unstable. A PBG can also be created by the connecting dielectric remnants of connecting air spheres. Microstereophotolithography planar layer-by-layer (LBL) processes of exposure with a spatial modulator are being used as a dynamic lithographic mask [15]. Another layering process involves multilayer lamination by radio frequency (rf) bias sputtering on a periodically hollowed silica substrate with a triangular lattice [16, 17]; this has proved interesting in the experimental investigation of PC lasers.

Recently, two-photon (2-p) excitation photopolymerization has been used in the fabrication of 3D PC structures [10, 18-21]. 2-p photopolymerization has many advantages over other methods previously mentioned. This method requires few steps in fabrication and the resin used is cheap to produce. High 3D spatial resolution allows the production of rods smaller than 1 μm, uniformity of the structures, stability and ease of doping and manipulation. The 2-p process decreases abberation [22] and scattering. The production of resin with a high 2-p cross-section increases the efficiency of photopolymerization, lowering the power required in fabrication.

2. Photopolymerization

Photopolymerization of resin by radical formation involves the absorption of photons by the resin, creating a radical from a chromophore; initiating chain radical formation and polymerization of the formed radical monomers and oligomers, as shown in Fig. 1. The affected resin is solidified; its decreased solubility from unpolymerized resin allows unaffected regions to be washed away. Photopolymerization of resin has been widely applied to micromachine fabrication with the production of real microstructures in various shapes such as coil springs, one-way valves and bending pipes [19, 21, 23, 24]. The production of microstructures by photopolymerization is relatively simple compared to alternative micromachining techniques involving multi-run sputtering and etching. The versatility of the configuration of structures produced by photo-polymerization is a great advantage. Self-ordered close-packed dielectric spheres, for example, are easy to produce but have very limited geometries [11]. A solid polymer is also much more stable than spheres in solution.

$$I \xrightarrow{h\nu\, h\nu} 2R$$

$$R + M \rightarrow R - M$$

$$R - M_n + M \rightarrow R - M_{n+1}$$

Fig. 1. Photopolymerization. I: initiator, R: radical and M: monomer.

3. Two-photon excited photopolymerization

The small scale of PCs relies on spatial resolution of a focused laser beam responsible for photo-polymerization. Longitudinal resolution of one-photon photopolymerization can be improved by using 2-p photopolymerization.

2-p excitation involves simultaneous absorption of two photons with long wavelengths of light promoting ground state electrons to an excited state (see Fig. 2). These electrons spontaneously return to the ground state passing energy to the chemical reaction in the resin. The 2-p absorption probability depends quadratically on the intensity of illumination. This means that the region excited by 2-p absorption occurs in the focal region of an objective. Under the tight focussing condition high 3D spatial resolution is produced [18]. A high spatial density of photons produced in the 2-p process leads to photopolymerization. In general mode locked pulsed lasers with high peak powers are required for 2-p excitation as the 2-p cross-section transition rate is generally very small.

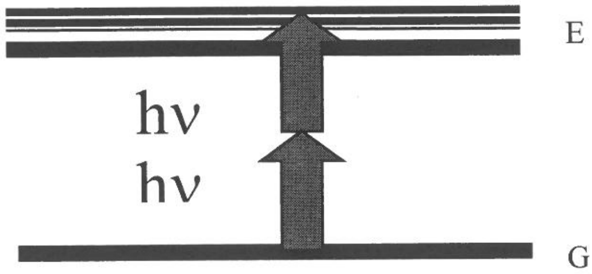


Fig. 2. Two-photon process. E is the excited state and G is the ground state.

The use of infrared wavelengths reduces Rayleigh and Mie scattering. In addition, 2-p excitation with a high numerical-aperture (NA) objective allows high 3D spatial resolution and thus LBL structures can be written into the resin with rods thinner than 1μm [18].

4. Materials

2-p photopolymerizable resins include a photoinitiator, urethane acrylate monomers and urethane acrylate oligomers [19].

Photoinitiators with large two-photon absorption cross sections have been designed and used in microfabrication [18, 25]. These are organic molecules with π conjugated bonds. π conjugated bonds are the second bonds between two carbon atoms, an overlapping of p orbitals which leads to electron sharing above and below the imaginary line which joins the two carbon atoms. These molecules have a symmetric structure represented by D-π-D and A-π-D-π-A (A is a chemical group prone to accept electrons, D is a chemical group more inclined to donate electrons in a reaction, π is a conjugated bridge) [14].

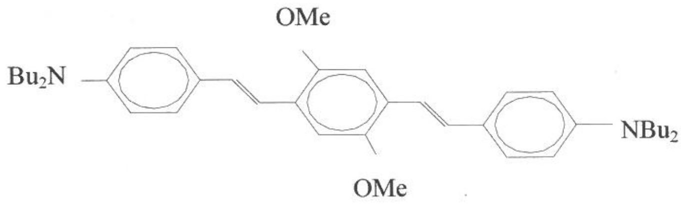


Fig. 3. An example of a photoinitiator with large 2-p absorption cross-sections.

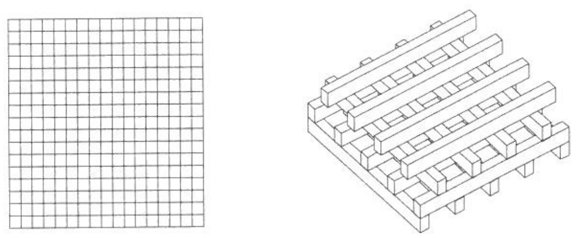
The absorption wavelength of the photoinitiator can be tailored by replacing the –OMe groups on the central benzene ring, (see Fig. 3). Groups such as –CN would increase the absorption wavelength [25]. These structures have both theoretically and experimentally proven to have a large 2-p absorption cross-sections, making them efficient for use in microfabrication of LBL structures [10]. It is important to increase the efficiency of the 2-p excitation process and reduce the power required to induce polymerization, so that a 3D structure can be fabricated deep within a resin.

5. Research on 3D photonic crystal structures at Swinburne

5.1 *Material*

The photoinitiator with a large 2-p absorption cross-section, shown in Fig. 3, was first fabricated at Swinburne University of Technology (SUT). Alkoxylated trifunctional acrylate ester (SR-9008 monomer) from Sartomer Co., tris(2-hydroxy ethyl) isocyanurate triacrylate (SR-368 oligomer) from Sartomer Co., poly(styrene-co-acrylonitrile) as polymer binder were added to the new photoinitiator [18]. Chloroform was used to dissolve the binder and control the viscosity of the resin.

5.2 *Structure*



(a) (b)

Fig. 4. Top view (a) 3D wire framed representation, and (b) of four layers of a woodpile

PBGs tend to appear in structures with a high dielectric contrast for most two-dimensional crystals. Complete PBGs are rarer for 3D crystals. It has been found that the face centred cubic (fcc) and hexagonal structures are capable of producing a complete PBG therefore it is the structure of choice for fabrication [11]. Layers of 1D rods stacked in a sequence that repeats itself every four layers gives the fcc or woodpile structure (see Fig. 4).

5.3 *Results*

The photonic crystal structures were fabricated using a reflection-mode 2-p microscope (see Fig 5). The Spectra-Physics Tsunami Ti:sapphire mode-locked laser, with a pulse width of 80 fs, was tuned to a wavelength of 800 nm. A neutral density filter (ND) controlled the intensity of the incident light. The laser beam was focused into a pinhole (P) to generate a point source that was then collimated by the first lens (L1). The aperture was used for matching the aperture width to the back aperture of the final objective allowing an accurate measurement of the pre-objective power. A computer controlled the translation stage and mechanical shutter to fabricate a pattern from a text file. A CCD camera allows in-situ monitoring of the fabrication process.

Woodpile structures were fabricated in our new material, with an average power of 20 mW before the 0.8 NA objective, and exposure times of 25 ms. The power necessary to fabricate in the new material was four times smaller than reliable powers for commercially available resins, such as SCR500 resin, with the same experimental setup. Four layers were recorded with 1.2 μm between each layer. Figure 6 shows horizontal (a) and vertical (b) lines in the transmission images obtained using 633 nm light through an Olympus 40X oil immersion objective.

6. Conclusion

Photonic crystals are currently an active research area around the world. We have described fabrication of 3D PC structures using 2-p photopolymerization of a resin with a large 2-p absorption cross-section. With the production of the photoinitiator with large absorption cross section, the efficiency of the 2-p photopolymerization method is increased dramatically.

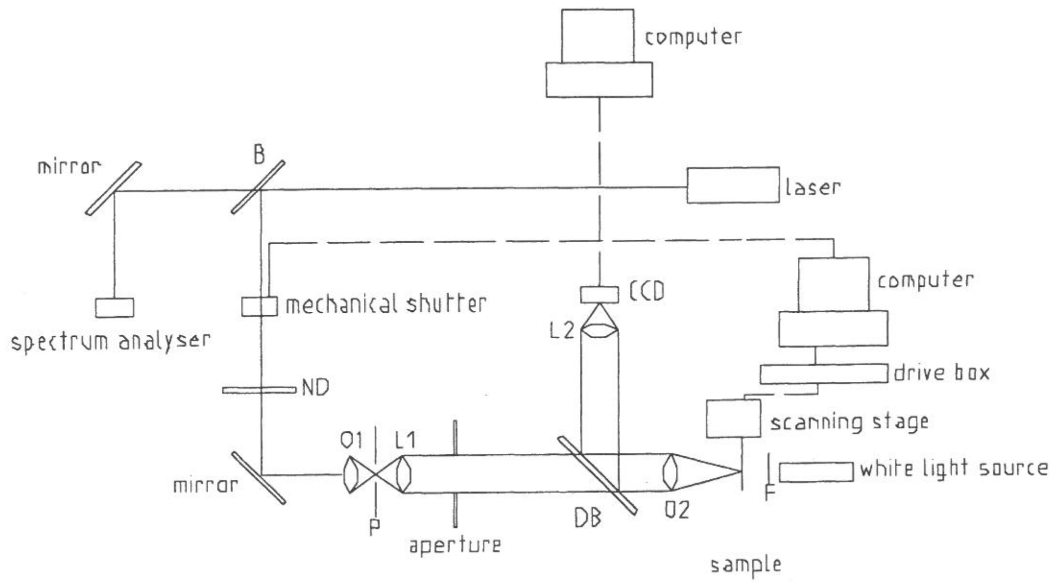
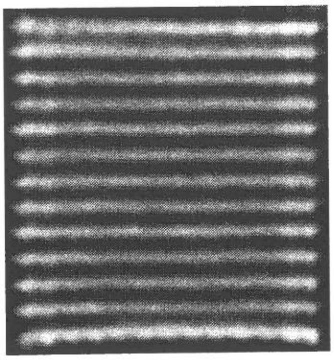
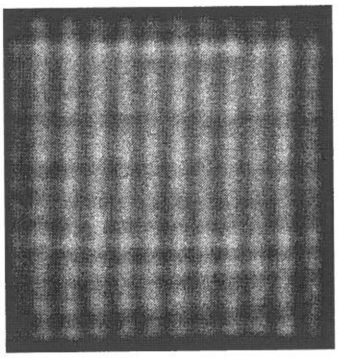


Fig. 5. Experimental setup for 2-p photopolymerization.



(a)



(b)

Fig 6. Transmission image of the first (a) and second (b) layers of a woodpile structure fabricated in a resin with a large 2-p absorption cross-section.

The new resin also helps the reduction of the exposure time, therefore increasing the accuracy of the 3D PC structures. Future work will include the fabrication and spectral characterization of novel photonic crystal structures with complete band gaps in both s- and p-polarizations.

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** IMPORTANT NOTE FOR AOS MEMBERS **

There are many people reading this journal that are not currently financial members of the AOS. It is vital to the survival of our society that all active participants in optical science in Australia are paid-up members. Conference attendance and contributions to the AOS News show that there is very strong support for the continued existence of the Australian Optical Society.

It is urgent that all non-financial members of the AOS pay their 2001 membership fees as soon as possible.

Apart from experiencing the warm inner glow of doing the right thing, you will also be able to claim your fees as a tax deduction for the 2000-2001 financial year.

Also, there appear to be a surprising number of people in the field of optical science (especially students) who are not as aware of the AOS as they should be. Encourage as many friends/colleagues/students/etc. to consider joining up (point them to the website, or make a copy of the subscription form in the back of the News.

- PLEASE PAY YOUR AOS SUBSCRIPTION NOW -

EDITORIAL

Firstly, my sincere thanks to all of the AOS members who responded to my pleas for help (particularly for articles/contributions). I believe that the content of this issue (and hopefully the next few at least) is indicative of the healthy state of optical sciences in Australia. Of course, dissenting opinions will also be graciously published.

This issue has a brief, but interesting, series of comments about last years AOS2000 conference. Unfortunately there were no suitable photographs found for publication; a situation that will have to be remedied for this year's conference. As a general reminder, conference reviews are always welcome contributions to the AOS News.

The article by Duncan Butler and Greg Forbes examines some recent developments in the theoretical treatment of diffraction, and offers some very relevant examples of their application. A special thank you also to Nina Rimac for her contribution. Nina completed her Honours last year in the group of Prof. Min Gu at Swinburne University of Technology, and has adapted her Honours thesis for an AOS News article - supervisors please take note!

Oh, and not forgetting that this issue is once again woefully late. Time for a new excuse, and of course more apologies. This time, well, a new baby daughter has only just arrived in my house, creating far more chaos than her mere size should allow.

Wayne Rowlands

Meetings Calendar

The following list of optics-related conferences is compiled from several sources and should be used as a guide only.

Date	Meeting 2001	Contact	Location
Jun 4-6	Complex Adaptive Structures	SPIE	Hutchinson Is., USA
Jun 6-8	Meteorological Optics	OSA	Boulder, USA
Jun 6-8	Optical Engineering for Sensing and Nanotechnology (ICOSN 2001)	SPIE	Yokahama, Japan
Jun 10-13	International Conference on Quantum Information	OSA	Rochester, USA
Jun 13-16	Eighth Rochester Conference on Coherence and Quantum Optics	OSA	Rochester, USA
Jun 17-20	European Conferences on Biomedical Optics (ECBO)	OSA	Munich, Germany
Jun 18-22	Industrial Lasers and Optoelectronic Devices	SPIE	Munich, Germany
Jun 20-22	Laser and Laser Information Technologies (ILLA 2001)	SPIE	Vladimir, Russia
Jun 26-Jul 1	XVII International Conference on Coherent and Nonlinear Optics (ICONO 2001)	SPIE	Minsk, Belarus
Jul 1-5	OECC/IOOC/ACOFT - OptoElectronics and Communications Conference + Integrated Optics and Optical Fibre Communication Conference + Australian Conference on Optical Fibre Technology		Sydney, Australia
Jul 16-19	CLEO/Pacific Rim 2001 The 4th Pacific Rim Conference on Lasers and Electro-Optics	OSA	Chiba, Japan
Jul 29-Aug 3	International Symposium on Optical Science and Technology (SPIE Annual Meeting)	SPIE	San Diego, USA
Sep 3-7	IV Iberoamerican Meeting of Optics (IV RIAO) and the VII Latin American Meeting of Optics, Lasers & Applications (VII OPTILAS)	SPIE	Tandil, Argentina
Sep 17-20	Advanced High-Power Lasers and Applications	SPIE	Kyoto, Japan
Sep 17-21	Remote Sensing	SPIE	Toulouse, France
Sep 17-21	X-Ray and Neutron Capillary Optics	SPIE	Zvenigorod, Russia
Sep 17-18	Opto-Southwest	SPIE	Tuscon, USA
Oct 3-5	Photomask Technology	SPIE	Monterey, USA
Oct 22-24	2nd International Symposium on Multispectral Image Processing and Pattern Recognition	SPIE	Wuhan, China
Oct 22-25	Micromachining and Microfabrication	SPIE	Santa Clara, USA
Oct 28-31	ISAM/EIS	SPIE	Boston, USA
Nov 7-10	Optoelectronics and Microelectronics	SPIE	Nanjing, China
Nov 12-16	APOC 2001-Asia-Pacific Optical Communications Conference and Exhibits	SPIE	Beijing, China
Nov 26-30	Photonics and Applications	SPIE	Singapore
Nov 27-30	Education in Optics	SPIE	Singapore
Nov 26-28	ETOP 2001: The 7th International Conference on Education and Training in Optics and Photonics	SPIE	Singapore
Dec 17-19	Microelectronics and Micro-Electro-Mechanical Systems	SPIE	Adelaide, Australia

Further information on the above conferences can be obtained from:

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The *AOS News* is always looking for contributions from its members. Here's a short summary of the how to make a submission.

What can you submit?

*** Scientific Article***
A scientific paper in any area of optics.

*** Review Article***
Simply give a run down of the work conducted at your laboratory, or some aspect of this work. Authors of scientific or review articles will receive proofs by fax.

*** Conference Report***
If you have been to conference recently, writing a short report would be greatly appreciated.

*** News Item***
Any newsworthy stories in optics from Australia or abroad.

*** Book Review***
If you have read an interesting (and relatively new) book in some field of optics please consider a review for the *AOS News*.

*** Cartoon or drawing***
If you have some artistic bent why not consider submitting a cartoon!

How can you submit?

The easiest way is by email. Either send the document text in your mail, or attach a word processor file. We accept nearly all file formats. (Famous last words!).

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