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President's Column  58
Great Expectations.  Ron MacDonald

EDITORIAL  59
All That Glistens is Not Gold.  Jak Kelly

LETTERS  60

ARTICLE  61
Tall Storeys - The Builders of Babel.  R Keam & M Johns

OF INTEREST  64

ARTICLE  67
Australasian Tertiary Science Education: International Perspectives.  P Drummond

ARTICLE  71
SPACE: Major Particle Physics Experiment.

INTERACTIONS  72

ARTICLE  73
Physics Educational Software WWW Sites.  Mick Pope

PRODUCT NEWS  74

ARTICLE  75
Surfing the Physics Webb.  David Maddison

REVIEWS  76
Prompt Critical: Towards a Defence of the Future of Science.  Colin Keay

CONFERENCES & MEETINGS  84

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This month's cover picture is a photograph of the loops of NGC 3576 taken by David Malin. The stars which excite this unusual nebula are not visible in this photograph. They are hidden in the dusty cloud at the base of the huge loops of material which have been blown out by radiation pressure and stellar winds from the concealed stars. Silhouetted against the tenebrous loops are dark clouds of dust with bright rims which indicate the direction of the stars which excite the nebula. This large complex of gas and dust is about the same distance as the Eta Carinae Nebula, about 7,000 light years away. Reproduced with permission © Anglo-Australian Telescope Board.
Great Expectations

I have driven the publisher to distraction this issue by delaying writing this column. One of the reasons for this is a hope that the new Federal Government might give some insight into what the future holds for science and technology in Australia. So far the only information we have is that the Government will make savings in the budget area of $4 billion over two years. The other bit of information we have is the promise that election promises will be kept.

While none of us, I am sure, is likely to be sceptical about the way in which we can expect these two somewhat contradictory promises might be met, it is worthwhile to look a little carefully at the words used in these promises. In the University sector we get $30m/year for three years in infrastructure, $30m over three years into collaborative grants in the ARC portfolio, and $9m over three years into postgraduate research scholarships. These are promises whose keeping is measurable and it doesn’t cost much to keep them anyway.

There was a commitment to place Higher Education wage demands high on the agenda, but this is in no way a commitment to fund any such demands. Indeed many of the commentators on the political scene suggest that the loan arrangements proposed by the former Minister might appear generous when measured against this new Government’s proposals.

In the more general science and technology area, there were not many promises with substance in them. There were commitments to the CRC concepts and some general comments about the benefits of major facilities, but very little which constituted measurable outcomes. The various proposals of the November Innovations Statement were more or less categorised as under review.

The discovery of a larger-than-expected Budget deficit was entirely expected. We can expect, however, that the follow-on from this discovery will make life difficult for all of us, on a number of points. What then can we do about it?

First and foremost we can support FASTS. This is, after all, the lobbying organisation to which we subscribe, and unless we support it actively and do not simply pay our fees, we cannot expect politicians to believe that FASTS speaks for 40,000 scientists, engineers and technologists. FASTS has reacted quickly to the challenge of a new government and has produced an updated policy manifesto. This ranges over all aspects of the practice of our respective professions and is a valuable common platform for all societies to use. Unless we all speak from such a common base and indicate our strong support for the policies espoused by FASTS, we will be regarded as wimps all over again.

The AIP plays a steady role in supporting and developing FASTS. We were in there at the beginning and individual members still play a major role in developing policy for FASTS. We will feature more on FASTS and its activities in the Physicist in the future, but for now I urge every member of the AIP to read the new policies as shown on the Web at


Acceptance of these policies and active support on all possible occasions will provide the solidarity which is essential to convincing politicians that we are a serious lot, to be taken seriously.

Ron MacDonald
vjkeb@cc.newcastle.edu.au
EDITORIAL

All That Glistens is Not Gold

Once upon a time, people with a scientific or technical difficulty could wander into a CSIRO lab and ask the receptionist who could help with their problem. If she didn’t know, they would be put onto the library who usually did. Not a form signed, not an agreement entered into, not a key card controlled door to protect the commercial secrets of the scientists. My first consulting job came about in this informal manner. A man from industry was brought to my office in the National Standards Laboratory and we were left to discuss his problem. By good luck it was in one of the few areas, as a new graduate, I really understood. I solved the problem in about ten minutes and suggested what they should do to overcome their production difficulty, I wrote it all out on a few sheets of paper and gave it to him. “What do I owe you?” He said “Nothing. All part of the CSIRO service’ I stupidly replied.

I was upset to find out that nothing was done about my solution. They subsequently brought in a consultant from the USA who cost them thousands of pounds and who came up with essentially the same answer. Spending this money had to be justified by action so the solution was adopted. It took me a long time to realise that I was at fault, not them. Most people value things in terms of what they cost. City people waste water because it is almost free, Free answers are clearly worth nothing. I should have been seen to consider the problem as more difficult than it was and pretended to take days or weeks over it, submitting a long report on official CSIRO paper, with many graphs and diagrams and a significant bill. They would have been more likely to accept my solution, to the economic benefit of both the company and CSIRO.

It is heartening to read (New Scientist 30 March 96) that future young scientists are expected not to be as commercially silty as most of us were. They will be the “gold collar workers” of tomorrow. Leaving aside the domestic pet connotations of such a ridiculous description, it seems that 90% of 300 senior managers interviewed in the USA think that the next generation of successful managers will have higher degrees in physics, chemistry, maths or computer science. They may be right. In 1991 19% of all American chief executives had technical backgrounds, this percentage increased to 24% by 1995. I don’t know what the comparative numbers are for Australia but I would be surprised if they are above a few percent.

Cornell University is offering an accelerated MBA for scientists, with the first year course condensed to three months. Seems a fair comparison between the abilities of a science PhD and their normal intake. I remain skeptical of much of the content that I have seen in MBA courses but at least some knowledge of the language and practices of commerce is a good thing, even if the student does not aspire to a “gold collar”. The real danger for a young scientist doing such courses is the risk of accepting current commercial practices as having the validity of scientific principles. They are expedient measures for the most part and can change as rapidly as do other fashions. Even Japanese corporations are now coming to realise that overworking your people is not efficient and are now encouraging them to go home at a reasonable hour.

One value system does not work for all activities. The sort of hype that inspires football teams to win is not necessarily good for a commercial and even less a scientific enterprise. The fees at present paid to motivational speakers indicates that management doesn’t widely appreciate this difference. Which makes it all the more important that we give public talks as often as we can, even if we are not paid $5000. This antidote to looney motivational claims about confidence being everything and you can become whatever you want to be if only you work hard enough, is greatly needed. Thinking was never a very popular activity, particularly with men of action. Shakespeare’s lines, that Julius Caesar considered his general Gaius Cassius Longinus of being guilty of not only having a lean and hungry look but thinking too much, is an accurate reflection of this attitude. Thinking too much was considered subversive then and it often still is.

Jak Kelly
kelly@unsw.edu.au
LETTERS

You May Make Some Money

Dear Editor,

The suggestions made by Professor Kelly in his Editorial article (ANZ Physicist, May 1995) should have received more attention.

Since reading his article I have applied the principal in a small way. Any and every telephone marketer, pollster and the like receives the reply “My fee for this information is $100”. I have made no money but the conversations are extremely short.

When requested to provide information to the bureaucracy university departments should react in a similar way. Either the information is important, in which case the seeker will pay, or it is not, in which case the request can be ignored with a considerable saving in time.

The quality of the information provided will increase dramatically since the recipient of payment is obliged to do something to earn the payment. When there are many requests the standard response is to guess, which is value neutral but has a very high standard deviation, or to supply the requesting agency with what you think they want to hear, or with what you think they do not wish to hear. Both of the latter responses can be very dangerous.

My guess is that one in ten of the requests is serious. The rest arise because it is easier for the bureaucrat to request information from the University Department rather than read the literature.

TM Sabine
Glebe NSW

Value of Collaboration Between Physics & Education Departments

Dear Editor,

The answer to the question “Physics education research: education or physics?”, asked by the Sydney University Physics Education Research Group (ANZ Physicist, Jan/Feb 1996) is surely - both. However, the question which they ask is really about who should carry out this research and the answer argued for in the article is - those who teach physics in tertiary institutions.

There is some evidence that the outcomes of educational research do not have a great deal of effect in classrooms unless the teachers themselves are actively involved in the research. This would support the recommendation of the Sydney University Group if the focus of their interest is only the teaching of tertiary physics. Most successful educational research is not carried out by outsiders who come in to experiment and observe but by teachers themselves in what is called “action research” (though often in collaboration with outsiders).

Most if not all of the research carried out by Education faculties and departments is directed towards improving teaching – including the teaching of physics – in primary or secondary classrooms (or preparing teachers to do this better). One would expect there to be large differences between teaching at school and teaching at University. You only have to look at the interests of Higher Education research units within Universities to see some of the differences.

However, there are also many areas of similarity because of some of the common features of teaching and learning at all levels and this indicates the value of some degree of collaboration between Physics and Education departments when research into physics education is carried out. This is especially important since some of those who are preparing teachers are also preparing them to teach physics in secondary schools.

Clink Gauld
School of Teacher Education
UNSW

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If possible email words (not diagrams) to:

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1996 FEES

If this isn’t your copy of the ANZ physicist then you are not a member. You should join, not only to get this journal every month and find out what is happening in Australasian physics and physics education, but to support the many activities that the AIP and NZIP carry out on your behalf. Most of the work is done by people who give considerable time and effort to advance physics. But we still need funds and every new membership helps. If you are already a member, why not make an effort to recruit others?

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Membership regulations and application forms are available from: Dr GJ Fraser, Secretary NZIP, Department of Physics & Astronomy, University of Canterbury, Christchurch, New Zealand. Tel +64-3-364-2581 / Fax +64-3-364-2499.
TALL STOREYS
The Builders of Babel

R KEAM & M JOHNS

Go to, let us build us a city and a tower whose
top may reach unto heaven... Genesis 11:4

The following investigation was precipitated
as a result of contemplating the construction of
a casino in Auckland, New Zealand, with a
tower to be 328 metres high - the tallest in the
southern hemisphere. The question which arose
was: at what height would it be necessary to
curve the axis of the tower measurably in
response to the changing direction of the Earth's
gravitational field?

Initially we consider the Earth to be a point mass \( M \) fixed at the
origin of a rectangular Cartesian coordinate system which is
rotating about the \( y \)-axis with the Earth's angular speed \( \omega \). At
any point fixed in the co-rotating reference frame the
gravitational field experienced is a combination of the Earth's
Newtonian attraction and the centrifugal field. Because of the
axial symmetry of the situation there is no loss of generality in
confining our attention to the \((x, y)\) plane. Thus, at an arbitrary
point \( P \),

\[
g = \frac{GM}{r^2} \mathbf{r} + \omega^2 \mathbf{x}, \tag{1}
\]

where \( g \) is the gravitational acceleration, \( G \) is the universal
gravitational constant, \( r \) and \( x \) are as in Figure 1, and \( r = |r| \).

In terms of its rectangular Cartesian components

\[
g = GM \left( \frac{-x}{(x^2 + y^2)^{3/2}} + kx, \frac{-y}{(x^2 + y^2)^{3/2}} \right), \tag{2}
\]

where \( k = \omega^2 / GM \) and is the ratio of rotational to Newtonian
effects. The gravitational acceleration field lines satisfy

\[
\frac{dx}{8x} = \frac{dy}{8y}, \tag{3}
\]

ie

\[
dx \left( \frac{-x}{(x^2 + y^2)^{3/2}} + kx \right) = dy \left( \frac{-y}{(x^2 + y^2)^{3/2}} \right) \tag{4}
\]

This integrates in terms of elementary functions and one finds

\[
k \frac{dy}{dw} = \frac{w^2}{\left(1 + w^2\right)^{3/2}} \tag{5}
\]

Figure 2 shows the resulting curves in the region
\( 0 < \theta < \pi/2 \). All solutions tend asymptotically to the \( y \) axis
as \( \theta \to \pi/2 \). One may distinguish three classes of solution,
namely those for which the \( \text{constant} \) is respectively negative,
positive and zero. When it is negative we may put \( \theta \)

RF Keam and MD Johns are in the Physics
Department, University of Auckland.
Gravitational acceleration ($g$) field lines in a co-rotating reference frame. The unit of distance is the radius of a geosynchronous orbit (i.e. $k = 1$ or $r_c = 1$). The dashed curve is a segment of the circle $r = 1$. Note the special case separating Earth-reaching and Earth-fleeing lines.

$$\text{constant} = \sin \alpha - \ln \tan \left( \frac{\alpha + \pi}{4} \right)$$

and the solution in this case approaches the origin (the Earth) at polar angle $\alpha$. When it is positive we may put

$$\text{constant} = \frac{1}{3} ky_0^3$$

and the solution does not reach the Earth but tends asymptotically to $y = y_0$ as $x \to \infty$, or equivalently, as $\theta \to 0$.

When $\text{constant} = 0$ the curve lies between the other two classes. As $y \to 0$, it approaches the $x$ axis at right angles at the point $(r_c,0)$, where $r_c = k^{-1}$. At this point there is no gravitational field and the circle through it centred at the origin and perpendicular to the $y$ axis is the geosynchronous orbit. The circle of the same radius about the origin, but lying in the $(x, y)$ plane, cuts all members of the constant-negative class curves at places where these curves have tangents parallel to the $y$ axis. On each curve the intersection is thus the point with the greatest value of $x$.

Although we keep all its mass at the origin we now improve our model of the Earth, a little, by assuming that it has a rigid surface (of approximately spheroidal shape) coinciding with one of the gravitational equipotential surfaces at an appropriate distance from the origin. This is shown diagrammatically in Figure 3.

The builders of Babel would presumably have used plumb-bobs to define their direction of upward extension as tower building proceeded. After a while (of course assuming materials of sufficient strength, negligible wind, and that they had found a way of dealing with progressively lessening oxygen pressure) they would have noticed that their plumb-bobs deviated slightly from the original upward direction of the tower. Soon afterwards their tower would have fallen over.*

The problem with this first approach was that the weight force of the uppermost storeys developed a moment about the tower base. The correct approach must be one that ensures that as each storey is added the moment of its weight about the 'point' at the base of the tower be zero. Or, in other words, the weight vectors for all elements of the tower must pass through the base of the tower. Applying this constraint we have a simple algebraic relation instead of a differential equation.

Let $(x, y)$ be any point along the curve representing the tower, and $(x_1, y_1)$ be the foot of the tower. Then

$$\frac{g_x(x, y)}{g_x(x_1, y_1)} = \frac{y - y_1}{x - x_1}.$$  \hfill (9)

Substituting from equation (2) one finds after some manipulation that

$$k(x^2 + y^2)^{\frac{3}{2}} = 1 - \frac{1 - x_1/x}{1 - y_1/y}.$$  \hfill (10)

Asymptotically every rigid tower not built on the equator must tend ultimately to the $y$ axis. Representative towers are shown in Figure 4. We note that if equation (10) is written in terms of polar coordinates, with $(r, \theta)$ replacing $(x, y)$ and $(r_1, \theta_1)$ replacing $(x_1, y_1)$, the limiting form as $\theta_1 \to 0$ is $\theta$.

* Footnote: It is suggested that the event of the 'confusion of tongues' (Genesis 11:7-9), which is recorded as occurring at this time, came down as a reflection in legend of the fact that the building entrepreneur, as a result of the collapse of his tower, and with it his solvency, started using words the rest of the inhabitants did not understand.
Tower profiles for representative geocentric latitudes. The heavy circle quadrant represents a section of the Earth’s surface. Note the ‘gallery’ branching from the equatorial tower, \( \theta = 0 \), at \( r = r_0 \sim 0.62 \).

The branch point is just over half way from the tower base to the geosynchronous orbit height.

A new entrepreneur arose in Babel, determined to rebuild the tower. Trial and error indicated that the correct way to use a plumb-bob was to ensure that, as each storey was added, the bob and string pointed towards the centre of the tower’s base. This attempt was successful until tidal effects of the Moon became significant.

Of course the Auckland casino tower is a pale shadow of the tower of Babel. Built straight up, its axis at height \( h \) is displaced sideways from the axis of a tower built like the second one at Babel by a distance

\[
\delta = \frac{1}{2} h^2 C
\]

where \( C \) is the curvature of the relevant curve (equation (10)). This curvature can with a little effort be shown to be approximately given by

\[
C = 4k \frac{r^2}{h^3} \sin 2\theta
\]

where \((r_1, \theta_1)\) are the plane polar coordinates of Auckland. Therefore

\[
\delta = 2 \left( \frac{h^2 r^2}{h^0} \right) \sin 2\theta
\]

Substituting numerical values shows that \( \delta \) is approximately 0.1 mm – reassuringly, by itself no significant source of instability!

For a selection of tower heights, \( h \), at the latitude of Auckland the sideways displacements, \( \delta \), at the tower tops are,

<table>
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<td>100</td>
<td>10.7 m</td>
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<tr>
<td>500</td>
<td>0.293 km</td>
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<tr>
<td>1000</td>
<td>1.31 km</td>
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</table>

Note that equilibrium of the towers considered in this paper implies nothing about their stability, and, indeed, all but sufficiently tall equatorial towers are highly unstable. The use, in principle, of tall equatorial towers has been considered by Artsutanov [1] and others and taken up by science fiction writers – notably Arthur C. Clarke [2] and Charles Sheffield [3]. (We wish to thank Garry Tice, Department of Mathematics, University of Auckland, for bringing these references to our notice.)

References
1 Yuri N Artsutanov, Komsomol’skaya Pravda, 31 July 1960
2 Arthur C Clarke, Fountains of Paradise, Victor Gollancz Ltd (1979)
3 Charles Sheffield, The Web between the Worlds, Ace Books (1979)
**The Purpose of the APCTP**
The APCTP would underpin and strengthen the sustained international competitiveness of its member countries/regions and would contribute to the world-wide progress of physics. It will become a focus for scientific achievement and for the training of researchers of the region. It aims to be:
- a center of excellence for research in theoretical physics.
- a center for the training of young physicists from member countries/regions.

**The Functions of the APCTP**
To fulfill its aims the centre will recruit as its faculty theoretical physicists with a strong reputation for excellence both in their personal research and in their guidance of young researchers. It will also provide first class facilities for its faculty, its visiting scholars and its post-doctoral fellows. Theoretical physicists from the member countries/regions will participate as associates and as post-doctoral fellows in the work of the center. The center will conduct research of its own, and it will facilitate research in the region through the organisation of workshops, symposia, and conferences.

**Activities of the APCTP**
The activities of the center would cover theoretical and mathematical physics, including:
- High Energy Physics
- Nuclear Physics
- Cosmology and Astrophysics
- Condensed Matter Physics
- Non-linear Dynamics
- Statistical Physics
- Computational Physics
- Plasma Physics

(See next page for more details on the proposed scientific activities in the year 1995 - 1996).

**Our Expectations**
A world class center for theoretical physics improves the academic level of theoretical physics, and thus strengthens pure and applied physics in the member countries/regions.

The APCTP will contribute to the enhancement of the basic sciences, which will play a major role in promoting long term economic development in its region.

**Proposed Sites of the APCTP**
The International Planning Committee (IPC) suggested that the center should be located near a major academic institution and to be close to international transport. The Seoul National University Research Park, and the Hongnung Campus of the Korea Advanced Institute for Science and Technology both satisfy these conditions. Both are in Seoul, and are close to both the Gimpo International Airport and the Young-hang International Airport, which is at present under construction. Seoul, one of the world’s largest cities and the political, commercial, educational and cultural center of Korea, is the home to government offices, major corporations, leading universities and entertainment facilities. It would be an ideal host city for the APCTP.

**Financial Arrangements**
Korea, as the host country, will provide the permanent office building and the residential facilities for the center, and a significant share of the running costs. The rest of the operational budget should come from the member countries/regions through the membership fees and contributions in a way to be determined. The IPC has suggested that no country should be expected to contribute more than 50% of the running costs. It is suggested that the Board of Governors, and the members, should review the cost sharing arrangements at regular intervals, possibly 5 years.

**Establishing the APCTP**
The Korean National Committee (KNC), in consultation with the International Planning Committee and the Advisory Committee chaired by N.C. Yang, established the APCTP. The APCTP would underpin and strengthen the sustained international competitiveness of its member countries/regions and would contribute to the world-wide progress of physics. It will become a focus for scientific achievement and for the training of researchers of the region. It aims to be:
- a center of excellence for research in theoretical physics.
- a center for the training of young physicists from member countries/regions.

**Milestones in Establishing APCTP**

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tr>
<td>1989.11.23</td>
<td>The idea of an international centre for theoretical physics in the Asia Pacific region first discussed at KEK in Japan</td>
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<tr>
<td>1993.2.25</td>
<td>Formation of the International Planning Committee (IPC) for APCTP during the First Pacific Winter School at Sorak Mountain Resort in Korea</td>
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<tr>
<td>1994.3.2</td>
<td>The IPC requested Korea Science and Engineering Foundation to cooperate in establishing APCTP in Korea</td>
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<tr>
<td>1994.5.1</td>
<td>The 1st IPC meeting of APCTP in Seoul, Korea. It was resolved that Korea be the host country for APCTP</td>
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<tr>
<td>1994.11.14</td>
<td>The Association for Science Cooperation in Asia (ASCA) endorsed Vietnam’s proposal for the APCTP to be located in Korea</td>
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<tr>
<td>1995.1.18</td>
<td>Formation of the Korean National Committee (KNC) for APCTP</td>
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<tr>
<td>1995.1.22</td>
<td>The 2nd IPC meeting (joint meeting with KNC) at Sorak Mountain Resort, Korea</td>
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<tr>
<td>1995.3.1</td>
<td>Professor C. N. Yang was appointed as Special Advisor of IPC</td>
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<tr>
<td>1995.8.28</td>
<td>The 3rd IPC meeting in Seoul, Korea</td>
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by the President of the Korean Physical Society, is responsible for the work required to inaugurate the Centre.

The permanent structure for the Centre will be an international body, made up of governments or academies of member countries/regions. The members would nominate representatives to the General Assembly, and the contributing members would nominate representatives to the Board of Governors of the Centre. The Board of Governors will appoint the director with the authority and responsibility of executing the business of the Centre. One possible international structure is a multilateral organisation of the CERN type.

As interim measures, the KNC will establish a legal structure for the APCTP, and the IPC will act as the Board of Governors until such a Board is established.


Power Lines May Not Be Good For You

New research, just published in The International Journal of Radiation Biology [1] may help explain the increased incidence of cancer associated with electromagnetic fields from electric wiring and overhead power cables. The research was funded by the Medical Research Council at the University of Bristol.

The Bristol researchers found [2] that the mains leads of ordinary domestic electrical appliances can attract radioactive particles formed from the decay of radon - the naturally occurring radioactive gas found in room air. Further experiments suggest that similar concentrations of these radon decay products, and other pollutants, may be present around overhead power lines. Radon and its decay products have been linked with cancer.

Radon decay products attach themselves to minute particles of water and gas in the air, known as aerosols. The researchers used special plastic films to detect these radioactive particles. Their experiments showed that the aerosols were attracted to mains power cables like iron filings to a magnet. Electric fields also make the aerosols oscillate in the air at mains frequency. This movement increases their chance of sticking to the skin or being inhaled by people in the vicinity. As well as being radioactive, the aerosols could contain bacteria, pollutants or other chemicals in the air.

The findings were repeated in a variety of domestic situations, and simulations of the electromagnetic fields from overhead power lines showed clear evidence of the build-up of radioactivity in the air around the source.

The problem of exactly how the changes in movement of the decay products and aerosols might affect the body's internal organs is still unresolved. But it is suggested that these effects may cause more particles to be inhaled. This, combined with the possible action of weak electric fields in the body, would increase the number of particles sticking to the mouth, throat and lungs. The radon decay products could then be absorbed into the blood, travel around the body, and deliver an increased radiation dose to sensitive tissues such as the bone marrow and the foetus.

Domestic electrical equipment is unlikely to cause health problems as the effects occur only very close to the power leads. The main effects will be around major sources of electromagnetic fields, such as overhead power lines, and that this is now an area for further investigation. "We have crossed a major conceptual barrier," said Professor Denis Henshaw, leader of the research team. "Previously, science could not explain how electromagnetic fields could cause cancer.

Now we have used principles from basic physics to show how these fields can concentrate a cocktail of known carcinogens around them.

And the good news is that it is relatively easy to shield against electric fields and possible to reduce radon levels in the home."

References
2. Further details of the research are available on the internet at http://wwwophys.bris.ac.uk/research track_analysis/emf_radon.html.\]
Physicists Awarded Bede Morris Fellowships

The Bede Morris Fellowship Scheme set up in 1989, honours the achievements of the late Professor Bede Morris, an immunologist at the Australian National University. Professor Bede Morris formed close ties with the French scientific community and was set to receive France's top award, the Légion d'Honneur; sadly, he was killed in a car accident in that country just before receiving the award.

Initially sponsored by Rhone-Poulenc Australia, the scheme has recently attracted sponsorship from the French Embassy, the Australia-France Foundation and the Commonwealth Government, thus allowing a greater number of scientists to participate in the scheme.

Dr Nail Akhmediev, of the Optical Sciences Centre at the Australian National University, will visit the Laboratoire d'Optique Quantique du Centre National de la Recherche Scientifique in Palaiseau to further his studies into non-linear optics. The application of solitons is one of the most important developments in modern non-linear optics. Solitons can be used for transmission, processing and storage of information in all-optical devices with highest possible speed. Optical activity, in combination with non-linear effects, can suggest new ways of switching and processing of information in all-optical devices. In his research in France, Akhmediev will study transmission characteristics of non-linear devices based on optical activity. Associate Professor DJ O'Connor, of the Department of Physics at the University of Newcastle, will go on a short two-week visit to the Laboratoire des Collisions Atomiques et Moléculaires at the Université de Paris-Sud. There he will continue his research into charge exchange; O'Connor aims to achieve a more complete understanding of ion surface charge exchange and to develop a better delineation between ion-solid and ion-atom processes. This can be used to calibrate standard surface analysis methods such as secondary ion mass spectrometry, low energy ion scattering and electron stimulated desorption. This will have the added benefit of opening the way to using solid targets for studies in ion-atom research, thus enhancing productivity in this field. The French research team is one of the few in the world studying ion-surface charge exchange.

Reprinted from Australian Academy of Science Newsletter, Number 31, January-March 1996.

Dr Nail Akhmediev

Associate Professor John O'Connor

A CORRESPONDENT from the Northern Territory University has drawn our attention to this advertisement which runs in the NT News. Could they mean Newton? Obviously one of the many delerious results of not having many physics students at NTU.

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AUSTRALASIAN TERTIARY SCIENCE EDUCATION
International Perspectives

PETER DRUMMOND

Tertiary science degrees in Australasia are currently very much shorter than present international standards. A brief comparison is given with the major industrialised nations, leading to the strong recommendation that the international 4+2+3 system of tertiary education in science ought to be adopted in Australia and New Zealand.

Introduction

There is little doubt that Australian tertiary science education is in a difficult situation. Currently, the admission scores required to enter science courses like physics are often much lower than in other professional courses, with similar problems in New Zealand. In other words, entering students have a worse academic standing than those of many other courses. Despite these low entry standards, science enrolments are not increasing; in Australia, they are generally reducing, compared to overall tertiary enrolments. Some universities, like Bond University or the new Sunshine Coast University College, are now opening without offering any courses at all in the fundamental sciences. It is certainly very unusual, in international terms, to find universities with essentially no science courses. They do exist now in Australia.

The result of nearly static enrolments, in a reducing funding environment, is a general decline in staffing levels. Just as worrying is the inadequate level of funding for essential laboratory courses, with a resulting loss of functionality in the experiments. Since the sciences generally have an evolutionary path that must be reflected in new experiments, it is important to replace and upgrade equipment regularly. Out-of-date teaching laboratories are a problem, in terms of educational quality. They are also a problem in terms of industry in Australasia. In industrialised countries with relatively high wages, the future of most job-seekers must rely on innovation and new technology. However, this can only happen if science, engineering and technology education is of the highest international standard.

These problems are part of a disquieting overall trend throughout Australasia. For example, OECD studies of relative levels of research investment leave Australia and New Zealand at the bottom of the list for per capita industrial investment. This, in turn, leads to poor corporate performance and restricted job opportunities. This is a chicken-and-egg situation, as Australasian corporate directors and executives are generally not science or engineering graduates. Thus, the largest recent Australian corporate investments have been in entertainment and sports – which corporate executives understand – rather than in science or technology research. This lack of investment discourages research, and hence the study of science or engineering. The end result leads inevitably to more of the same type of executive.

Another problem is the lack of advanced training in science required of science teachers, together with low salary levels compared to other professions. This reduces job opportunities and incentives for Australasian science graduates. It also has a large effect on educational quality. It is common in Europe for a science teacher to have the equivalent of a postgraduate (master’s) degree in science. By comparison, in Australasia, a science teacher can sometimes teach in an area that he or she has never really studied past high school. It is very hard to justify this. Most of the loss of interest in mathematics and science occurs at the high school level. It is precisely here that a well-educated and enthusiastic teacher can play a large role, in bringing the excitement of scientific discovery to a new generation, as well as an essential understanding of the workings and application of science and technology in modern life.

Solutions?

There is an area where science job growth has occurred in Australia in recent years. This is in the federally funded

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research centres. However, the growth of jobs in research centres has largely been in the area of temporary research positions. With some predictability, these have not proved attractive enough to increase the number and entrance standards of prospective science students. There is truly excellent research taking place at the research centres. Yet, since research output is rather similar at Universities and research centres, it would seem preferable to fund more permanent University jobs. These positions are both attractive to prospective employees, and more functional in transferring knowledge to students.

A possible solution that is currently being tried at a number of Universities, is a general attempt to increase research output and graduate enrolment for the PhD degree. This can be achieved within the current academic framework, and is intended to improve science funding via student-based funding formulae. On the other hand, as the current number of government funded science postgraduate scholarships is fixed, any overall national increase can only come from self funded students – who are relatively scarce. Foreign graduate students might help, but (as we will see) this is made less likely by the unusual degree structures in Australasia. Increased research is a worthwhile goal. As a means of increasing the funding of science education, this approach is best characterised as 'rearranging the deck chairs on the Titanic'. It can result in short-term gains in one area, only at the expense of other Departments elsewhere.

In student-based funding systems, it is usually more productive to try to increase enrolments at all levels, rather than to focus just on PhD students. In smaller Departments, in the former Australian CAE’s, this is really the only viable option. In fact, these Universities are more likely to lose than to gain student numbers, if the larger traditional Departments mount vigorous recruiting campaigns. In these former CAE’s, the emphasis in education is generally on vocational training, and suitability for employment in industry – rather than on graduate research. There are often major problems with existing degree structures in this area. In recognition of this, three Australasian Universities have introduced innovative four-year BTech degrees in applied science. The success of these programs shows that it is possible to attract new students into industry-relevant technology training, provided the underlying goals and degree structures have good planning behind them.

There is an even more fundamental difficulty with the approach of simply trying to increase student enrolments, without questioning the existing degree structure. This is the serious question of the goals of the Australasian tertiary system. In other words, one can ask if the degrees currently gained are really sufficiently up-to-date, and appropriate for the employment of large numbers of graduates. In order to determine this, it is useful to compare our system with that found elsewhere in the world. Quantifying our educational levels relative to international standards is clearly an essential part of this. In the recent Quality surveys of Australian universities by the federal government, there was unfortunately no attempt to compare Australian degree requirements with those found elsewhere in the world.

This question is an important one, which can be asked even of degrees offered in currently fashionable areas like biology and computer science. For example, the software industry is now becoming more and more dominated by a number of large international corporations. These will employ only a relatively small number of Australasian graduates, while saturating local software markets to an unprecedented extent. In this situation, it appears that it is most likely that there will be a high demand for graduates who know about computers, together with a knowledge of the discipline where they are to be used. On the other hand, the number of operating system writers needed may be reducing – as operating systems converge onto a few common types. Despite this, computer science graduates with a relatively narrow range of skills will graduate in increasingly large numbers out of Australasian universities in the '90s.

In summary, the solution to problems in science education is to aim for international standards of excellence, and to educate students broadly – rather than in just one field of science.

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**International Standards**

To describe international standards, it is necessary to group countries into those with comparable tertiary education systems. The main groups in the Asia-Pacific are USA-Latin America, Russia-FSU, Japan-East Asia, and China-Taiwan. All these nations – representing over half the world's population – have a rather different approach to tertiary education to that found in Australasia. In the Asia-Pacific, the large industrialised nations follow a system that is roughly comparable to the US style of education. In this system, there is a broadly based four year undergraduate degree, which is then followed by two or three years of specialised graduate education. Finally, students interested in research can start on their PhD thesis.

It is very common for students to change courses or Universities after completing any one of these stages, which means that portability and interchangeability of degree requirements and standards is an important factor in international tertiary education.

In the USA, students can enrol directly in a 5-year PhD, after a 4-year undergraduate degree. In this case, the first two years of study would include 12 or more advanced graduate courses. Thus, the initial years of postgraduate study would be equivalent to a master's degree. By comparison, in Japan, it is usual to divide the postgraduate study into distinct coursework (MSc) and research sections (PhD). This is called the 4+2+3 system, which is therefore nearly identical to that in USA and Latin America. It is simplest to regard these countries as having just one interchangeable system. In China there is currently a 4+3+3 system - due to an industrial training component in the MSc. degree. A unique feature of Japanese research degrees, is that they often take place in industrial laboratories.

The situation is more variable in Europe. The largest grouping of similar tertiary systems includes the German-speaking countries, the former Soviet Union (FSU) and Eastern Europe, all with roughly comparable tertiary education systems. Here, there is a 5 or 6 year undergraduate degree, usually called the Diplom. This is similar in standard to the 6 year master's degree in Japan or the USA, but typically includes a research thesis. Some Russian universities are likely to eventually change to the US system, in line with other recent changes in the FSU. Thus, all these leading industrial nations have very similar overall tertiary education standards. In Diplom granting countries, there is also a further qualification, the Habilitation. This is a postdoctoral research thesis, which
Comparative international degree structures in science.

might take a further two years, and is equivalent to international requirements of research experience for a University position. On average, this can be called a 6+3+2 system, with a higher final qualification than elsewhere.

Clearly, the principal Asia-Pacific degree standards are becoming increasingly important to Australasian students. Not only is our trade mostly in the Asia-Pacific, but employment and student exchange occurs mostly with the major industrial and educational groupings listed above. It seems highly likely that international exchanges of this type would be expedited if the educational systems were closely comparable.

Of the other major international tertiary systems, there is little doubt that the US-Japan system is the most influential and successful. Quantitative measure of quality are notoriously misleading, so there is little point in quoting statistics on citations, publications, industrial output, patents, or student numbers. These all favour the USA-Japan system, but this could be attributed to other factors. However, the Nobel prizes for several decades now, are a very strong indicator that the USA system is able to produce researchers of the highest international standards. Similarly, the figures on industrial output and international trading competitiveness, indicate the strength of the East Asian economies that use the Japanese variant of this system.

We see that the international systems of tertiary education in the Asia-Pacific all very similar. The first degree takes at least four years of study, with an emphasis on breadth of knowledge, rather than specialised study in just one Department. This is followed, for advancing students, by more focussed course work in professional areas - together with project work. Training at this level is often directed towards direct employment in high-technology industry. Entrance to a PhD program usually comes only after six years of tertiary education.

Comparisons with Australia

Australasia is almost unique in the Asia-Pacific, in that most Universities offer a 3+1+3 system of tertiary education in science. In this system, a highly specialised three year first degree is followed by a one-year honours course or postgraduate diploma. This is the highest level of course-work generally available, and can be followed directly by enrolment for research thesis work, usually towards a PhD degree. This system was adopted from the UK some time in the 1960's. It is currently used only in British colonies or ex-colonies. In New Zealand there is a mixture of systems, with some Departments just offering more international-style two-year MSc degrees, in a 3+2+3 system, without providing the UK style BSc (Honours) course.

Even if the UK-based honours system was educationally desirable, it is not a current international standard. There appears to be no universal movement to adopt the UK system. A chart showing the comparisons between international tertiary systems is shown above.
The much shorter degree structure in Australasia is clear, from the chart above. Given excellent facilities, a very selective intake, and high staffing levels, shorter degrees could be acceptable. Even so, it would not be easy to keep the standards high, over the whole course structure. Great benefits accrue from longer first degrees in the sciences, which typically allows a broader education in mathematics, computation and communication skills. The additional 12 months or more of highly intensive graduate courses in the USA-China-Japan system, have educational benefits also. Students can focus on advanced topics, since they start with more complete understanding of the fundamentals. Longer graduate courses are also more viable in terms of specialised industry training in technology, engineering and science.

**Recommendations**

The final results of Australasian PhD theses have generally reached or exceeded the required international levels of competence. In fact, many have reached exceptionally high standards. However, when they have, other factors are often at work. Foreign students in Australasia have often completed additional courses elsewhere. In other cases, local students find that they must take longer than the standard three years for the thesis. In practically all cases, Australasian PhD graduates are educated more narrowly than current world standards would require. This repeats itself at every stage, in a comparison of Australasian and international degrees.

These problems can only be solved in the earlier years of study, for example, as in the USA-Japan 4+2+3 degree structure. This is the most highly successful degree structure in all the industrialised nations of the Asia-Pacific region. As Australia and New Zealand gradually move towards becoming republics, it would be wise to also remove vestiges of colonialism from the tertiary education system. This seems inevitable at some time in the future. Any previous advantage of compatibility with the 1% of the world’s population living in the UK, now seems very minor, in comparison with the advantages of internationally standard, broadly based tertiary science degrees. It is likely that Australasia would then be more widely attractive to international students – who are mostly from the Asia-Pacific. Local students would also receive a better, more up-to-date education, which is the most important point in the long run.

It is noteworthy that some medical schools in Australia have already started to change away from the UK system. In fact, there are numerous advantages to longer, international-style degrees, many of which are applicable in other areas as well as in science.

- Less specialised first degrees allow much more flexibility later on. This allows incoming students to delay their final choice of specialisation, without omitting an essential course.
- Compared to the German-FSU system, the 4+2+3 degree structure has the advantage that students have more options as to what type, and how much education they desire.
- The larger number of graduate courses that are possible in a two-year postgraduate degree, give students greater professional knowledge than in a one-year honours course.

**NOMINATIONS**

- **The Magnetism Award of the IUPAP Commission on Magnetism**
  The award is made in recognition of outstanding contributions to magnetism with emphasis on recent accomplishments.
  The award is presented at the triennial International Conference on Magnetism, at which the recipient will be invited to give a plenary talk.
  The Award Committee is appointed by the IUPAP Commission on Magnetism. **All members of the scientific community are invited to nominate candidates for the award.** Letter-writing campaigns to support a nomination are not encouraged. Each nomination should contain a full description of an individual’s accomplishments and their impact on the field of magnetism.
  Nominations for the award to be presented at the 1997 International Magnetism Conference in Melbourne, Australia, should be sent before 1 August 1996 to: R. Street, Research Centre for Advanced Mineral and Material Processing, The University of Western Australia, Nedlands WA 6009

- Industry is likely to be more receptive to the master’s degree level of training, as an indication of general problem-solving ability. Multi-disciplinary courses are also possible here.
- For students wanting the more research-oriented career path, a PhD, thesis is an easier task for students with greater preparation than is currently possible with just one honours year.
- Attracting international students would be easier if our degree structures were compatible with the usual international practice, already found in neighbouring Asian-Pacific countries.

Achieving these changes is of course difficult, but not impossible. Degree regulations need to be changed, to require more broadly based four year BSc degrees. It would be highly desirable to restrict courses, so that at most 50% could be taken in one Department. At the moment, students in Australia pay essentially no fees past the fourth year. Thus, it would be helpful to provide fee-exempt admission of qualified students into the new, two-year MSc courses, including both coursework and research. It would also be useful if the major Universities (at least), changed their PhD admission policies to require this more rigorous standard of achievement. Scientific bodies, like the ANZIOP, could help by only accrediting the international four-year type of degree – thus, the old-style three year BSc would no longer be regarded as suitable for professional accreditation. A strong move like this would help motivate Universities throughout Australasia to modernise our increasingly outdated degree programs in science. We owe no less than this standard of education to our students.

In conclusion, it is time to change Australasian tertiary science education from the current 3+1+3 system, to the international 4+2+3 tertiary system.
NASA and the US Department of Energy (DOE) have signed an agreement to fly a major particle physics experiment on the Space Shuttle in 1998 and later on the international Space Station. Samuel C.C. Ting of MIT will lead the experiment's scientific team.

The DOE-sponsored experiment will look for antimatter originating from outside our galaxy and give hints of the mysterious 'dark matter' – as yet undiscovered material that could make up most of the universe. It extends the repertory of spaceborne detection techniques to explore the Universe beyond the stiffer blanket of the Earth's atmosphere. A collaboration of some 37 universities and laboratories in Europe, the US, Russia, China and Taiwan will use the Alpha Magnetic Spectrometer (AMS) – the first large experiment equipped with a magnet ever placed in orbit - to study cosmic particles and nuclei.

Special contributions have come from Bologna, ITEP (Moscow), ETH Zurich, Geneva and Perugia.

Sam Ting, who shared the Nobel Prize in 1976 with Burton Richter for their independent 1974 discoveries of the J/ψ particle, currently leads the large L3 experiment at CERN's LEP electron-positron collider. He described plans for the AMS experiment in his summary talk at this year's major international Lepton-Photon Symposium in Beijing.

The 3-tonne AMS magnetic spectrometer will include a solid-state (silicon) tracker measuring to within 10 microns, supplemented by Cherenkov counters and with strip/scintillator assemblies for triggering.

The detector design ensures that it is as light as possible compatible with its aim of making repeated measurements, while providing a high level of spare capacity (called 'redundancy' by physicists) ensuring that the detector is able to operate unattended in the harsh conditions of outer space. Three levels of triggering are foreseen before passing the data to the on-board computer prior to transmission to earth.

The magnetic material, a special alloy of rare-earth (neodymium), iron and boron, will be supplied by China. Additional space is reserved for a 1-tonne astrophysics detector beneath the magnet for accurate measurements of positrons, antiprotons, nuclei, etc. A major physics objective is the search for nuclei of antimatter, which will show up as oppositely curved tracks.

With naturally-occurring antimatter almost unknown in our narrow experience, conventional Big Bang theories naturally incorporate an 'arrow of time' which ensures that antimatter has long been annihilated and that the resultant Universe is composed of matter alone. However on the intergalactic scale, there could be room for a different picture. The plan is to fly AMS initially as a Space Shuttle payload on the STS90 mission in April 1998. The detector will operate for approximately 100 hours during this mission. This flight will provide data on background sources and verify performance under actual space flight conditions, as well as testing ground control and data communications. Providing a substantial sample of cosmic antiprotons, positrons and high energy gamma rays, this exposure could already provide interesting new cosmic ray and astrophysics data.

The second space flight is scheduled for Space Shuttle mission STS110 in 2001 for installation on the international Space Station as an attached payload. The detector will operate for three years before being returned to Earth on the Shuttle. The first element of the International Space Station is scheduled for launching in November 1997.

As well as considerably increasing our understanding of known intergalactic physics, these new windows on cosmic particles in their natural environment could lead to totally unexpected new insights.

The growth of surface science in the past decade has been intricately linked to both the developments in surface analytical techniques and the increasing applicability of such techniques in a number of different areas. Presently, one of the most versatile surface analytical techniques available is X-ray Photoelectron Spectroscopy (XPS) and its recent extension to include imaging facilities over micron-sized areas. XPS involves irradiating a material surface of interest with soft X-rays of well-defined energy in order to measure, among other things, surface elemental composition and distribution or mapping.

This was the theme of the Australasia-Asia XPS Symposium 1995 held at the Hotel 19 Beach from 14-17 November. Like its predecessor, the first Australia-Germany Surface Science Workshop held exactly four years earlier at the same venue, it successfully examined a wide range of surface research studies from a uniquely regional perspective. The Symposium was again hosted by the UNSW’s Surface Science and Technology Group in the School of Chemistry and was in collaboration with the Research Centre for Electron Spectroscopy and Surface Science at La Trobe University. It was supported by BHP, Physical Electronics (USA), Kratos Analytical (UK), Fisons Instruments (UK), the Royal Australian Chemistry Institute, The Australian Institute of Physics and the UNSW.

As a mark of the success in attracting such strong support and sponsorship, the Symposium found that it did not require any Government support. Over 90 participants (from Australia, New Zealand, China, Japan, India, Singapore, Hong Kong as well as Europe and North America) discussed topics ranging from characterisation of corrosion in steel-reinforced concrete bridges to dosimetry of proteins from artificial tears onto contact lens surfaces.

Symposium Organisers Prof Robert Lamb (UNSW) and Assoc Prof John Liesegang (La Trobe U) said that XPS offered a number of advantages to both the surface scientist and the non-specialist involved in practical materials analysis. Unfortunately, at over half a million dollars for the most basic instrument, they are still a long way from being classed as routine laboratory tools.

The meeting served to highlight the multidisciplinary nature of surface science and the growth and maturity of XPS as the pre-eminent tool in practical surface analysis. With representatives from virtually all university, government and industrial groups involved in surface science laboratories and centres in Australia and leading figures from Japan, it also served as a forum for examining the future of what is an expensive but growing area of science and technology within the region.

Proceedings will be published in Surface and Interface Analysis, a leading international surface science journal published by John Wiley and Sons. The Symposium concluded with competing offers to hold the next such symposium in Japan, Singapore or Hong Kong in 1997.

Robert Lamb, UNSW
John Liesegang, La Trobe University

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**1996 New Year's Resolution**

By the end of 1996 100% of the submissions for publication in the A&NZ Physicist will be electronic, i.e via email.

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**WE NEED** interesting or incredible pictures for the front cover of the ANZ Physicist.

Please send your contribution together with a descriptive caption to the enquiries contact on the contents page of this issue.
PHYSICS EDUCATIONAL SOFTWARE
WWW SITES

MICK POPE

As the information super-cliche marches ever on, it is still a
tenacious that is sometimes all too difficult or time consuming
to navigate. When a physicist has to teach as well as do
research, how do they find time to 'surf' the net for useful
information on other software for their lectures, labs, etc? UniServe Science is a clearinghouse for educational software
in the tertiary sciences, funded by CAUT and the University of
usyd.edu.au/su/SCH/physics.html with a searchable database
of physics software. Searches can be done on subject areas (eg.
Astronomy & Astrophysics, Electricity & Magnetism),
platform, year level and key word. The information provided
includes descriptions, tech specs, supplier details, and reviews
solicited by UniServe Science. To help this resource grow,
UniServe Science would appreciate reviews on software you use.
The webpage also includes pointers to other sites. These
pointers contain remarks about content and how quickly the
pages download. These sites include software/resources for
download, commercial distributors and physics education
research groups. Recommend sites are marked as 'hot'.

The Physics Academic Software site at http://www.aip.org/
pas/pashome.html includes a catalogue of all the items with
detailed descriptions and a small image of what the screen
looks like. Many of the packages on this site are award
winners. There is also a downloadable demo of three of the
programs, mirrored at http://www.usyd.edu.au/su/SCH/
physics/pas/demo.zip.

Another commercial site is that of the Consortium for Upper
gmu.edu/~cups/Welcome.html. This site has a graphics and
text version, and includes notes on each simulation in each
package. These packages are very good, so the site is worth
looking at.

As time goes on more reviews of CUPS programs will be
added to the UniServe Science database. Another interesting
site is that of the Computers in Teaching Initiative (CTI)
Centre for Physics at http://www.ph.surrey.ac.uk/ctl/
home.html.

The UniServe project is based on the CTI project, however
there are six CTIs for the areas that UniServe Science covers.
CTI Physics has been running for a number of years, and so
has reviewed a number of packages in their newsletter at
http://www.ph.surrey.ac.uk/ctl/news/cov.html. They also
have a catalogue, but the items included are also to be found in
the searchable UniServe Science database, with Australian
suppliers where possible.

Yet another site of note is the Computers in Physics magazine

This magazine is of more general interest to physicists as it
includes articles about research as well as educational tools.
The page provides information on how to submit an article,
software listings, source code of programs that have featured
in past issues, and how to enter the software contest that they
hold each year. Developers of software note, this is a good way
to get peer review.

The Web contains some useful information, which I have tried
to collect. I am always on the lookout for good sites to add, so
drop me a line. AWP

Mick Pope can be contacted via email
PhySciCH@extro.ucc.oz.au

1996 CRC Guided Wave
Optics Meeting

The annual CRC Guided Wave Optics Meeting is
being held at the ANU, Canberra from the evening
of Wednesday 10th July to mid-afternoon on Friday
12th July 1996. These dates have been chosen to
precede the IQEC conference in Sydney, which
commences on Sunday 14th July, in order to
facilitate attendance at both meetings.
The deadline for 1-page abstracts for papers or
posters is Friday 31st May. Registration,
accommodation arrangements, cost and other
details will be sent out towards the end of April.

For details contact:
Helen McMartin, Administrator
Australian Photonics Cooperative Research Centre,
RSPhysSE, ANU, Canberra ACT 0200.
Tel 61 6 249 0693, fax 61 6 249 0029
email hjm111@rsphysse.anu.edu.au
New Products from Bubble Technology

Bubble Technology Industries Inc of Chalk River, Canada, serves customers in health physics and radiation protection, offering solutions based on novel technology and high quality service. BTI manufactures personal neutron detectors and dosimeters and offers expert radiation measurement services. BTI have recently released two new products in Australia and New Zealand.

**Microspec-2**

is a portable spectroscopic system that provides both dose and dose rate, together with spectral information and isotope ID, all at the touch of a key. This instrument comes with a choice of gamma and X-ray probes, as well as the first commercial beta system with spectroscopic/dose modes. Typical applications for the Microspec-2 include radiological accidents/spills response, general environmental monitoring, decommissioning and decontamination of nuclear laboratories/facilities, commission/contamination monitoring at nuclear generating stations, waste analysis and accelerator target analysis and shielding verification.

**Neutron Bubble Detectors**

are reusable, integrating, passive dosimeters that allow instant, visible detection of neutron radiation. Each detector consists of an elastic polymer throughout which droplets of superheated liquid have been dispersed. When these droplets are struck by neutrons they form small gas bubbles that remain fixed in the polymer to provide a real-time, immediately visible record of the dose. Bubble detectors are available at various sensitivity levels, with or without temperature compensation, and responsive to a range of energies. Automatic bubble counting systems are also available. Applications include neutron dosimetry at nuclear generating stations and research laboratories, accelerator/general shielding verification and high altitude/space neutron dosimetry.

*For information on these products and services please contact.*
Roger Alsop
Roger Alsop Consulting
PO Box 255
Gordon NSW 2072
Tel (02) 878 5300, fax (02) 878 4854

**Plasma & Vacuum Deposition Systems Monitoring**

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A full spectrum is acquired every 80 ms over the UV-VIS-NIR wavelength range using a spinning diffraction grating and a range of detectors. The spectrum may be displayed fully or selected multi-wavelengths can be captured. The system can be used in transmission, specular/diffuse reflection and thin film measurement modes. Background subtraction, peak library database and time plots can be used for controlling the process.

For further information contact:
Rofin Australia Pty Ltd
442-44 Garden Boulevard
Dingley Vic 3172
Tel (03) 558 0344, fax 558 0252

**Oscilloscope Catalogue**

Wavecom Instruments has available a free book entitled *The XYZ's of Oscilloscope* from Tektronix giving information related to Analog and Digital Oscilloscopes.

The 56 page book looks at the basics of Analog and Digital Oscilloscopes including: How does an Oscilloscope Work, Types of Waves, Waveform Measurements, Performance Terms, Setting up the Oscilloscopes as well as Written Exercises and Answers.

For more information contact
Con Kondis
Wavecom Instruments Pty Ltd
45 Charles Street,
Norwood SA 5067
Tel (08) 331 8892, fax (08) 331 3648
email wavecom@senet.com.au

Mid and Far IR Gas Lasers

Coherent Scientific is the Australian distributor for Edinburgh Instruments, makers of mid- and far-infrared gas lasers. Edinburgh Instruments, now in its third decade, is well known for its tunable infrared gas lasers.

- The MTL-3 mini TEA CO2 laser is a compact laser system with high repetition rates (up to 100Hz) suitable for a variety of scientific and industrial applications.
- The PL series of grating tuned lasers cover the region 5.2 to 6.0 microns and 9.1 to 10.9 microns, with models having CW output powers up to 180W.
- Optically pumped far-Infrared lasers are also available and provide output in the range 40 microns out to 1.2mm.

For more information please contact:
Robert Purvinskis or Narelle Murphy
Coherent Scientific
116 Burbridge Road, Hilton SA 5033
Tel (08) 352 1111, fax (08) 352 2020
coherent@adam.com.au

Fluorescence Lifetime Spectrometer

Coherent Scientific also represents Edinburgh Analytical Instruments, which formed in 1990 and is a leader in the field of time resolved luminescence spectrometers.

The current product line includes the FL900 Spectrofluorimeter system, which can provide fluorescence spectra in the UV, Visible and Infrared regions. The FL900 uses the Time Correlated Single Photon Counting (TCSPC) technique which provides maximum sensitivity, dynamic range and measurement precision. The FL900 can be used with a variety of excitation sources which covers the entire lifetime range from picoseconds to steady state.

Applications for the FL900 include Monomer/Excimer kinetics, amino acid and polymer dynamics.

For more information please contact:
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http://www.adam.com.au~coherent
SURFING THE PHYSICS WEB

DAVID MADISON

There has been an almost-exponential growth of the Internet in recent years. Much of it is due to the popularity of the World Wide Web which makes the Internet easy to use and provides a hypertext user interface which is highly suitable for presenting complex information structures in a simple and intuitive way. Nearly all scientific organisations, including companies, now have a Web presence and we will review some of these sites.

This month’s survey provides a brief review of a number of general interest sites but it is hoped to make this a regular feature and that other readers will contribute reviews of their favourite sites. It is impossible to provide a comprehensive review of all Web sites both because of their rapid growth and the sheer number of sites.

Most societies are now on the Web. The American Institute of Physics home page can be found at \texttt{http://pinet.aip.org/} and it includes membership information and Physics Today previews. The American Physical Society can be found at \texttt{http://aps.org/}. For those interested in science at the grass roots level, the Society For Amateur Scientists, \texttt{http://www.thesphere.com/SAS/} is a research and educational organisation. It is dedicated to helping anyone who has a passion to take part in the great scientific issues of our time.

The World Wide Web Virtual Library can be found at \texttt{http://www.w3.org/hypertext/DataSources/bySubject/Physics/Overview.html} and contains pointers to numerous physics resources, including several electronic publication archives.

There are several specialist materials societies on the Web. The Materials Information Society at \texttt{http://www.asm-intl.org/} which gathers, processes and disseminates technical information. The Materials Research Society can be found at \texttt{http://dms.mrs.org/} and is dedicated to goal-oriented basic and applied research on materials of technological importance.

If you want to visit some laboratories you could try The Laboratory for Atomic and Surface Physics, \texttt{http://bohr.mss.virginia.edu/ep/LASP.html} the Harvard Condensed Matter Theory Group at \texttt{http://cntw.harvard.edu/} or the Niels Bohr Institute, \texttt{http://www.nbi.dk/}. If unusual acoustics is your thing you can try the International Lung Sounds Association at \texttt{http://www.umanitoba.ca/Medicine/Pediatrics/ILSA/index.html}.

Looking for somewhere to spend the Winter? Try \texttt{http://www.techexpo.com/events/cvnts-p1.html}, a calendar of coming technical conferences. Other conference information is available on the Yahoo web index, \texttt{http://www.yahoo.com} under \texttt{http://www.yahoo.com/Science/Physics/Conferences/}.

Those interested in the lighter side of physics can visit \texttt{http://www.brandonu.ca/~johannes/billorights.html} where they will find The Physicists' Bill of Rights by an anonymous author. Physicists are entitled to such inalienable rights as "To take on faith any principle which seems right but cannot be proved".

New Scientist magazine is at \texttt{http://www.newscientist.com/} and there is an unofficial Scientific American site at \texttt{http://www.history.rochester.edu/Scientific_American/}. This site has many articles from 19th century Scientific American issues.

For those interested in history, interesting things about Richard Feynman can be found at \texttt{http://users.aol.com/plank137/feyn.htm}.

Numerous local contributions to the Web also exist. There is a site at \texttt{http://coombs.anu.edu.au/Project/AAS/physics/phys_con.htm} specialising in physics in Australia before 1945 which contains a bibliography and biographical register compiled by RW Home with assistance from PJ Needham. The physics museum at the University of Queensland is online at \texttt{http://www.physics.uq.oz.au:8001/physics_museum/homepage.html}.

Go on a virtual tour. See the famous pitch drop experiment. There are also links to other online museums. There are many excellent physics links at \texttt{http://www.tp.unm.edu/physics-services/}, and at \texttt{http://www.tp.unm.edu/physics-services/countries/physics_australia.html}.

There is quite a comprehensive list of Australian physics sites. The NSW branch of the AIP is at \texttt{http://www.physics.usyd.edu.au/aiap/index.html}. There are many other worthy and interesting Australian sites. This brief review necessarily covers only a small number of sites but visiting them will be an interesting experience and most provide pointers to many other interesting sites. There are millions of sites and it is possible to spend many hours surfing the Web. I wish everyone happy surfing and hope you find something useful.

David Maddison is a Condensed Matter Physicist with an interest in the Internet, currently living in Melbourne.
Prompt Critical

Towards a Defence of the Future of Science

A resurgence of public interest in pseudoscience, from creationism and UFO research to crackpot concepts like iridology, is seen by most scientists of my acquaintance as silly but harmless. Few recognize the phenomenon as a threat to their own research. Yet the burgeoning public belief in dull new-age notions and the flawed nostrums of alternative science is part of a potent anti-sciencism movement reasserting its dismal influence within western society.

Not so long ago I discussed, and dismissed, two books of a blatantly anti-scientific cast. They represent a print genre proliferating like a pestilence to satisfy the demands of a scientifically illiterate readership out there.

At last a fresh defence of real science has arrived to give the reading public a positive insight into the power for good of real science, when practised with integrity. It is Facing the Future by science writer Michael Allaby, who roundly debunks as nonsense the myths and fantasies served up by the partisan troops of anti-science and convincingly exposes their intellectually dishonest tactics. He refutes the pessimistic proposition that science as we understand it has run its course and is in terminal decline. Allaby argues instead for optimism: the essential optimism of a true scientist which is sorely needed in these uncertain times. Hence the success of anti-science must be resisted, and, to quote his words, “Unless they are challenged vigorously, the pessimists who rejoice in their predictions of the apocalypse may prove themselves right.” And to quote him again, in discussing C P Snow's two cultures, “...the triumph of the anti-science branch of our culture threatens to close our minds and foreclose all our most hopeful options for the future.”

The message is clear. Scientists and their institutions must act to combat the surge of anti-intellectualism pervading our society. Allaby exposes the minefields of misinformation and their fashionable drive, demonstrating with facts and reasoned argument the absurdity of their polemic. Unfortunately the general public prefers anecdote to fact, simple assertion to reasoned argument. As H L Mencken once explained the success of creationism: “...the cosmogony of Genesis is so simple that even a yokel can grasp it.” The average person prefers simplicity. The depth and subtlety of science frightens and confuses. Science education has never been more crucial to our civilisation.

These problems are addressed in a more academic tone in another challenging book Science and Anti-Science by Harvard Professor Gerald Holton. Not as case-specific as Allaby, Holton traces the development of differing world-views in science, taking Ernst Mach’s attack on metaphysical tendencies in science as an opening to discussion of an older, deeper rooted dichotomy. However, in their differing articulations, their conclusions are identical: better education of everyone professing to be civilized.

Holton concludes by identifying three levels of intervention to overcoming the problem of scientific illiteracy. First, most effective but most difficult: a sound educational system inculcating “from an early age on, a modern world-view that will preempt the attractions of its opposite.” Second, less likely to succeed: massive and persistent adult-education rather like the English Open University. Third, even less likely to succeed but easiest of all in principle: “widely visible exposure of the failure of claims of parascience and persistent action to prevent its formal acceptance into schooling systems.” This latter level is about where we are at in Australia, with the Australian Skeptics organisation putting up the strongest attack. Rather it should be our Academies of Science and Engineering taking on this role.

The two books are highly interesting and informative. Both contain extensive reference lists. They are Facing the Future by Michael Allaby, published in 1995 by Bloomsbury; 280 pages in hardcovers at AS59.95 (ISBN 0-7475-2066-6) and Science and Anti-Science by Gerald Holton, published in 1993 by Harvard University Press; a 203-page quality paperback at AS28.50 (ISBN 0-674-79299-8). To any scientist worrying and caring about the future of science they are highly illuminating. To those of our profession who are unperturbed, they are essential reading.

Colin Keay
Reviews Editor

Material for Reviews Should be Handled in the Following Manner

Email your review as a plain ascii file without embedded codes (not in "LaTex" format) to:
phcik@cc.newcastle.edu.au

Also snail-mail a paper copy to:
Dr Colin Keay
Reviews Editor
Physics Department
University of Newcastle
Callaghan NSW 2308

The snail-mail copy is essential for proof-reading, to ensure accurate mathematical formulæ and correct punctuation.

Reviews

Polarization Spectroscopy of Ionised Gases

SA Kazantsev & JC Hénoux
Kluwer Academic Publishers
Dordrecht 1995
214pp. US$114.00 (hardcover)
ISBN 0 7923 3474 4

This book describes remote sensing applications in laboratory and astrophysical plasmas of measurements of the degree of polarization of spectral line emissions under conditions of anisotropic excitation or relaxation processes. It draws attention to the special diagnostic capabilities of the new method applying especially to unmagnetized dc and high-frequency discharges.

The book represents an impressive body of experimental work strongly supported by difficult and involved theory that couples both quantum and plasma physical behaviour. The underlying quantum mechanical framework is established in a concise but terse opening chapter. The quadrupole moments of the anisotropic plasma excitation and relaxation tensors (due to electron impact, radiation self-absorption, ion-ion collisions etc.) are linked to the equivalent moments of the resulting atomic density matrix and thence, via dipole transitions, to the associated photon polarisation density matrix and the Stokes components of the observed line radiation. A firm grasp of the opening chapter is crucial to an understanding of all that follows. For the non-expert, this will require considerable effort and resort to additional reference works. ▲
Plasma parameters inferred from polarisation measurements, including internal electric field, momentum transport and energy deposition profiles, show good agreement with estimates using other methods. While the experimental methods described in the second chapter are reasonably straightforward, the spectropolarimetric measurements, however, require to be interpreted using complex theory combined with accurate kinetic modelling of excitation processes (to estimate quadrupole moments) and reliable estimates of excitation and depolarization collision cross-sections.

Technically, the book suffers occasional notational inaccuracies, while the figures are sometimes of low quality and poorly labelled. The book cites numerically over 100 references though these are not numbered in the bibliography. This is definitely a book for specialist practitioners and those wanting a detailed and comprehensive insight into this promising but difficult area of plasma diagnostics.

John Howard
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Complex General Relativity
G Esposito
Kluwer Academic Publishers
Dordrecht 1995
xii + 201pp., US$96.00 (hardcover)
ISBN 0 7923 3340 3

Spinor calculus has been applied to a wide variety of problems in general relativity since the pioneering work of Roger Penrose in the late 1960s. It allows a particularly elegant reformulation of the classical theory, and is vital for an understanding of the mechanics of advanced geometry. Nonetheless, it is probably fair to say that spinor techniques remain unfamiliar to the vast majority of relativists, in part because of the difficulty of using them to perform explicit calculations.

In Complex General Relativity, Giampiero Esposito has attempted to make spinor theory and its most recent applications in areas allied to general relativity accessible to postgraduate and other research workers in theoretical physics. The book is well organised and admirably concise. It is divided into nine chapters on topics as diverse as conformal gravity, twistor theory, anti-self-dual space-times, torsion, and the Dirac and Rarita-Schwinger potentials. Each chapter is prefaced by an abstract, and Esposito makes a considerable effort to place the material in context and justify its inclusion. He even provides a list of problems for the more ambitious reader.

Overall, Complex General Relativity would make an excellent foundation for a graduate reading course in spinor theory, and also a useful reference work. That being said, however, only the first three chapters are really of interest to the general reader. The reasons adduced for wanting to study complex space-times or space-times with torsion are not very convincing, while twistor theory seems unlikely to ever fulfill its early promise of leading to a workable quantum gravity. I would therefore hesitate to recommend the book, although exemplary, to anyone who does not intend to specialise in the area.

Malcolm Anderson
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Edith Cowan University

Introduction to Plasma Physics
RJ Goldston & PH Rutherford
Institute of Physics (IOP) Publishing
Bristol/Philadelphia 1995
xvi + 491pp., £29.50 (hardback)
ISBN 0 7503 0183 X

This excellent book comprehensively addresses plasmas in six units: single particle motion, the fluid model, collisional processes waves, instabilities and kinetic theory. A feature of the text is that topics are covered which are not normally presented in introductory books on plasmas. The particle motion unit includes an account of the conservation of the second adiabatic invariant (J) and concludes using non-conserving orbits to introduce Hamiltonian mapping. The velocity space instabilities and nonlinear/quasilinear treatments in the kinetic theory unit are also pleasing to see. Other features are the logical structure and clarity, eg the insightful treatment of the cold plasma dispersion relation. It is also commendable that a student text presents the key aspects of both fusion plasma and space/magnetospheric wave particle interaction processes equally well.

Two worthwhile working graphics programs accompany the text. The first acquaints one with the mapping of particle trajectories in dynamical systems. The second allows experimentation with the cold plasma dispersion relation.

There may be concerns about its use as an introductory text since it assumes thorough familiarity with Maxwell’s equations and tensors and generally provides insufficient diagrams showing the geometry of interrelated vector quantities. Nonetheless, the book is extremely well written and error free and should become widely used as the basis of future courses in plasma physics.

HJ Hansen
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The Principia In Its Fourth Century:
Newton’s Principia for the Common Reader
S Chandrasekhar
Oxford University Press, Oxford 1995
xix + 594pp., AS180.00 (hardcover)
ISBN 0 19 85174 0

Force and Geometry in Newton’s Principia
Francois de Gandt
(Translated by Curtis Wilson)
Princeton University Press
Princeton NJ 1995
xvi + 296pp., AS49.50 (hardcover)
ISBN 0 691 03367 6

The Principia is hard to read. It always was, Roger Cotes, who worked for four years on the second edition of the Principia and tended to take his work too seriously, was towards the end advised by Newton himself not to go to “the trouble of examining all the Demonstrations in the Principia”. For other draughtsman Newton’s advice was: “It is easy enough if one carefully reads the definitions, the laws of motion, and the first three sections of Book I, then passes to this book [Book III] concerning the system of the world, and consults at pleasure such of the remaining propositions of the first two books as are cited here”. Since then readers have known that in a pursuit such as this pleasure often embraces pain.

The two books here are rather different ways of coming to terms with this and introducing the reader to an appreciation of the Principia in its own terms.

Chandrasekhar’s primary purpose is to give an account of those parts of the Principia that are directly related to Newton’s sequential development of his mathematical theory of gravity. He basically follows Newton’s advice and restricts himself to Books I and III, omitting only Sections IV and V (on theorems in analytical geometry of conic sections) and Section X (on motions on surfaces and on the oscillations of ‘pendulous’ bodies). But Book II is not entirely neglected. In the Miscellanea he presents Lemma III and Propositions XV-XVIII of Section IV.

Australian & New Zealand Physicist Volume 33, Number 4, April 1996
on the circular motion of bodies in resisting mediums, Proposition XV of relevance to the motion of present day artificial satellites as they descend towards the Earth, Propositions XXI-XL on the propagation of sound in elastic mediums, and the first eleven propositions of the Calculus of Variations and Euler-Lagrange equations and the associated Brachistochrone problem (where, upon seeing a brief anonymously published solution of this problem, Johann Bernoulli recognised the author 'by his style even as the lion by its paw').

The 'common reader' of Chandrasekhar's imagination is defined on the opening page by a quotation from Dr Samuel Johnson as one 'uncorrupted by literary prejudices, after all the refinements of subtlety and the dogmatism of learning' who must in the end generally decide 'all claims to poetical honours'. This is rather ironical - for who among us working physicists could hope to qualify? The very mode of our existence as physicists has been conditioned by the prior existence and dissemination of the ideas contained in the Principia. But Chandrasekhar does have some such audience in mind. His method is to analyse the propositions and theorems and use his own proofs for the new mathematics based on calculus and vectors. This is then followed by a description of Newton's geometrical proofs. The idea is that "with the impediments of language and syntax thus eliminated, the physical insight and mathematical craftsmanship that inevitably illuminate Newton's proofs come sharply into focus.'

What we get therefore is a major reworking of a large part of the Principia in modern terms. Most of the references tend to be to standard textbooks and preference for the more recent ones. One looks at the Principia more in terms of what it engendered rather than in terms of its antecedents, although Chandrasekhar does allow that some acquaintance with its antecedents of less than two years' is essential and provides a sketch of these in the first chapter. So, even though we have some long quotations from the text with detailed annotations, this is rather far from traditional Newtonian scholarship. On the other hand, Chandrasekhar is a forceful guide, commenting on the originality, the style and the importance of the arguments and the results - in the text and in variously placed paragraphs entitled personal reflection(s).

So, how does all this make the Principia accessible to the common reader? It does so in the same way as modern technology makes Mount Everest more accessible. You have your oxygen bottle and other aids. Your attention will be drawn to selected vantage points. You have a high probability of getting there and coming back with things to say and show. You may even breathe the mountain air as the guide allows. But the mountain is high and has other aspects to offer and to actually get used to the air and the terrain is a different experience. Our second book takes us into this other aspect of things.

There is a long standing tradition starting from Laplace and d'Alembert, with some anonymous help from Newton himself, that the results of the Principia were first discovered by the methods of calculus or fluxions. Chandrasekhar simply says that he does not believe in this legend. De Gandt on the other hand takes his time over this, pointing out the contrary evidence from papers and manuscripts and from the internal structure of arguments in the Principia. This illustrates the different disposition of attention and detail between the two books.

De Gandt's book is about conceptual history in the context of the ferment of ideas in the seventeenth century which involved not just Kepler, Galileo and Huygens but many others like Torricelli, Descartes etc. Geometrisation of force is a very felicitous choice for the theme. This is the core of the great advance. It is already accomplished in the little precursor treatise De motu composed by Newton for Halley. In Chapter I we are given a discussion on De motu along with a translation and commentary. Chapter II deals with the context and Chapter III entitled Mathematical Methods deals with the conceptual intertwining of the ideas of geometry, calculus and dynamics. The conclusion by itself is a valuable essay on the role of mathematics in the new natural philosophy contained in the Principia.

De Gandt carefully defines the position of his work in the corpus of Newtonian scholarship. The translation from the original French by Curtis Wilson is a seamless delight to read. As Wilson says in his preface we have here "a deep original meditation on the sources and meaning of Newton's Principia' - in the best sense of the words.

To sum up, in the first place, both books would be good to have in the library. You might even find some suitable student assignment out of Chandrasekhar. But in view of its price, do have a careful look before ordering your own copy. It is extraordinary that a book of this size and scope has not been provided with an index or bibliography. The quotations are set in the same type as the rest of the text without quotation marks. This often causes confusion in spite of the fact that the quotations are indented. Diagrams are not numbered nor are the original diagrams from the Principia distinguished from the recent additions.

There are no such reservations regarding De Gandt's book. It is well priced. You can read it in bed, and follow the references or meditate with it - at pleasure.

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Quantum Mechanics
F Schwabl
Springer-Verlag, Berlin 1995
416 pp., DM58 (paperback)
ISBN 3 540 59187 7

This is the second revised edition of the English translation of the book "Quantenmechanik" by Franz Schwabl; a text that is the outgrowth of his lecture series for students at the Universities of Linz and Munich. There are but slight differences between the first (1992) and this, the second, edition primarily with a number of the chapters having one or two problems in the sets with which they end. The most notable difference in fact is that this edition is in paperback and much more affordable than the first.

As stated in the preface, the book treats nonrelativistic quantum mechanics solely and basically in first quantised form. Second quantisation is introduced early in the text as an 'algebraic approach' but is not utilised as the major framework in the studies of diverse bound and scattering properties of quantum systems that follow.

Schwabl assumes that the reader will have had courses in classical mechanics and is familiar with canonical variables, Poisson brackets and the like, and has knowledge of matrix algebra and (standard) differential equations. Furthermore the reader will need to have had courses in electrodynamics so that she/he is familiar with Maxwell's equations and their wave solutions, and that he/she has a basic knowledge of phenomena that vibrate classical physics explanations and of the successes of old quantum theory.

The book is structured into 20 chapters which show their origin as a lecture series. Home of the chapters are quite short reflecting the author's requirement to discuss the material involved in a 2 to 2 hour lecture session. It is the
Advances in Atomic and Molecular Collisions and Spectroscopy

Refereed papers presented at the Australia-USA Advanced Workshop on Atomic and Molecular Physics held at the Australian National University, Canberra, in February 1995

Introduction. Stephen J. Buchman and Erich Weigold 107

Scattering Theory and Structure Calculations

Calculation of electron scattering on atoms and ions. S. A. G. Bray 301

The electron-atom ionisation problem. J. R. McCarthy 219

Summation of the dominating diagrams in many-body perturbation theory.

V. A. Drisko, Y. V. Flambaum and W. A. King 231

Ab initio calculations on excited molecular ions of ethylene and acetylene.

R. R. Davidson and Y. A. Wang 247

Electronic structure from polarized neutron diffraction. G. S. Chandler,

D. Jagdhuber and S. K. Wolfe 361

Cross-scattering formalism for electron/positron-atom systems and

underlying scattering theory. Andrzej T. Stehliska and Lindsay Berys 273

Principal quantum number dependence for electron-hydrogen collisions.


Spin-resolved alignment and orientation effects in atomic collisions.

Klaus Bartels and Nils Andersen 301

Coincidence Studies

Electronic structure information from electron impact ionisation experiments.


Angular and polarisation correlations between cascade photons.

J. H. Wang and J. P. Williams 335

Recent applications of $(e,2e)$ techniques. M. J. Brungard 347


Brian Lohan 385

The triple coincidence detection of the helium $^3P$ state decay.

A. G. Mikeska and J. F. Williams 375

Spin effects in the $(e,2e)$ cross section of xenon. B. Granata, X. Guo,

J. M. Burn, J. Louwer, S. Masevick, J. E. McCarthy, Y. Shen and E. Weigold 383

Molecules, Clusters and Spectroscopy

Dispersive attachment studies of halogen containing molecules: Problems,

applications and challenges. P. D. Burrow, G. A. Gallup, L. I. Pahlsson and

E. D. Jordan 403

Monte Carlo calculations of effective surface tension for small clusters.

Barbara N. Hafe 425

Methoxy and methylide adducts of fullerene-60: Semitheoretic experimental studies.

J. Baros Paol 435

Excited-state structure and dynamics of nitric oxide probed by resonant four-wave mixing techniques. E. P. McCormack, S. T. Paul, P. M. Dehmer and J. L. Deaver 445

Core-hole electronic structure studies on molecules using synchrotron radiation.

Frank P. Leevers 457

Spatially resolved inter-electron interaction of autoionizing states.

J. G. Story, D. I. Danson and T. F. Gallagher 471

Magnetic Studies

Laser assisted collisions of electrons with metal vapours. P. J. O. Truhlar,

P. M. Forrest, V. Kuvarev, M. B. Lepage and V. Babarro 481

New data from laser interrogation of electron-atom collision experiments.

A. T. Masters, R. T. Seong, W. R. McCallum and M. C. Standage 499

Electron collisions with metastable helium. Marcus Jock, Jennifer Kelly,

Brian Lohan and Stephen Buckman 515

Surface Studies

Interaction of highly charged ions with surfaces. Joachim Böngarster,

Carlos Reinhold, Lutta Hopp and Fred Meyer 527

Direct observation of energy-momentum densities in solids. E. Weigold,


Atmospheric Physics

Laser focusing of atoms for nanostructure fabrication. J. J. McClintock,

R. Gupta, J. J. Jacobson and R. J. Cecot 555

Production of ultrahigh density atomic beams using laser cooling. M. D. Hopperland,

D. Miller, W. Liu, R. A. Booker, G. L. H. Falken and S. J. Buckman 567

Multipolarising beams of ultr-cold atoms with a static magnetic field.

W. J. Routledge, D. C. Lee, C. I. Opat, A. I. Sidro, R. J. McLean and P. Hansford 577

Reviews

Lecture origin of this text, that I found appealing as that transcribed into a concise presentation of a broad range of topics. Furthermore there is a careful linkage of those topics so that the reader of this book progresses smoothly from a brief discussion of the historical foundations of quantum mechanics through a well thought out exposition of the elementary concepts and definitions with some quite detailed dimensional examples, to formal theory based upon the Dirac notation and on to the quite diverse set of topics that span most (nonrelativistic) quantum field. Another attractive feature of the text are the concluding chapters in which the theory of measurement, the Bell inequality and supersymmetric quantum mechanics are introduced. The books on quantum mechanics by Schiff and Merzbacher are comparable in their scope with this one of Schwab, albeit that Schwab does not include any chapter on relativistic quantum mechanics. For its clear and concise presentation I find Schwab's book to be the one of the three I would recommend for students to study, and I concur with the observer~tion made by another reviewer of this text namely that "Anyone wishing to develop mathematical skills and deepen their understanding of the technical side of

K. Amos

School of Physics

University of Melbourne

Magnetism in Disorder

T. Hicks

Oxford University Press, Oxford 1995

$xxx + 147pp., AS$80.00 (hardcover)

ISBN 0 19 85101 6

This book is volume eleven in the excellent series of monographs on neutron scattering in condensed matter published by OUP. Having stated at the outset that neutron scattering is the most powerful tool for studies of the magnetic properties of disordered solids, the author goes on to provide a concise and balanced account of why this is so. The discussion ranges from neutron scattering studies of isolated ferromagnetic impurities through ferromagnets and antiferromagnets to spin glasses and amorphous magnetic systems. In doing so the book provides a unique insight into the diversity of properties found in these magnetic systems. This is not a book for the casual reader but rather for the enthusiast as it contains no soft preliminary.
Complex Systems and Binary Networks
R Lopez-Pena, et al (eds)
Springer-Verlag, Berlin, 1995
x + 223pp., 88DM (hardcover)
ISBN 3 540 60339 5
This volume in the series “Lecture Notes in Physics” is one of a very disparate collection of highly mathematical topics. Quoting from the Preface: “A leading figure in Complex Systems once said “Complex Systems are like beauty: You know it when you see it”, but, by way of justification, goes on to quote a remark due to Benoît Mandelbrot: “At an early stage of the development of a subject, a certain vagueness in the definition is advantageous in that it doesn’t limit future paths of evolution.” The titles of the lectures (given in Guanajato, Mexico in 1995) are:

Randomness and Complexity in Pure Mathematics
GI Chaitin
The Berry Paradox
GI Chaitin
Knots and Complex Systems
LH Kaufman
Towards a Theory of Landscapes
PF Studier
Coeasening Phenomena in One Dimension
B Derrida
Cosmology as a problem in Critical Phenomena
I Smolin
Except for the technical usage of the words “Landscape” and “Coeasening”, the titles are more or less self-explanatory – at least for people interested in the topics. But what is the Berry Paradox? No, it is not named after Michael (Geometric Phase) Berry, but after a Mr GG Berry, Oxford Librarian, who suggested it to Bertrand Russell. Consider “the first positive integer that cannot be specified in less than a billion words”
This in itself is, of course, a specification – hence the paradox. In Chaitin’s hands it metamorphoses into: “the first positive integer that can be proved to have the property that it cannot be specified by a computer program with less than N bits” and other delightful ideas concerning complexity (theory, information theory, and incompleteness in the Go’del sense). Tentative conclusion: Mathematics is quasi-empirical – it should be done more like physics is done. Of course we, physicists, knew that all along!

AG Klein
School of Physics
University of Melbourne

The Data Handbook: A Guide to Understanding the Organisation and Visualisation of Technical Data
B Fortner
Springer-Verlag, New York 1995
xviii + 350pp., DM 59(hardcover)
ISBN 0 387 94505 9
If your experiments generate a large amount of data and you want to know what scientific data formats are available to assist in the storage and visualisation of the data, then this book is for you.

Towards a Theory of Landscapes
PF Studier
Coeasening Phenomena in One Dimension
B Derrida
Cosmology as a problem in Critical Phenomena
I Smolin
Except for the technical usage of the words “Landscape” and “Coeasening”, the titles are more or less self-explanatory – at least for people interested in the topics. But what is the Berry Paradox? No, it is not named after Michael (Geometric Phase) Berry, but after a Mr GG Berry, Oxford Librarian, who suggested it to Bertrand Russell. Consider “the first positive integer that cannot be specified in less than a billion words”
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AG Klein
School of Physics
University of Melbourne

Semiconductor Optics
C F Klingshirn
Springer-Verlag, Berlin 1995
xviii + 490pp., DM 79(hardcover)
ISBN 3 540 6312 2
The telephone request to review a book titled Semiconductor Optics triggered expectations of a book analogous to one which might be titled “glass optics”. Klingshirn’s book is more analogous to one which might be titled “crystal optics”. It concentrates, as its stated aim, on the interactions of light with semiconductors and says little about the many devices, and their applications, which are based on the optical phenomena that occur in semiconductors.

The book is an ambitious undertaking as it introduces all the necessary strands of background physics which underpin the optical characteristics of semiconductors in the domains of frequency/wave vector and energy/wave vector. These include relevant parts of electromagnetism, interactions of light and matter, classical mechanics, quantum mechanics, optics, quantum optics and solid state physics. Equations are mostly quoted and concepts are described with very good physical insight. These introductions are necessarily sketches (the 12 background chapters comprise two fifths of the book) but the book is well referenced (with a preference to quote texts of German origin) so the reader has direction to more complete treatments in all topics. This makes the book suitable for inclusion on the reading list in a number of second and third year physics courses as it gives an excellent example of how many different fields of physics need to be drawn on to describe the particular topic of the optics of semiconductors.

One fifth of the book deals with the linear optics of semiconductors and one seventh with the nonlinear optics. There is no attempt to give an overview of the reflection, transmission, luminescence, photoluminescence and absorption spectra of a large range of important semiconductors, subject to various...
external fields, etc. Instead single experimental examples are drawn, mostly from Cds, ZnO, GaAs and GaAlAs, to illustrate the physics being outlined. The discussion of nonlinear optics is quite limited in scope. It is however, the only section in which optical characteristics of the semiconductors as a function of time are discussed in the book. The final two chapters, one on experimental techniques followed by one on the next step in the theory – group theory in semiconductor optics – are useful additions to a book of this type.

The book is written at a level that is accessible to third year students and in parts to second year students. It is a valuable teaching resource because of its format of sketching all the background areas of physics that underpin the main subject of the book. I do not consider it to be suitable for use as a textbook, even at honours level, because it is unlikely any course would deal with this subject in sufficient depth to require such a text, and the format is one that would require the reader to do a good deal of study from other books to gain deep understanding. The book will be of value as an introduction to research on semiconductor optics to researchers new to this area.

Deb Kane
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Macquarie University

Scanning Tunnelling Microscopy and Its Application
C. Bai
Shanghai Scientific Publishers, 1992

This is an interesting book, first because it is based on a translation of the 1992 Chinese edition, secondly because of the high quality of the translation, thirdly for a significant number of typographical errors and finally for the additional material which updates the original publication. The integration of that material into the text provides a coherence which was lacking in the recent second edition of Springer’s books bearing the same title.

The structure of the book is familiar but the lucidity of the chapters on tunneling spectroscopic imaging and STM instrumentation makes this book one to be remembered and well-suitied to any researcher approaching this field of instrumentation for the first time.

Chapter 5 is an informed report on other scanning probe microscopes developed and developing in recent years. Scanning force, lateral force, magnetic force, ion conductance, tunnelling potentiometry, ballistic electron-emission and near-field optical microscopies are covered in detail.

Chapter 6 covers the scanning tunnelling microscopy of geometric and electronic structures in metals and semiconductors, layered compounds, charge density waves and superconducting oxides. The final chapters deal with the tip-surface interaction, surface modification and the manipulation of atoms and clusters, the surface chemistry of adsorbates and the techniques in the application of scanning probe microscopy to biological surfaces and molecules, particularly the structure of DNA.

This is a very impressive introductory text to the expanding field of scanning probe microscopy.

B. Mainsbridge
Magnolia Gardens
Yangchep WA

Advances in Radiation Measurements Applications and Research Needs in Health Physics and Dosimetry
A.I. Walker, P. Pihet, H.G. Menzel (eds)

This volume combines a variety of topics which are currently discussed in the field of radiation measurements. In total, 56 papers cover the dosimetry of photons, electrons, neutrons and charged particles mainly in the context of health physics (radiation protection physics). Particular focus lies on active, electronic devices which allow an immediate dose readout and the discussion of biological concepts of dose on a cellular or sub-cellular level. The former allows a more interactive approach in radiation safety while the latter demonstrates the fascinating possibilities of dosimetry on an increasingly microscopic scale.

As a useful appendix, the publication includes an author index and a list of participants of the workshop with their addresses.

A common feature of proceedings of scientific meetings, as this is, is the somewhat disjointed nature of a compilation of non-related topics. Advances in Radiation Measurements shares this problem. However, it illustrates one important point quite clearly: nowadays it is not sufficient to state just the absorbed dose – radiation quality and target cell population have to be considered and determined to give a biologically meaningful result. As such, the present publication gives a snapshot of health physics at this very moment. It is food for thought for physicists engaged in radiation safety.

Tomas Kron
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Gravitation and Inertia
I. Ciufolini and J.A. Wheeler
Princeton University Press
Princeton NJ 1995
xv + 498 pp., US $49.50 (hardcover)
ISBN 0 691 03323 4

"Gravity is not a foreign and physical force transmitted through space and time. It is a manifestation of the curvature of spacetime... First there was the idea of Riemann that space telling matter how to move must itself – by the principle of action and reaction – be affected by mass. It cannot be an ideal Euclidean perfection standing in high mightiness above the battles of matter and energy,... Second, there was the contention of Ernst Mach... inertia here arises from mass there. Third was that great insight of Einstein that we summarise in the phrase free fall is free float, the equivalence principle... With those three clues vibrating in his head, the magic of the mind opened to Einstein one of mankind’s most precious insights: gravity is a manifestation of spacetime curvature." So begins Gravitation and Inertia by Ignazio Ciufolini and John Archibald Wheeler.

Ciufolini and Wheeler are quick to explain that they use the word ‘inertia’ in the sense of local inertial frames – freely falling reference frames – which in Wheeler’s evocative language is “the grip of spacetime here on mass here”, and so they summarise general relativity as follows: “Inertia here... that is the grip of spacetime here on mass here, is fully defined by the geometry, the curvature, the structure of spacetime here... every bit of momentum-energy, wherever located, makes its influence felt on the geometry of space throughout the whole universe – and felt, thus, on inertia right here.”

“...inertia everywhere and at all times is totally fixed, specified, determined, by the initial distribution of momentum-energy, of mass and mass in motion. The mathematics cries out with all the force at its command that mass there does determine inertia here.”

Australian & New Zealand Physicist Volume 33, Number 4, April 1996
...gravitomagnetism. Such a new name is justified for a new force. This force differs as much from everyday gravity as a magnetic force differs from an electric force. Magnetism...was analysed long after electricity. It took even longer to recognize that an electric charge going round and round in a circuit produces magnetism. Gravitomagnetism...predicted in 1896-1916 but still not brought to the light of day is produced by the motion of a mass around and around in a circle. How amazing that a new force of nature should be enveloping us all and still stand there undetected!

Gravitation and Inertia carries the unmistakable stamp of John Archibald Wheeler. Besides being one of the great physicists of the twentieth century, he is a writer of unmistakable and vivid style. His brilliant and original grasp of English has as its trademark the invention of powerful and compact turns of phrase that make intangible and complex ideas suddenly much simpler.

In addition, the book is set out according to the country parson's formula which Geoff Opat first brought to my attention in a thesis assessment and which I have promoted ever since. The formula is stated as follows: A country parson describes (in an English country accent!) how he gives a sermon: First I tell 'em what I'm going to tell 'em, then I tell 'em. An' finally I tells 'em I told 'em. The formula is most effective for everything: lectures, papers, theses, seminars, reports. The harder it the more repeats you need and Ciufolini and Wheeler go one better. First in a rather plain preface they tell us what they are going to tell us. Then in a beautiful first chapter, carrying all the hallmarks of Wheeler, they tell us the story in plain language: general relativity for poets, and containing a rare little poem by Wheeler. Then they REALLY tell us - five solid chapters containing two parallel tracks: one which senior undergraduates could use and a second advanced track. Finally they tell us what they told us in an extensive summary which again carries Wheeler's mark and which an elaboration on the first chapter, is a pleasure to read in isolation.

In the second chapter Ciufolini and Wheeler take us from the equivalence principle, in its various forms, into a broad survey of geodynamics, the standard form of general relativity. In 60 compact pages we cover Einstein's field equations, their exact solutions, the boundary of a boundary principle, black holes, singularities, gravitational waves and lastly geons. Geons were discovered by Wheeler in the 1950's. They are self confined entities of pure pendulum. Others looked for the effect on gyroscopes, unaware that the magnitude of the effect on earth is about 10^-10 of its rotation rate.

Today several experiments have hopes of observing the earth's gravitomagnetic field. One of these is NASA's Gravity Probe B, the relativity gyro - that jewel of the twentieth century technology developed by Francis Everitt at Stanford. Another is the LAGEOS laser ranging geodesy experiment still awaiting the final satellite, LAGEOS III. The third consists of laser gyro experiments on earth.

I think this book is excellent. It has a superb subject index, author index and extensive glossary of mathematical symbols, a 30 page mathematical appendix and separate index for this appendix. All these practical features make the book an extremely valuable and up-to-date reference work. But it is much more than this. It has inspired me to design a new general relativity course for honours. At the University of Western Australia Ian McArthur and I plan to use it with the new edition of Ohanian and Ruffini's Gravitation and Spacetime for a new honours course in 1996.

I recommend this book most highly. If it is not in your library, order it. At a time when gravitational physics is becoming an exciting experimental field full of promise, this book will certainly help to deepen the understanding of general relativity by the whole physics community.

David G Blair
Department of Physics
University of Western Australia

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Neural Networks:
An Introduction
Second Edition
B Muller, J Reinhardt & MT Strickland
Springer-Verlag, Berlin 1995
xx + 329pp plus disk, DM58
(softcover)
ISBN 3 540 60207 0

This is an updated and somewhat expanded version of the first (1990) edition. The field of neural networks has continued to expand rapidly and this new edition does not attempt to give a comprehensive coverage of everything that has happened in the meantime.

It has new sections on genetic algorithms and on recurrent nets, and has an updated and expanded section on applications.

The book is in three sections. The first gives a comprehensive coverage...
of neural networks, striking a good balance between broad overview and detailed analysis.

Inevitably, some topics are covered rather briefly (eg Kohonen feature maps) and the reader wanting to come to grips with the topic would have to seek further, but here the really good list of references gives the necessary guidance.

The second section gives a comprehensive account of the statistical mechanics approach to associative memory networks, based mainly on the analysis of Amit and co-workers and of Gardner on the model popularised by Hopfield. The enthusiasm for this approach has waned somewhat from the days of the first edition, and this is perhaps reflected in the fact that no changes have been made to this section. The early promise of this approach has only partially been fulfilled, with the basic network showing several limitations both as an artificial memory storage device and as a reflection of biological reality. Nevertheless, the fact remains that this was the first rigorous treatment of highly connected networks and at least a partial understanding of the techniques and results is necessary for anyone who wants to pursue research in this field. But be warned that the material is far from easy: a background in statistical mechanics (and preferably lattice systems) is a prerequisite.

The third section is a description of a selection of computer programs which are provided on an accompanying disk. This is where this book attains a definite advantage over comparable texts (and the now "elastic" text by Hertz, Krogh, and Palmer comes immediately to mind). The great resurgence in neural networks over the past decade has been in no small part due to the availability of considerable computing power to almost every graduate student and researcher. Computer simulation has proved necessary both for the understanding of network behaviour and for the guiding and testing of theoretical advances. The supplied programs, which run on an IBM-compatible PC, give a good coverage of the basic networks; they are easy to run, have a good graphics interface, and the text provides a good amount of background to make their operation comprehensible. A further plus is that there are some ready (in C++) are provided, so the reader can use these programs as the basis for modifications and extensions to others.

Thus the two outer sections of the book, with the accompanying disk, can be recommended as a good introduction to the field. The extensive set of references enables further exploration of special topics, and the central section gives as clear account as one is likely to find of the rigorous statistical-mechanical treatment of memory networks.

WG Gibson
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Sydney University

The Light Element Abundances
P Crane (ed)
Springer-Verlag, Berlin 1995
xvi + 432pp., DM48 (hardcover)
ISBN 3 540 58978 3

In 1983, DW Schramm said that “Standard Big Bang nucleosynthesis (BBN) is a triumph for cosmology.” Indeed, it is widely held that the success of BBN in predicting the relative abundance of the lightest elements is the most compelling evidence that the universe began with a hot big bang. BBN has also limited the number of neutrino flavours to 3, years before this was confirmed by experiment, and predicts that the baryon to closure density ratio is in the range 0.01 to 0.04.

The text is well structured compared with most conference proceedings. The opening sections will be of most general interest to graduate students in physics as they deal with light elements in the early universe, at high redshift (primarily towards QSOs), and during galaxy/stellar evolution.

Work in these areas has intensified since 1990 with the advent of space-borne and large aperture, ground-based observatories.

A large part of this text is given over to bringing BBN up to date, with due reference to recent observational and theoretical work. Useful reviews are given by Aubouze, Stelgas, and Schramm, with an alternative view by Hoyle and colleagues.

Major developments are high resolution observations with the Keck 10m telescope (optical; eg Boesgaard, Soderblom) and the Hubble Space Telescope (ultraviolet; eg Jakobsen, Linsky), results of ESO Key Programs, and from long-term mid-size telescope campaigns (eg systematic surveys of ultra-metal poor stars; Ryan, Beers). These facilities came into operation during the current decade but already there is clear evidence of D and He, in addition to H, at high redshift, and evidence for rapid metal production in the redshift range 2-3. These observations have profound consequences for parallel fields, in particular, deep searches for galaxies at high redshift.

The celebrated B3FH paper showed how elements heavier than Boron were produced by nucleosynthesis in stars. Sections IV-VIII deal with the specifics of measuring the important elements D, He, Li, Be and B, particularly towards individual stars, stellar groups, and in nearby galaxies. The observed abundance gradients in galaxies has encouraged a wide industry which attempts to explain how galaxies formed in the early universe. A good starting point is the review by Pagel, which shows a different emphasis from Schramm.

The book could have done with a Conference Summary which described in the main general terms where the subject is going, either technically or conceptually. There was no discussion of Solar System abundance measurements, ROSAT/Ginga observations of Fe lines in hot cluster gas, or the consequences of recent detections of molecules at high redshift. But, after all, this is a conventional text of a specialized subset of astrophysics, and will no doubt serve students in the field well.

Joss Bland-Hawthorn
Anglo-Australian Observatory

New Books

Self-Dual Chern-Simons Theories
G Dunne
Springer-Verlag, Berlin 1995
x + 271pp., DM62 (hardcover)
ISBN 3 540 60257 7

Complex Systems and Binary Networks
R Kopez-Pena et al (eds)
Springer-Verlag, Berlin 1995
xii + 223pp., DM88 (hardcover)
ISBN 3 540 60339 5

CD Physics for Windows
D Hailiday, H Resnick & J Walker
John Wiley & Sons, New York 1995
vi + 558pp., + CD ROM
A$127.95 (paperback)
ISBN 0-471-59123-8

Waves and Optics Simulations
A Antonelli, et al
(Consortium for Upper-Level Physics Software)
John Wiley & Sons, New York 1995
xiii + 257pp., + diskette
A$39.95 (paperback)
ISBN 0 471 54887 1

Advanced University Physics
S P Palmer & M S Rogaski
Gordon and Breach, Amsterdam 1996
xix + 876pp., US$39.00 (paperback)
ISBN 2 88449 066 3
CONFERENCES & MEETINGS

1996

June 12 - 28 Research Workshop on Electron Interactions with Atoms and Molecules National Centre for Theoretical Physics, ANU, Canberra
Contact Dr BA Robson, Department of Theoretical Physics, RSPHySSE, ANU, Canberra ACT 0200 Australia. Tel (06) 249 2971, fax (06) 249 4676, email bar105@phys.anu.edu.au

July 1 - 5 Twelfth AIP Congress, University of Tasmania, Hobart. High profile speakers will present papers on the challenges of physics in their areas of expertise. See the conference web page at http://www.utas.edu.au/docs/physics/AIPCongress for additional details.
Contact (accommodation and registration) ApplePhysics 96, Mures Convention Management, Victoria Dock, Hobart TAS Australia 7000. Tel (002) 34 1424, email mures@hba.trumpet.com.au
Contact (scientific program) Prof R Delbourez, Physics department, University of Tasmania, GPO Box 252C, Hobart 7001 Australia.

July 10 - 12 1996 CRC Guided Wave Optics Meeting, ANU, Canberra.
Contact Helen McMartin, Administrator, Australian Photonics Co-operative Research Centre, Research School of Physical Sciences & Engineering, ANU, Canberra ACT 0200 Australia. Tel 61 6 249 0693, fax 61 6 249 0029, email hjm1111@rsphysse.anu.edu.au

July 23 - 27 Fourth Western Pacific Geophysics Meeting (WPGM), Brisbane Convention and Exhibition Centre, Queensland
Contact (General Information) 1996 WPGM Meeting, American Geophysical Union, 2000 Florida Avenue NW, Washington DC 20036 USA. Fax (202) 328 0566, AGU Web Site: http://www.agu.org
Contact (Scientific Program) Prof BJ Frazer, Physics Department, University of Newcastle, NSW 2308. Fax (049) 21 0907, email: pbjff@cc.newcastle.edu.au

Sept 9 - 13 Fifth International Conference on Plasma Surface Engineering Garmish-Partenkirchen, Germany.
Contact George Collins, ANSTO, Materials Division, PMB 1, Menai NSW 2234 Tel (02) 717 3400, fax (02) 543 7179, email gcz@anssto.gov.au

Sponsored by ASPEN (Asian Physics Education Network)
Contact Dr Alex L. Mazzolini, School of Biophysical Sciences, Swinburne University of Technology, Melbourne.
Tel (03) 9214 8866, fax (03) 9819 0856, email amazzolini@swin.edu.au

Nov 11 - 13 SCICOMM 96, The Copland Theatre Complex, University of Melbourne, Australia Hosted by the University of Melbourne and CSIRO, Australia.
Contact Michael Pickford, Contracted Conference Manager Tel (039) 832 400, fax (039) 832 223, email aso@gw.mel.metro.net.au
Conference Home Page http://www.scicomm96.unimelb.edu.au/SCICOMM96/

1997

January 20 - 24 First Asia Pacific EPR/ESR Symposium
Department of Physics & Materials Science, City University of Hong Kong
Co-sponsored by The Croucher Foundation and Lee Hysan Foundation
Contact Professor Czeslaw Rudowicz, Chairman, LOC & IOC, Department of Physics and Materials Science, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon, Hong Kong. Tel (852) 2788-7787, fax (852) 2788-7830, email APSEPR@cityu.edu.hk
THE WALTER BOAS MEDAL

Nominations are invited for the 1996 award of the Walter Boas Medal of the Australian Institute of Physics and should reach the Honorary Secretary not later than May 31st 1996.

The Medal was established in 1984 to promote excellence in research in Physics in Australia and to perpetuate the name of Walter Boas. The award is for physics research carried out in the five years prior to the year of the award, as demonstrated by both published papers and unpublished papers prepared for publication, which should accompany the nomination.

Any AIP member may make nominations or self nominate for the award. Nominees need not be members of the AIP or be Australian citizens but should have been residents of Australia for at least five of the seven years preceding the closing date for nominations. The Medal shall not be awarded more than once to any person.

The award is conditional on the recipient delivering a seminar on the subject of the award at a meeting of the Victorian Branch of the AIP in November 1996. The recipient is also expected to provide a manuscript based on the seminar for publication in the Australian and New Zealand Physicist.

Further details may be obtained from:
The Honorary Secretary
Australian Institute of Physics
1/21 Vale St, North Melbourne VIC 3051
Phone 03 9326 6669 / Fax 03 9328 2670
email aip@ariel.ucs.unimelb.edu.au

Health Effects of Ozone Depletion

Wrest Point Convention Centre
HOBART
9 - 11 September, 1996

In 1989 the Menzies Foundations sponsored the first international conference on "The Ozone Layer and Health". The conference papers discussed stratospheric ozone depletion, increased exposure to ultraviolet radiation due to that depletion, and possible human health consequences.

Since then the results of a considerable body of research on the effects of ultraviolet radiation on health have been published, whilst recent evidence has confirmed that depletion of the ozone layer is continuing.

Consequently, the Menzies foundation is sponsoring a second conference on the theme "The Health Consequences of Ozone Depletion". The conference will again be held in Hobart, since Tasmania is the Australian State most likely to be at risk from increasing levels of ultraviolet radiation.

The objective of the conference is to synthesise what is known about continuing ozone depletion and to provide up to date information on the possible health consequences of exposure to increased levels of ultraviolet radiation.

The conference is planned to include papers from 20 specialists in health, in atmospheric physics and in epidemiology.

Cost per delegate is $300 for the full conference. Early Bird Registration (before 30/4/96) is at the reduced level of $240. This includes morning coffees, lunches and afternoon teas and a complete set of the papers which will be published as a special supplement to the November 1996 edition of Cancer Forum.

For further information please contact:
The Menzies Foundation
210 Clarendon Street
East Melbourne VIC 3002
or fax 03 9417 7049
- Boxcar Averagers
- Lock-in Amplifiers
- Digital Delay Generators
- Photon Counters
- High Voltage Supplies
- Thermocouple Monitors
- Low Noise Amplifiers
- FFT Spectrum Analysers
- Function Generators

Separate the signals from the noise

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