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FRONT COVER
A rare earth magnet levitating above a YB2Cu3O7
superconductor at liquid nitrogen temperature. The "fireworks"
display happened when the glass dish with liquid nitrogen was
placed onto a hot bakelite stand for photographing.
Photograph by Maria Basaglia.

The Australian Physicist, Vol. 24, 1987 - Page 129
President's column

The Australasian "high Tc superconducting industry is gaining momentum like some giant (supercooled?) snowball set in motion on a slope. On May 29 a joint progress/planning meeting at the CSIRO Division of Applied Physics in Sydney was attended by some 120 physicists, bureaucrats and industrial research managers. Four scientists attended from New Zealand, and a team of six spent precious research funds to travel even further - from Western Australia.

During the morning 25 research reports were given. The majority were short, sharp five-minute presentations: a slide or two, a summary of what had been attempted and achieved, no introductory waffle and lots of self-discipline in keeping to schedule. It was particularly effective in transmitting essential information on a common theme.

The unexpectedly large response to the call for papers has also caused some (pleasant?) embarrassment for our Editor, who agreed to my request to publish in the July issue brief reports on research presented at the meeting. We have been forced to split the papers over two issues (July and August) and I apologize to those authors whose work we have had to hold over until August.

The afternoon was devoted to a planning meeting, chaired by the experienced, ever-tactful and courteous Vice Chancellor emeritus and enthusiastic born-again bench physicist, Prof Robert Street. Against the background of a position paper presented on behalf of the Federal Department of Science by its permanent head, Dr Greg Tegart, and focussing on a scheme for national co-ordination of high-Tc research floated by scientists of the host laboratory, the meeting spent two and one-half hours discussing what should be done.

The day was very interesting on several levels. I shall try to put aside my protagonist-self, as a CSIRO physicist, and endeavour to report as an interested, but dispassionate, AIP observer.

The level of scientific enthusiasm for the subject is unabated, while the volume is increasing as more laboratories discover that they too can make and test samples. Almost all of the work reported was fundamental. Work towards applications and devices has either not been done - or was not reported.

At least four levels of Federal bureaucracy, plus state interests, are moving towards chosen strategic positions in a manner that is, at this stage, even less co-ordinated than the research.

Industry is watching closely from the sidelines, perhaps waiting for the emergence of teamwork to guide them in placing their bets, perhaps just sizing up the players.

The majority of the players are running enthusiastically with the ball, but are looking eagerly for a coach/manager to co-ordinate their efforts. A few would like to buy their own ball and play in an exclusive major league.

What transpired? The meeting finally gave implicit endorsement to the suggestion, promoted by the Department of Science and its supporters, that they run a two-day, intensive, invited workshop to produce a plan for national co-ordination of this research. A representative steering committee was elected to advise the Department, and we all went home.

Despite the joint problems of the approach of the end of the financial year and the almost coincidental Federal election, the Department of Science has subsequently moved swiftly to sponsor and organize the workshop for 17-18 July.

This attempt to plan and coordinate physics research on a national scale is a new and very important step. Let us hope it succeeds.

J.G. Collins.

The Australian Physicist, Vol. 24, 1987-Page 130
Editorial

Last week I went to Canberra to attend the National Forum on Publishing in the Natural and Social Sciences held at the CSIRO Headquarters Conference Centre during Friday and Saturday the 29-30th of May. It was organised by Peter Judge, Chairman of the ACT Division of ANZASAC, who had obviously put a great deal of effort into the organisation. The food was excellent!

Earlier in the year, he had distributed a questionnaire to editors asking 45 searching questions about their publication and during the conference he distributed the names of the 142 who replied. He also invited us to participate in a Forum and about 60 people were listed in attendance, but a few more may have been present. It was, therefore, very noticeable that the 11 scientific editors from CSIRO Publishing Division in Melbourne were absent.

After a short opening by Dr M.F. Day, Chairman of the Publications Committee of the Australian Academy of Science, Peter Judge took us through his detailed analysis of the questionnaire. In his introduction he stated that the Forum had its origin in concerns being expressed in the latter half of last year about the viability of "long genre of journals", which we know include the AJP. He hoped that the Forum would help prepare a situation report on the state of publishing in the natural and social sciences, promote an exchange of experiences among editors and publishers, see whether cooperation among societys could be helpful and, if appropriate, use the Forum as a platform from which to contribute to the Government's National Information Policy discussions. The detailed analysis proved of great interest to me and, no doubt, be obtained from him. Some of the questions were still being analysed and I hope that a further report will be issued in due course. Then he raised the point that $7M per year were being spent on these journals and went on to say that this was a considerable sum of money including hidden support by the taxpayer. As I had just spent several boring hours in Sydney Airport, where more than 400 expensive magazines (with foreign currency involvement in printing and production) lined the news-stand, I was able to point out to the Forum that $7M represented the cost of one week-end paper per Australian per year in comparison. This constitutes a pitiful amount spent on the intellectual component of publications, considering that it represents most of the scientific and social journals of this country, and hardly warrants a reduction. Hopefully I have put pay to this absurd argument!

The second part of this session was given by Dr Neil Russell on peer review. He pointed out that most Australian Scientists preferred to publish in overseas journals, as that increased their standing with their peers and thus created a better chance for their promotion. Obviously this subject should be given much attention by those senior physicists who are making the decisions about the AJP. It had become obvious to me that there was a large political component to this meeting!

Fortunately the following papers dealt with more practical topics. Representatives from Blackwell Scientific Publishing and from Cambridge University Press gave very sound information on improving the financial structure of journals. Ms Margaret Davies, the editor of the Proceedings of the Royal Society of South Australia had brought some copies of her very interesting and beautifully presented journal and her talk was followed by Prof. P. Weller (Australian Politics) and Dr Max Lay (Engineering). On Saturday we had a very interesting talk presented by Dr Roger Hooley, who has had a Journal Editorial Management Systems' computer program written for his publication. This has enabled him among other things to keep track of all articles sent to reviewers. He found that with this simplified office management, cost savings were encountered. Also, changing the size of the journal to A4 had substantially reduced the cost of printing for the same number of words. Then much to my surprise Mrs Ruth Inall of the Science Centre Foundation, of which the AJP is a member, said that they offer an editorial service. Mr Trevor Honour's talk (Queensland Department of Primary Industry) described their way of typesetting/printing, which interacts directly with the government printer. Using about 20 typesetting instructions their computer discs can interact directly with the bromide copy machine of this printer who has the interactive computer program. As far as general desktop typesetting is concerned, which can interact with any printer, you will be pleased to hear that The Australian Physicist is in the front line and I have had many requests for copies of our magazine.

All in all the meeting was very useful. It was perhaps just as well that the whole sad story about the scientific publications has now been brought into the open. After all it has been discussed for almost one year. We, Australian Physicists, need a well produced scientific journal. Most of the changes are relatively minor. The change to A4 paper has advantages such as cost saving in printing and provides a far better width for printing long equations. Other important questions to be answered are the number of pages that a professional editor should be able to edit, the appearance of the front cover, the back page and whether the unavoidable filler pages at the back should be used for good quality advertising or for fast letters. The abstract service should include a summary in Japanese, Mandarin, Malay and/or Russian. This way we would be offering a first class, well-viewed physics journal to the whole South East Asian region, no doubt with an ever increasing readership. It would also be highly thought of in academic circles and beat the peer review argument. As there is a very powerful editorial committee attached to the present AJP, I cannot see any reason why these minor problems cannot be solved quickly.

The "delicate discussions" have gone on far too long and if the Academy of Science, a body that I have come to regard as autumnal rather than august, cannot settle the matter then the A.I.P. should turn the discussions into decisions. Losing our scientific publications is scientific suicide.

Trudi Thompson.

Errata: Please note R. Jory not R. Jorey, TAP, page 112. Quentron Advert, ISC FAX No. (02).

* * *

Hard Times in Heaven

From our extra-terrestrial reporter:

The current hard economic times have not only hit research in Australian Universities, but are also being felt in the research branch in Heaven. This has moved no less a person than God himself to put in an application to the Australian Research Grants Scheme in order to eke out dwindling funds. However, after appropriate consideration, His proposal has been knocked back, and, upon making discrete inquiries, has been given three reasons by the referee:

1. It was felt that his best work had been done some time ago;
2. Instead of using the normal publication channels through refereed journals, he had arranged to have his results published in book form;
3. In spite of continuing and persistent efforts, no one else had been able to reproduce his results.

Visiting Lectureships for Basic Science/Bridging Program at the Bandung Institute of Technology, Indonesia.

Expressions of interest are invited from Australian academics in Physics to teach for periods of between 4 to 6 weeks at Institut Teknologi Bandung (ITB) in the latter part of 1987. Further information may be obtained from IDP, Box 2006, Canberra, ACT 2601; or via telephone Dr E. Brash (on 062) 49 7833, or Dr B. Scott (on 02) 20 2417.

The Australian Physicist, Vol. 24, 1987-Page 131
Newton's 'Principia' On the 300th Anniversary of its Publication
J.F. Callow, M.I.E. Aust., Member of the Astronomical Society of W.A.

"Nature and Nature's law lay hid in night. God said 'Let Newton be' and all was light."
Pope

"Nearer the gods no mortal may approach."
Halley

Newton was no saint. This is evident from the way he reacted to criticism, the acrimonious public disputes, and the fact that he concealed from Church authorities his unorthodox religious beliefs. What inspired the authors of the above lines, and many of his contemporaries and followers, to regard him as having divine connections and as being one of the greatest men to have lived was the almost superhuman ability he revealed in the writing of his great book, "The Mathematical Principles of Natural Philosophy", first published in July 1687. It is generally referred to as Newton's 'Principia' because it was written in Latin with the title "Philosophiae Naturalis Principia Mathematica".

Edmund Halley, Secretary of the Royal Society, when announcing in the 'Philosophical Transactions' of the Society the publication of Newton's book said "This incomparable Author, having at length been prevailed upon to appear in publick, has in this treatise given a most notable instance of the extent of the powers of the Mind and has at once shown what are the Principles of Natural Philosophy, and so far derived from them their consequences, that he seems to have exhausted his Argument, and left little to be done by those that succeed him."

Posttery owes a great deal of gratitude to Halley, for not only did he persuade the at first reluctant Newton to prepare his work for publication, he was also responsible for arranging and financing its publication. His tact, forbearance and skill in dealing with the difficult genius Newton and others showed him to be a man of science with rare social accomplishment.

In R.J. Westfall's biography of Newton "Never at Rest" he records that at a Meeting of the Royal Society in January 1684, Halley, Wren and Hooke discussed an inverse square law for gravitational force. This was then the great unanswered question confronting natural philosophy, the derivation of Kepler's laws of planetary motion from principles of dynamics. Hooke claimed he could demonstrate all the laws of celestial motion from the inverse square relation. Halley admitted that his own attempts to do so had failed. Wren was sceptical of Hooke's claim. To encourage investigation he offered a prize of a book worth forty shillings to the one who could bring him a demonstration within two months. Hooke again asserted that he had the demonstration, but he intended to keep it secret until others, by failing to solve the problem, learned how to value it. Nothing was achieved until Halley visited Newton in August.

Abraham de Moivre recorded Newton's recollection of the visit in the following words.

"In 1684 Dr Halley came to visit him in Cambridge, after they had been some time together the Dr. asked him what he thought the Curve would be that would be described by the Sun and Planets supposing the force of attraction towards the Sun to be reciprocal to the square of their distance from it. Sir. Isaac replied immediately that it would be an Ellipsis, the Doctor struck with joy & amazement asked him how he knew it, why saith he I have calculated it, whereupon Dr. Halley asked him for his calculation without any further delay, Sir Isaac looked among his papers but could not find it, but he promised him to renew it, & then to send it him..."

The calculation was not really lost as it has survived among Newton's papers. It may be that Newton was being cautious. If so it was just as well as there is an error in his original work.

Newton completely reworked the problem and extended its scope. In November Halley received a treatise of nine pages with the title "On the Motion of Bodies in Orbit". In it Newton demonstrated that an elliptical orbit entails an inverse square force to one focus. It also showed that an inverse square force entails a conic orbit, which is an ellipse for velocities below a certain limit. From postulated principles it demonstrated Kepler's second and third laws as well and hinted at a general science of dynamics. When Halley received the treatise he realised that it contained an advance in celestial mechanics so immense as to constitute a revolution. He wasted no time in making another trip to Cambridge to confer with Newton.

He found Newton was still working intensely on the problem. He agreed to Halley entering his copy on the Royal Society's register, with the date, for priority purposes but he insisted on reworking and extending the treatise before it was published.

The famous incident of the falling apple in the garden at Newton's family home in Woolthorpe had occurred almost two decades previously. At that time he had found the inverse square relation from Kepler's third law and showed by calculation that such a gravitational force causing the apple to fall to the Earth applied "very nearly" when extended to the orbit of the Moon.

On one occasion during the intervening years Newton had replied to a query from Hooke about the path followed by a body falling freely to the Earth. In the correspondence Newton showed the path of a body falling freely to the centre of the Earth as a spiral. Hooke pointed out that this was wrong. Newton acknowledged his error which he excused on the grounds that he had replied in haste as he was busy with other matters. This was possibly the basis of Hooke's claim, after the publication of the 'Principia', that Newton stole his ideas on gravitation from him.

Prior to Halley's approach in 1684 Newton had published very little. Although he had made many discoveries and advances in natural philosophy he had completed almost nothing and generally preferred to keep his new found knowledge to himself and so avoid arguments. Now, under the stimulus of Hooke and Halley he gave himself up completely to mastering the problem. It seems that he had decided that if he was going to make his ideas public he would do it so thoroughly and well that few would be able to argue with it.

For about two years from August 1684 Newton devoted himself almost exclusively to writing the 'Principia', reducing his social contacts to an absolute minimum. Although he continued to lecture at Cambridge the manuscripts he deposited as lectures were merely drafts of the 'Principia'. Halley also devoted himself to arranging publication, proof reading, liaising with Newton and keeping the peace between Newton and Hooke and others.

One of the puzzling aspects of the 'Principia' is that Newton did not, in the book, use the calculus he had developed. This was largely responsible for the later bitter controversy with Leibnitz over priority for developing the calculus. Many of
Newton's proofs were based on geometrical constructions. As is well known, one of his problems in establishing his theory of gravitation was to show that if every particle of matter in the Earth attracted a body near its surface according to the inverse square law, the effect on it would be just the same as if the mass of the whole Earth was concentrated at its centre. Even Newton was doubtful of this until he found out how to prove it mathematically. Another problem that gave Newton much trouble was the orbits of comets. When he wrote to Halley in mid-1686 he had not solved it. Sometime during the following nine months he was able to develop a method of determining the orbit of a comet, in a plane different from that of the Earth, from three evenly spaced observations. It was Halley's application of this method to the observations of a comet that appeared in 1682 that enabled him to determine its orbit and correctly predict its return in 1758-9. It is of course this comet that has been known ever since as Halley's Comet.

While Newton was by no means unknown among natural philosophers before the publication of the 'Principia' his book took Britain by storm and made him a national celebrity. Almost at once it became the reigning orthodoxy among natural philosophers. On the Continent men like Leibnitz and Huygens were reluctant to accept its concepts and were more critical although they could not refute the solutions to its propositions. All over the western world it did establish Newton as the leading natural philosopher of the age.

Newton's concepts and theories as put forward in his 'Principia' became the basis for the development of classical physics during the eighteenth and nineteenth centuries. Although early in the nineteenth century his corpuscular theory of light was discarded in favour of the wave theory, twentieth century developments, including Einstein's Photons theory have led to a partial return to Newton's theory.

Modern physicists have also rejected Newton's concepts of absolute space and time, and a unique frame of reference at absolute rest, in favour of Einstein's four-dimensional space-time. However the recent measurements of the (absolute?) motion of the Earth relative to the unique frame of reference defined by the isotropic 2.7K micro-wave background radiation may require a further unification of Newton's and Einstein's concepts. It may be that Einstein foresaw this, for Bernard Cohen reported on an interview with Einstein shortly before his death as follows, "Looking back over all of Newton's ideas, Einstein said, he thought Newton's greatest achievement was his recognition of the role of privileged systems. He repeated this statement several times and with great emphasis. This is rather puzzling, I thought to myself, because today we believe that there are no privileged systems, only inertial systems; there is no privileged frame which we can say is privileged in the sense of being fixed in space, or having special properties not possible in other systems...

Newton's solution appeared to Einstein ingenious and necessary in his day. I was reminded of Einstein's statement: 'Newton, you found the only way which, in your age, was just about possible for a man of highest powers of intellect and creativity. The concepts that you created still dominate the way we think in physics although we now know that they must be replaced by others, further removed from the sphere of immediate experience if we want to try for a more profound understanding of the way things are interrelated'."

When the 300th Anniversary of Newton's birth was being celebrated Einstein wrote a verse in German which is still appropriate. It is difficult to translate into English, but Banesh Hoffman gives the following version:

"Look to the Heavens, and learn from them How one should truly honour the Master. The stars in their courses exalt Newton's laws In silence eternal."

Newton's Law of Gravity and the Fifth Force Controversy
Frank D. Stacey, Gary J. Tuck, G. Ian Moore, Steven C. Holding and Barry D. Goodwin,
Physics Department, University of Queensland, Brisbane.

Why Question Newton's Law?
In the early 1970's particle theorists groping for clues to the possible unification of gravity with electromagnetism and the nuclear interactions began to suggest the existence of forces with macroscopic but finite ranges. In the scheme of quantum effects this means interactions mediated by particles, or pseudo-particles, of very small but non-zero masses. By very small we mean of order $10^{-9}$ eV/c$^2$, or $10^{-15}$ of an electron mass. Such an interaction is represented by a Yukawa potential of the form

$$\phi \propto \frac{1}{r} \exp (-r/\lambda)$$

**equation (1)**

which gives the variation of mutual potential energy $\phi$ with separation $r$ of two bodies, where $\lambda$ is referred to as the range of the interaction and is related to the mass $m$ of the exchanging pseudo-particle that mediates it:

$$\lambda = \frac{\hbar}{mc}$$

**equation (2)**

($\hbar$ is the reduced Planck constant and $c$ is the speed of light).

As far as we know both electromagnetism and gravity are infinite range forces, implying zero masses for the photon (which is very familiar) and graviton (which has never been observed). The weak and strong forces, mediated by particles of order 90 and perhaps $10^{19}$ proton masses respectively, are restricted to nuclear dimensions. In principle it would appear easier to observe forces with ranges intermediate between these extremes, so that lack of observations of them is reasonable evidence for the conventional view that they do not exist. Thus, if it can be shown that such force or forces do indeed exist, even if very weak, there is a possibility of a far-reaching revolution in fundamental physics.

Consider the form of Eq. (1). If $r = \lambda$, then $\phi$ vanishes; the interaction cuts off exponentially at $r = \lambda$. But if $r < \lambda$, the exponential term becomes indistinguishable from unity and the potential describes an inverse square law of force. Thus, if one or more forces of ranges, say $10^2$ to $10^5$ m exist and are superimposed upon gravity they will not be seen at all by Kepler's law astronomy or its modern version using man-made satellites. They will be observed as part of the gravitational interaction in laboratory experiments on the Newtonian constant ("big G"), but being of inverse square law form at short range they will not be immediately identifiable. The possibility that the planetary value of $G$, $G_{\odot}$, and the laboratory value, $G_{\text{lab}}$, differ by up to 10% is not disallowed by any combination of astronomical, satellite and laboratory observations. The inverse square law is very precisely observed at distances from about $10^7$ to $10^{13}$ m and much more approximately verified by laboratory measurements from.
Figure 1. Gravity residuals (observed minus calculated) as a function of depth in the mine at Hilton. The curves are plots of Eq. 5 with $\lambda = 1000m$, $\alpha = -0.010216$ (broken line) and $\lambda = 200m$, $\alpha = -0.007636$ (solid line). The values of $\alpha$ are least squares fitted results for the selected values of $\lambda$. From Stacey et al. (1987).

0.05 to 1.0 m, but the two ranges were joined only by an assumption until we began an investigation of geophysical methods.

Geophysical Measurements of the Gravitational Constant

The history of the study of gravity is closely tied to the history of geophysics. The first attempts to measure the gravitational constant were by P. Bouguer in the 1730’s, about 50 years after Newton’s publication of his law of gravity. Bouguer used the extreme topography of the Andes to seek direct measurements of the gravitational attraction to mountains. Although he did not succeed in obtaining a useful estimate of $G$, his studies established the principles of gravity surveying and his name is now identified with a standard procedure for processing gravity data and representing anomalies. One of Bouguer’s methods was applied successfully by N. Maskelyne in the 1770’s using Mt. Schiehallion in Scotland and Maskelyne’s results on deflection of the vertical on opposite slopes of the mountain were accepted as standard for many years, with repeated revisions to the estimate of $G$ obtained from improved data on the geology of the mountain.

Although Cavendish’s torsion balance experiment in the 1790’s was more reliable than the geophysical methods, it was not widely accepted as such for most of the following century, at least partly because of confusion arising from an error in arithmetic in the original paper that was corrected many years later. In the 1850’s Astronomer-Royal G.B. Airy (better known in geophysics for his ideas on the principle of isostasy, the hydrostatic balance of mountain ranges which had confused Bouguer’s observations 120 years earlier) recognised a new geophysical opportunity with the opening of deep mines. Airy noted that the vertical gradient of gravity $g$ with depth $z$ in a mine is (in the simple approximation of a spherical, non-rotating earth)

$$\frac{dg}{dz} = \frac{2g}{r} - 4\pi G \rho$$

where $r$ is distance from the centre of the earth and $\rho$ is the density of the layer penetrated. This provides the best geophysical scale method of measuring $G$ and our revival of Airy’s method, using mines at Mount Isa and Hilton in North Queensland, has provided the only kilometre-scale estimates of $G$ for about a century (Holding et al., 1986). The most reliable value, obtained from the Hilton mine, is

$$G_{\text{mine}} = 6.720\pm0.024 \times 10^{-11} \text{m}^3 \text{kg}^{-1} \text{s}^{-2}$$

The uncertainty estimate is about 9 standard deviations and represents an assessment of possible systematic errors, especially in density data. This compares with the best laboratory value (with its standard deviation - Luther and Towler, 1982).

$$G_{\text{lab}} = 6.6726\pm0.0005 \times 10^{-11} \text{m}^3 \text{kg}^{-1} \text{s}^{-2}$$

The motive for the mine measurements is simply to make observations on a scale that might embrace the range(s) $\lambda$ of finite range component(s) of gravity with the form of Eq. (1). In fact an anomalous gradient will appear for any value of $\lambda$ smaller than the radius of the earth, but the effect is doubled if it is also smaller than the depth of measurement. For a single Yukawa term added to normal Newtonian gravity to give a total potential due to a point mass of the form

$$V = -\frac{G \cdot m}{r} \left(1 + \alpha e^{-r/\lambda}\right)$$

Figure 2. Mutual constraint on parameters $\alpha$, $\lambda$ of a single Yukawa term added to Newtonian gravity (Eq. 4) imposed by the mine data (acceptable values between the solid lines) (Holding et al., 1986) with shaded areas disallowed by satellite-surface gravity comparisons (Stacey et al., 1987) and a hydroelectric lake experiment (Moore, 1986). Broken lines enclose the range compatible with the experiment of Thieberger (1987).
there is a depth $z$ a gravity anomaly relative to the surface, given by

$$\Delta g(z) = \frac{4\pi G I_{\text{lab}} \alpha}{(1+\alpha^2)} \left[ 1 + \frac{1}{2} \left( 1 - e^{-2z/\lambda} \right) \right]$$

where $G_{\text{lab}} = G_{\infty} (1+\alpha)$ relates the short range (laboratory measured) value of $G$ to the planetary value, $G_{\infty}$.

Fig. 1 is a plot of the gravity discrepancies measured in the mine at Hilton, compared with theoretical curves from Eq. (5) with different values of $\lambda$.

It is evident that the mine measurements provide a reasonable estimate of the parameter $\alpha$ in Eq. (4), that is the amplitude of the intermediate range force, relative to normal gravity, but very little constraint on $\lambda$. We therefore represent the results as a plot of the mutually acceptable values of $\alpha, \lambda$, as in Fig. 2, which shows also constraints imposed by other observations. The shaded areas at large $\lambda$ are disallowed by the comparison of surface and satellite measurements of the Earth's gravity, as discussed by Stacey et al. (1987). The shaded areas at short range represent constraints imposed by preliminary results from a hydroelectric lake experiment using the recently completed Wivenhoe power station on the Brisbane River (Moore, 1986). This experiment weighs the gravitational attraction between layers of lake water and 10 kg masses suspended in evacuated tubes in the lake, and the initial data give a value of $G$ coinciding with the laboratory results. Fig. 2 is useful in demonstrating the nature of the effect which is observed, but the values are relevant only if a single Yukawa term suffices to explain the non-Newtonian effect. In that case it represents a repulsive force, that is, all of the observations point to a negative value of $\alpha$. However, we now doubt whether it is realistic to suppose that a single Yukawa term suffices. Theoretical arguments (Goldman et al., 1986) suggest that this should occur in pairs with opposite signs, that is, an association of a repulsive term and an attractive term. If we admit just one pair of terms it is still possible to impose useful constraints on the parameters, but they are quite different from the limits in Fig. 2. Ranges up to 450 km become admissible and the only restriction on amplitudes is that the repulsive force must be stronger than the attractive force by about 1% of gravity.

The Eötvös Experiment and its Successors

The equivalence principle in relativity has traditionally taken the classic experiment by Eötvös et al. (1922) as observational justification. Eötvös had developed torsional balances for gravity gradient measurements as exploration tools, but also used these for some fundamental measurements, especially to determine whether the centrifugal component of gravity, due to the Earth's rotation, was a fixed proportion of total gravity, being the same for all materials.

The conclusion was that, within the experimental uncertainties (about 5 parts in 10^9), all of the 10 pairs of materials examined were gravitationally equivalent. More recent and more sensitive experiments, appealing to centrifugal acceleration of the earth in orbit about the Sun (which avoids disturbing the apparatus by rotating it in the course of the observations), confirmed this conclusion with more than 100-fold greater sensitivity (Roll et al., 1964). This is all precisely in accord with general relativity. Hence the alarm and disbelief expressed when a re-examination of the original Eötvös data revealed that when the apparent gravity differences between pairs of materials were plotted as a function of the nuclear mass excess differences a striking correlation appeared (Fischbach et al., 1986), as in Fig. 3.

The concept of nuclear mass excess was unknown in Eötvös's time.

The significance of Fig. 3 is that we should expect any intermediate range force which appears as a repulsive component of gravity to be composition-dependent.

Specifically, if the force is a particle force, rather than a mass force like normal gravity, then it may be proportional to the number of fundamental particles present in the interacting masses. A material like copper, which has more nucleons per kilogram than, say, water, because it has lost more mass as nuclear binding energy, will experience a relatively stronger intermediate range particle force. Thus Fischbach et al. (1986) identified the composition effect they had discovered in the Eötvös data with the intermediate range force apparent in the Queensland mine observations. The more sensitive solar Eötvös-type experiments are then irrelevant because they are not sensitive to short range forces.

The geophysical doubt about gravity that had been hardening gradually as we accumulated more and better mine data was suddenly projected into an intense debate in the particle physics community.

It must be noted that if the effect apparent in Fig. 3 is correctly attributed to an intermediate range force then it must arise from the misalignment of the force with total gravity, due to local topography or density irregularity - a point that was not recognized in the original reanalysis. Modern variants of the Eötvös experiment are designed specifically to take advantage of steep local topography.

The race is now on to find the crucial experiment that will provide a convincing check of the existence of a non-Newtonian component of gravity - one that conflicts with the equivalence principle, although this should not be construed as a serious threat to relativity. The first that we became aware of (Thieberger, 1987) already looks persuasive. A 20 cm diameter hollow copper sphere, having its centre of mass coincident with its geometrical centre within a few microns, just floating (i.e. almost neutrally buoyant) in a tank of water maintained at 4°C (to avoid any convective tendency) and screened from magnetic influences, was found to drift steadily away from a nearby cliff at 4.5 mm/hour for the 120 hours of observation. Very little movement was apparent.

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in a laboratory well removed from topographic irregularities. Interpreting the effect as an excess repulsive baryon-number force of the material of the cliff acting on the copper relative to the water, Thieberger obtained the $\alpha, \lambda$ limits represented by the broken lines in Figure 2. However, in a more conventional upgrading of the Eötvös experiment, involving pairs of copper and beryllium masses suspended by a fine tungsten wire on a modest hillside, Stubbs et al. (1987) found zero effect with an uncertainty of only 10% of the effect expected from the Thieberger experiment. Their experiment was plagued by gravity gradients which they removed by trial and error, by introducing 80 kg of lead bricks to the apparatus, 30 cm from the suspension. It is not evident that this invalidates their conclusion, but it introduces a complication about which one must be cautious in view of the uncertainty about the nature (and multiplicity) of the forces that are sought and we must look for more observations as clean as those of Thieberger appear to be. But with this contrary result the doubt remains.

More New Experiments

There are, to our knowledge, at least 30 laboratories, including our own, with new gravity experiments under development or in progress. Most of these are directed to the composition-dependence problem, but there are a few total gravity experiments, including measurements of $g$ in the deep ocean and in the Greenland ice sheet and our own development of a gravity gradiometer for use high above the ground. It seems that we should not have to wait many years for the matter to be settled. However, this will not necessarily give a clear indication of the nature of the new force but only whether there is one. Assuming so, then the next stage will require more elaborate experiments. The first step is already being taken with an antiproton experiment by a joint team from Los Alamos and CERN. Following the argument of Goldman et al. (1986) it is believed that the repulsive (vector) field is almost cancelled by a similar range attractive (scalar) field and that the present observations are only of the small difference between them, but that the vector field will cause attraction of antiprotons by the Earth. In that case the discrepancy with Newtonian (or Einsteinian) gravity will be much greater for antiprotons than for ordinary matter.

As physics-based geophysicists we are accustomed to the application of fundamental physical principles to problems of the Earth. We may be participating in one of those much rarer events, a contribution of geophysics to fundamental physics.

We acknowledge support by the Australian Research Grants Scheme, Mount Isa Mines Ltd., B.H.P. and the University of Queensland.

References


The photograph of this etching of Sir Isaac Newton was taken from David Brewster’s biography published in 1831.

The First Ewald Prize

The First Ewald Prize for outstanding contributions to the science of crystallography has been awarded jointly to

Prof. J.M. Cowley and Dr A.F. Moodie

for their outstanding achievements in electron diffraction and microscopy, especially for their fundamental contributions to the theory and technique of direct imaging of crystal structures and structure defects by high resolution electron microscopy.

Their pioneering work on the dynamic scattering of electrons was reported in a series of papers in *Acta Crystallographica* and other journals from 1957 onwards.

John Maxwell Cowley, a graduate of Adelaide University, was formerly a Chief Research Scientist at the Division of Chemical Physics, CSIRO, Melbourne, Australia. Later he was Professor of Physics at the University of Melbourne, and since 1970 has been the Galvus Professor of Physics at Arizona State University, Tempe, USA.

Alexander Forbes Moodie, graduated from St. Andrews University, Scotland, in 1948. Since then he has been a member of CSIRO in Australia where he is a Chief Research Scientist at the Division of Chemical Physics. This Division was incorporated into the Division of Materials Science and Technology at the end of 1986.

The presentation of the Ewald Prize will take place at the Opening Ceremony of the XIV International Congress of Crystallography at Perth, Western Australia, on 12 August 1987.
Editorial Comment

Some time early in May, John Collins, our President, phoned me about a meeting on high-temperature Superconductors and asked for space, about five printed pages, to be set aside in the July issue for the report. Even he did not realise the enthusiasm that this meeting would reveal nor the number of individual contributions that this journal would receive. The copy of his original invitation is shown as I received it, but, please note, not my signature.

The Australian Physicist is a non-refereed journal and should contain articles of general interest and not rival the AJP... which should have mechanisms to incorporate such speedy publishing. Because a genuine misunderstanding has occurred I will publish most contributions on high-temperature superconductors sent to The Australian Physicist in this particular instance. Some of these will be published in this issue and some next month. The reason for selection has been entirely based on readability of the subject by the uninitiated, which I believe is our editorial duty.

A Complete Superconducting Transition at 108K in Substituted YBa$_2$Cu$_3$O$_x$

K.N.R. Taylor, D. Matthews, G.J. Russell,
School of Physics, The University of NSW.

The recent discovery of superconducting oxide ceramics with critical temperatures of 40K (La$_{2-x}$Sr$_x$CuO$_4$) and 90K (YBa$_2$Cu$_3$O$_x$) has stimulated an intense study of possible applications of these materials and a wide ranging search for compounds showing even higher transition temperatures.

Studies of the high temperature material at elevated pressures have shown that the transition temperature increases with pressure [Shelton, 1987] while variation of the detailed oxygen composition has demonstrated the extreme importance of oxygen content of the specimens [Tarascon et al., 1987]. The origin of the pressure dependence is not yet understood, but it seems reasonably certain [Beyers et al., 1987] that the effect of reduced oxygen composition is to remove oxygen atoms from the layered Cu-O-Cu chains lying along either the a- or b- axes of the double layered perovskite structure. It is possible that the application of excess pressures to these materials can have a similar effect, by modifying the occupancy factor of the chain oxygen atom sites.

As part of a detailed systematic search for the factors which control the superconducting process in these materials, and for materials with transition temperatures in excess of 100K, we have been investigating the effects of group VI element substitution for oxygen into the ceramic.

In a recent series of measurements involving sulphur additions, we discovered a number of important effects which are described below.

Samples of YBa$_2$Cu$_3$(O,S)$_x$ were prepared by our normal process of sintering a lightly pressed pellet of mixed compounds at 950°C for several hours, followed by an oxygen soak treatment of 550°C during the final cool down. In the present study, samples were made in which 3% 10 and 20% of the O was substituted by S.

Visual inspection of these samples showed unusually large grain dimensions (100-200µm) compared with samples of the normal YBa$_2$Cu$_3$O$_x$ composition. X-ray diffraction observations of the crystal structure showed no sign of the impurity phases which are a common feature of the pure oxide ceramic and we suggest that the addition of sulphur may serve to initiate and stabilize the orthorhombic lattice in these materials.

The resistivity of the 10% sample was measured in a conventional 4-probe configuration with a stabilized d.c. current of -10mA. The specimen voltage was measured directly onto the Y axis of an XY recorder as the temperature was increased from 77K to 300K at 1K/min. The thermocouple output was displayed directly onto the X-axis which had been previously calibrated. The initial observational run revealed a transition well in excess of 100K, with an onset at 113.5K and a final zero resistance (10$^{-6}$ ohm) at 108K. Repeated cycling at room temperature produced a continuous drop in this transition temperature as is shown in Figure 1, from which it is also obvious that the width of the transition decreases markedly as the critical temperature falls on successive runs.

Parts of this sample which had remained in the laboratory atmosphere for approximately 24 hours also degraded, and exhibited transition temperatures of 86K.

While this is the highest temperature, full superconducting transition which we are aware of, it unfortunately occurs in a material which appears to be highly unstable to both thermal cycling and atmospheric attack. The origin of this instability is not yet clear, although there is growing evidence that these

![Figure 1. The temperature variation of the resistivity of the 10% sulphur substitution sample for three successive observational runs from room temperature to 77K.](image-url)
solid are highly susceptible to moisture which causes severe lattice degradation.

Attempts to restore the high temperature superconducting state by heating (300°C for 15 minutes) and vacuum treatment (2 hours at room temperature) both failed to have any significant effect on its deteriorated performance as a superconductor.

In conclusion, the substitution of other group VI elements for oxygen in the YBa$_2$Cu$_3$O$_{x}$ structure has led to the discovery of the highest critical temperature reported for total superconductivity.

References

Phonon Spectra of Thermally Modified YBa$_2$Cu$_3$O$_{x}$ Perovskite Superconductors
H.B. Sun, D. Matthews, K.N.R. Taylor and G.J. Russell, School of Physics, The University of NSW.

The detailed DTA and TGA observations, coupled with careful neutron scattering results on the new ceramic superconductor YBa$_2$Cu$_3$O$_{x}$ have shown that considerable manipulation of the oxygen distribution can be brought about by suitable thermal annealing [Tarascon et al., 1987].

The double layered perovskite structure shown in Figure 1 consists of extended, two-dimensional Cu-O planes separated from each other by Ba-O layers and in the centre of the cell a plane of one-dimensional chains of Cu-O-Cu parallel to the a- or b- axes. Oxygen vacancies in these chains are known to be critical for the appearance of superconductivity in these compounds although whether the chains represent the conduction path is not yet clear.

Thermal annealing of the ceramic in the temperature range 470-550K leads to a change in the occupancy probability for the chain oxygen atomic sites [Capone et al., 1987] which become mobile and may be removed from the sample by performing a thermal anneal in vacuum. This treatment results in a loss of the superconducting state. Conversely the oxygen atoms may be replaced by reannealing the pure oxygen which also restores the superconductivity.

Since the chain structures represent a rather idealised atomic arrangement with predictable phonon spectra, and since this phonon structure may play a decisive role in the mechanism responsible for superconductivity, we have begun an intensive investigation of annealed samples using infrared and Raman spectroscopy.

Samples were prepared by the normal dry mixing route used in our laboratory. This involves a preliminary extended grinding of the powders to improve the homogeneity followed by a pelletization at 10$^4$ kPa. The samples are then heated to 950°C at 350°C per hour and sintered for several hours. After cooling and regrinding, the process is repeated twice more, with the final pelletization taking place at 5x10$^4$ kPa. The final cool down includes a three hour soak at 550°C in pure oxygen.

Specimens prepared in this way show the well known YBa$_2$Cu$_3$O$_{x}$ orthorhombic X-ray diffraction pattern. Infrared reflectivity spectra taken at room temperature using polished samples on a Perkin Elmer 500B spectrometer, revealed a simple spectrum consisting of four phonon peaks similar to those reported by other workers [Bonn, 1987]. After annealing in vacuum at 550°C for 2 hours to remove chain oxygen atoms the infrared reflectivity spectra were repeated. The two spectra are shown in Figure 2. Measurement of the resistivity confirmed that in this state the sample is no longer superconducting.

Finally, a 15 minute anneal at 550°C in pure oxygen restored the oxygen to the lattice, the sample regained its superconducting state and the infrared reflection spectrum returned to its original form.

As may be seen from Figure 2 the original sample shows the presence of 4 phonons on a broad increase in reflectivity with wavelength. These correspond to frequencies of 279, 310, 548 and 609 cm$^{-1}$ in agreement with the work of Bonn [1987]. After the vacuum anneal, the absolute reflectivity has increased at all wavelengths, while three phonon peaks are clearly visible at 355, 590 and 620cm$^{-1}$.

The two higher frequency transitions of the original structure appear to have shifted to slightly higher energies following the removal of the oxygen, but more importantly the amplitude of the lower energy peak has been dramatically reduced and replaced by the strong line at 355 cm$^{-1}$.

Since the heat treatment technique which we have been
using is known to remove oxygen atoms from the chain sites, we conclude that it is the lower energy phonons which can be associated with these chains. This would indirectly support the findings of Bonn, who observed these peaks to decrease in intensity as the temperature fell below the superconducting temperature. The origin of the new transition at 355 cm\(^{-1}\) is not yet clear, however it may be associated with either redistributed oxygen atoms lying in b- rather than a- chain directions or with higher frequency modes of chains having a significant reduction in mean length caused by the introduction of oxygen vacancies.

References

Specimen Resistivity and Superconductivity Distribution in the CuO-Y\(_2\)O\(_3\)-BaO Phase Diagram

It is evident from our studies of specific pseudobinary compositions in the series Y\(_2\)Cu\(_3\)O\(_7\)-BaCuO\(_2\) [Dou et al., 1987] that the room temperature resistivities of these superconducting ceramics materials vary dramatically with composition and are excellent indicators of likely superconducting phases. This characteristic is also obvious from the published resistivity-temperature diagrams of other workers.

In the course of a detailed examination of the entire CuO-Y\(_2\)O\(_3\)-BaO phase diagram, we have recently studied the distribution of room temperature resistivity and superconductivity at all compositions. The results of this study are given below.

Half gram samples were prepared using our normal processing techniques which are described elsewhere in the journal [Sun et al., 1987], but with a final pelletization at only 10\(^5\) kPa rather than the normal higher value of 5x10\(^5\) kPa. Both X-ray diffraction and infrared reflection spectra were taken of all these samples, and their relevance to the phase diagram will be published separately.

The resistivity of each sample was measured using a four probe technique with specimen currents of approximately 20mA. Contacts were made using fine copper wire and silver paste electrodes. The critical temperatures, indicating the existence of superconductivity, were determined from the resistance-temperature increase between 77K and room temperature. This change in resistance was recorded directly onto an XY recorder, the specimen voltage and thermocouple output being displayed on the Y and X axes respectively.

Figure 1 shows the distribution of room temperature resistivity across the phase diagram, in which the tie lines and stable compounds are taken from Frase et al., [1987]. This diagram shows the expected, high resistivity semiconducting compounds in the yttrium rich regions where the specimens exhibit both green and blue colouration due to different oxidation states of the copper ions.

Two relatively large zones of low resistivity materials were found, both in the yttrium poor section of the diagram and both extending over considerable composition ranges. These two regions are tentatively connected at a composition

\[ Y_{x}B_{4}CuO_{x} \]

The lowest room temperature resistivity of any sample was observed at a composition \( Y_{x}Ba_{3}Cu_{55}O_{x} \). All the samples were explored for superconducting transitions above 77K, and the compositions at which these occurred are shown in Figure 2, again overlaid on the phase diagram. As may be seen, essentially all those compositions lying within the major low resistivity contours of Figure 1, exhibit superconductivity. While the majority of these have critical temperatures close to 95K, which can tentatively be identified with the presence of \( YBa_{2}Cu_{3}O_{6} \) as a component phase, this is not true for those compounds lying in the \( CaCu_{3} - Y_2BaCuO_4 \) - \( YBa_{2}Cu_{3}O_{6.5} \) triangle which has no link to the \((123)\) composition at this temperature. It is of extreme importance, that three of the six compositions lying in this triangle had resistivity-temperature curves which showed evidence for higher temperature transitions (T\(>120K\)) in addition to the main transition at 95K. The observation of

\[ \Delta T_c = 95 K \]
\[ \ast \text{ Transitions } T > 100 K \]

Figure 2. The location of superconducting phases.

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these higher temperature transitions in this restricted region of the diagram, suggests that there may be a second superconducting compound in these oxide ceramics and that this may be the origin of some of the anomalous transitions observed by other workers.

References

Preliminary Auger and ELS/CLS Spectra for a High Temperature Y-Ba-Cu-O Superconductor.

School of Physics, The University of NSW.

A study of the new high temperature superconductors from the Y-Ba-Cu-O system using the surface sensitive techniques of Auger (AES), electron energy loss (ELS)/characteristic core-loss (CLS) spectroscopies should provide detailed bonding information, including compositional changes in the surface and bulk regions (using ion milling), filled and unfilled density of states information, and characterisation of the processes which cause deterioration of some samples over time.

A 'hard' Y_{1.66}Ba_{0.34}Cu_{0.66}O_{6.6} sample, produced in our laboratory, and which had a T_c = 89 K and a ΔT = 1 K was carefully polished to a 'shiny' finish and placed in a conventional UHV Auger system. The system has gas handling, ion milling and sample heating (1100K) and cooling (~80K) facilities. After an 8 hour bake-out of the vacuum system the background pressure was ~5x10^{-10} torr.

The initial AES spectrum showed a substantial carbon signal (dotted curve in Figure 1) which exceeded that observed in previous studies of as-prepared normal crystalline metal and semiconductor surfaces. This carbon signal was reduced by a factor of 26 after argon-ion bombardment at 600 eV and 2.5 μA cm⁻² for 30 minutes. A further four 30 minute cycles of ion bombardment did not reduce the carbon signal (compared to the oxygen signal) below that shown in Figure 1. The shape of the remnant carbon signal suggests the presence of a carbide. During the ion bombardment cycles the sample was cooled to 225K and the AES spectrum showed no significant change from the representative spectrum shown in Figure 1. For the energy range 16-57 eV a small change in the peak shapes was evident, but further work, with improved resolution over the range 16-135 eV, must be undertaken.

It has been found that these superconductors can be depleted of oxygen by low temperature vacuum annealing. This prompted a study of the peak-to-peak height of the oxygen-signal over a 30 minute period with the incident electron beam (E_0 = 1700 eV, I_p = 50 μA) remaining at a fixed point on the surface. The beam was then moved to points 1mm on either side of the initial position. Within the accuracy of the measurement (~5%) there was no change in each of the initial oxygen peak-to-peak signal heights for each position; however, 30 minute heating by the incident electron beam at one point gave ~15% increase in signal height. Switching off of the incident electron beam for a period of 15 minutes returned the oxygen signal height to its initial value.

Figure 2 shows a representative ELS/CLS spectrum for a primary electron energy of 450 eV. Table 1 lists the electron energy loss peak positions. These peaks may arise from intra-, inter-band transitions, surface and bulk plasmon losses and characteristic core-losses. Of immediate interest are the core-losses which are a measure of the energy involved in raising a particular core-level electron to the maxima in the unfilled density of states. Therefore, the values quoted in row 1 for possible core-losses will be higher than a binding energy relative to the Fermi level by the amount the UDOS is above E_F. Row 2 of the Table is an attempt to correct the CLS values so that a comparison can be made with the photoemission data of Cardona and Ley [11] for the core-level binding energies of the relevant metals. Obviously, the agreement between the CLS and XPS data will be poor as the quoted XPS energies shift due to configurational, chemical and relaxation energy changes for this oxide system. Identification of the other loss features will be difficult for such a mixed oxide system.
NEW SUPERCONDUCTORS

| Table 1 |

Electron energy loss peak positions (in eV) taken from the spectrum of Figure 2 and stated in row 1. Row 2 is an attempt to correct possible C1s peaks to E_g. Row 3 are photoemission core-level binding energies for the relevant metals (reference [1]).

<table>
<thead>
<tr>
<th>Row 1</th>
<th>10.0</th>
<th>14.6</th>
<th>25.0</th>
<th>35.9</th>
<th>45.0</th>
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<th>79.4</th>
<th>95.3</th>
<th>100.1</th>
<th>108.7</th>
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<th>121.9</th>
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<td>33.6</td>
<td>41.7</td>
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<td>121.0</td>
<td>122.2</td>
<td>134.2</td>
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<tr>
<td>Row 3</td>
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<td>1.8</td>
<td>2.0</td>
<td>2.2</td>
<td>2.4</td>
<td></td>
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</tr>
</tbody>
</table>

We think the extra structure in the ac susceptibility of the pellet is caused by the formation of contiguous shells of superconducting material which effectively shield internal parts from contributing to the signal. We have also measured the dc susceptibility of a small piece of sintered material. Figure 2 shows deviations from the Curie-Weiss law near 240 K.

Reference

Characterisation of High Temperature Superconductors
CSIRO Division of Applied Physics.

Objectives
We expect our laboratory can make meaningful contributions to the development of the new superconductors by inventing new devices which will use them. First we need to perfect techniques for preparing and evaluating yttrium-stibarium-copper-oxide materials.

Sample preparation
We have prepared samples from both co-precipitated oxalates and mixed dry oxides/carbonates, calcined in air at 900°C for 2 -- 14 hours. X-ray diffraction showed only the 1:2:3 phase. We pressed pellets 6mm diameter by 6mm long at 300-900 MPa and sintered them in air at 900-950°C for 6 hours.

Magnetic Measurements
To measure the Meissner effect we repeatedly insert and withdraw the sample from a pair of matched coils wired in series opposition and measure the resulting change in flux. We compare the signal from the sample with that obtained from an identically shaped piece of Pb to determine how much of the sample is superconducting. The results depend on the strength of the magnetic field imposed during the transition to superconductor because the material is type II with a low Hc1. Figure 1 shows that the Meissner effect is constant until about 25 K below the transition temperature. Figure 1 also compares the ac susceptibilities of the powder and a sintered pellet made of the same material.

Figure 2. The dc susceptibility of YBa2Cu3O7.

but the changes in slope may be associated with a minor impurity that we cannot find in the scanning electron microscope or in X-ray diffraction patterns. The effective magnetic moment is 0.25 μB. The Curie constant corresponds to only 2% of the copper atoms being in a spin 1/2 state.

Electrical resistivity
Figure 3 shows the resistivity of our sintered samples. At room temperature it is about 3 milliohm-cm and decreases almost linearly to within a few K of the transition. The half-width is 3 K and the transition is complete at 89 K.

Figure 3. The dc electrical resistivity on cooling.
NEW SUPERCONDUCTORS

Figure 4. The ac susceptibility of one pellet after heating to 900, 500, 820, and 950°C in that order, in air.

Withcraft

We demonstrate the reversibility of whatever happens during the heat-treatment of a hard-pressed pellet in Figure 4. The pellet was initially sintered at 900°C, then heated in air for several hours at 500, 820 and 950°C with measurements of ac susceptibility at each step.

Conclusions

We have produced starting materials good enough for trial with more exotic deposition techniques. We can now say with authority whether any such material is promising for magnetic or electronic applications.

Microstructure of the High Temperature Superconductor

Ba$_2$YCu$_3$O$_7$

A.F. Moodie, R.J. Whitfield,
A.F. Moodie, H.J. Whitfield,
Division of Materials Science and Technology, CSIRO;
and T.R. Finlayson,
Physics Department, Monash University.

High temperature superconductor of composition Ba$_2$YCu$_3$O$_7$ has been synthesized and examined by high resolution electron microscopy and in situ convergent beam electron beam diffraction. Extensive microstructure is associated with appreciable strain as shown in the low magnification micrograph (Figure 1) of a crystal viewed down [001] direction of the orthorhombic cell (a=3.83, b=3.88, c=11.69 Å).

Convergent beam electron diffraction patterns taken at points A and B of Figure 1 and selected area diffraction patterns taken across the whole field of view show that in the large, grains are aligned along the <110> direction with the b axis of one crystal at an angle of 89° to the b axis of the adjacent crystal. The difference in their dimensions is sufficient to distinguish the a and b axes in the JEOL 200CX electron microscope used in these experiments.

High resolution images which include an interface (indicated by an arrow in Figure 2) in the field of view at first sight have a single crystal appearance. No dislocations have been detected but strain can be observed in the atomic rows. An atomic model of this microstructure has been constructed.

AC susceptibility measurements show a transition to the superconducting state between 85.7° K and 64.1° K.

89-Y NMR in Y-Ba-Cu-O Systems

T.J. Bastow, E.F.W. Seymour, G.W. West and
H.J. Whitfield,
CSIRO Division of Materials Science and Technology.

We have observed a narrow resonant from $^{89}$Y (I=1/2) in the ceramic metal Y$_1$Ba$_2$Cu$_3$O$_7$ (Figure 1) at temperatures above the superconducting transition. Measurements have been made of the Knight shift, spin lattice relaxation time (Figure 2) and linewidth at 150 K, 296 K and 400 K. The resonance has a small negative, slightly temperature dependent shift (-96 ppm at 150 K) with respect to YCl$_3$(aq). However the related insulating ferroelectric compound Y$_2$BaCuO$_5$ has a very large negative $^{89}$Y shift which exhibits Curie-Weiss behaviour and a magnitude which is roughly consistent with a direct dipolar field from the copper ions of average moment $(\mu_0^2)^2 H_{\text{dip}}/kT$. The spin lattice relaxation time ($T_1$) for $^{89}$Y
in $\text{Y}_1\text{Ba}_2\text{Cu}_3\text{O}_7$ is inversely proportional to temperature, characteristic of relaxation by conduction electrons. The product $T_1T = 400 \pm 15$ ppm, which indicates a rather small density of states at the Fermi level $N(E_F)$ for electrons with non-zero density at the yttrium site. The linewidth approximately doubles on cooling from 400 K to 150 K.

We conclude that the electromagnetic moments on copper ions produce a large negative chemical shift. These moments are strongly exchanged coupled which gives a rather weak spin lattice relaxation process. The conduction electrons (of $\alpha$- or $\beta$- origin) produce a much faster relaxation rate and a positive Knight shift corresponding to $N(E_F)$ of order 0.2 of that for yttrium metal.

(a) Cu-L$\alpha$ at 13.3 Å arising from transitions 2$p$(4$s$,3$d$) and which is intense in the metal is not seen at all in the ceramic. This implies either a profound change in the symmetry of the 3$d$,4$s$ states or an Auger de-excitation of the 2$p$ level in the ceramic.

(b) O-K$\alpha$ at 23.7 Å (Figure 2) arising from transitions 1$s$-

**Figure 1.** Energy level diagram for Y-Ba-Cu-O illustrating the transitions observed to date.

2$p$ is observed with a half-width (corrected for instrumental broadening) of 4.3 $\pm$ 0.1 eV which reflects the width of the bonding electron distribution around O sites folded with a Lorentzian K level width of perhaps 0.5 - 1.0 eV.
The O-K\alpha band from the ceramic superconductor.

(c) The Y-M\textsubscript{45} spectrum at 75-100 Å (Figure 3) comprises a group of lines arising from initial 3d vacancies filled by transitions from 4p states (the intense M\textsubscript{2} lines) and a band identified as arising from valence band final states with a width of some 6.0 ± 0.3 eV. The M\textsubscript{2} line(s) is broadened compared with the pure metal (FWHM = 2.0 ± 0.2 eV as against 0.5 eV) and there is an extended tail of emission to the high energy side, part but not all of which arises from spectral contamination with the second order of C-K\alpha.

(d) The Ba-N\textsubscript{45} spectrum at 130-175 Å (Figure 4) is similar in form to that for Y-M\textsubscript{45} with the N\textsubscript{45} group of lines arising from N\textsubscript{45} - O\textsubscript{3} transitions together with a diffuse band identified as arising from the valence states and with a half-width of about 5 eV. Relative to the pure metal, the N\textsubscript{45} line is shifted some 0.1 eV to lower energies, and is grossly broadened while the intensity of the (N\textsubscript{4} - O\textsubscript{2}) component relative to (N\textsubscript{5} - O\textsubscript{3}) is increased by a factor of 2.1 ± 0.3.

Following this preliminary study, we conclude:

(i) from the intensities that the valence or bonding electrons are in p-states, and are localised around O cores. Apart from the intense O-K\alpha, which involves a 1s initial state, the complete absence of spectra involving 2s, 3s, 4s etc initial states is predictable, notwithstanding the assumed p-symmetry of the majority of the valence electrons. The situation near the Cu sites is especially interesting and may well hold the clue to the special behaviour of these materials.

(ii) from the bands observed that some valence electrons in p-states are to be found close to Y and Ba sites (cf the s-symmetry of the valence electrons in the pure metals).

(iii) from a comparison of the Y-M\textsubscript{2} and Ba-N\textsubscript{45} lines with those from the pure metals that the Y N\textsubscript{23} and Ba O\textsubscript{23} levels are broadened and shifted to lower energies in the ceramic indicating significant interactions with the lattice potential from neighbouring sites.

In this ongoing work the problem of thermal bonding of thin samples to the liquid nitrogen cooled target is seen as crucial to ensure integrity of the sample under the electron beam and to allow spectra to be recorded from targets with measured temperatures below and above T\textsubscript{c}, notwithstanding the necessary power input of some 3W. Since the emission features of interest (especially the Y-M\textsubscript{45} and Ba-N\textsubscript{45} bands) are in general of low intensity, long recording times of many hours will be needed to achieve statistics good enough for valid removal of the (high) background prior to a detailed analysis of the band shapes and widths.

Short Papers on Superconductors by the following authors are in the pipeline for the August issue:

C. Bowden, P.R. Elliston, K.T. Wan,
Physics Department UNSW.

S.X. Dow, K.E. Easterling, A. Bourdillon, C.C. Sorrell,
School of Material Science, UNSW.

B.A. Cornell, F. Separovic,
Division of Food Research, CSIRO.

N. Savvides, J.B. Dunlop, R.B. Roberts,
Applied Physics, CSIRO.

A.M. Stewart,
Department of Mathematics, ANU.

T.E. Freeman,
School of Mathematics, Macquarie University.

F.J. Lincoln, B. Franklin, B.G. Hyde,
Department of Physical and Inorganic Chemistry, UWA.

C. Edwards, M.J. Buckingham, C.D. Mann,
Physics Department, UWA.
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   Telephone: 29 7747   Telex: 25578
International Experimental Facilities

For a decade or more some members of the condensed matter physics community have concerned themselves with the problem of maintaining access by Australian scientists and students to modern experimental facilities. It was clear that the trend established in nuclear physics towards the centralisation of facilities would soon apply to all branches of physics. These central facilities have the properties that they are extraordinarily expensive, of the order of $10^9, and are extraordinarily efficient. The first property requires that they are built by very wealthy countries or consortia of countries. The second property requires a large user community; in practice the community based on approximately 10^8 people.

Australia is too small to either build these pieces of equipment or to use them effectively if they were built. On the other hand the benefit to Science in Australia of the results of experiments carried out on these facilities is potentially very high.

In the 1960s Australia did possess a major facility in the Hifar reactor. The Australian Institute of Nuclear Science and Engineering pioneered the user community concept among Universities. In that period the cost of the facility, and the cost of operating it, was in balance with the size of the user community. (This is an upmarket way of saying that the beam intensities were sufficiently low, and the detectors were sufficiently inefficient to render the time of an experiment long enough to occupy the interested users full-time.)

This plateau situation changed dramatically in the early 1970s. The High Flux Reactor at IL-L, Grenoble, was built jointly by France and Germany (later to be joined by UK). As well as a ten-fold increase in reactor flux, advances in instrumentation led to an increase in efficiency over older installations by a factor of about one hundred.

The immediate consequence was an enormous increase in the quantity and quality of experiments which could be carried out.

Australian scientists saw the increase in quality that could be achieved, and simultaneously saw that the increase in quantity would make such an installation non-viable in Australia even if it could be funded.

These scientists then used friendships and collaborations established in the early days of the science (this period is well documented in a recent book [Bacon, 1987]) to obtain access to IL-L. No charges were made for the use of facilities, and travelling expenses were within the range of grants by ARG and similar bodies.

The new generation of spallation sources followed with IPNS at Argonne National Laboratory and ISIS at the Rutherford-Appleton Laboratory, UK. This period also saw the development of synchrotron sources of high enough energy to produce X-rays of wavelengths low enough to interest crystallographers. Again these sources are very expensive and very efficient.

Australians gained access to these new instruments on the "old boy" basis, however, strains were becoming apparent. We are not a poor country, and others were responding to "user pays" arguments.

Approaches were made to Government to rationalise Australian use of these instruments. Results were favourable with the following recommendation by ASTEC (1985).

Recommendation (5)
(i) That an additional amount of $250,000 per annum be appropriated to the Australian Research Grants Scheme (ARGS) for the establishment of a dedicated nuclear science and technology travel fund.
(ii) That this fund be used to support the travel of Australian scientists whose projects have been determined to be of the highest international standard and require accelerator or neutron beam facilities which are not available in Australia.

Following, and enlarging upon, this recommendation the Department of Science made a serious study of the possibility of Australia taking a share, as a member country, in an international facility. The facility chosen as an initial target was ISIS. I was appointed to the Scientific Advisory Committee for ISIS, and an Australian engineer, John Edwards, was seconded from the AAEC to ISIS. In early 1986 prospects were good.

The Department of Science then did something else. As part of its charter it attempted to quantify the real needs for research equipment in Australian higher education. In a carefully planned exercise it surveyed departments of physics, physical chemistry and biochemistry in nineteen universities and nine CAEs.

One of the questions was:
If greater funding of research equipment were possible in which single area would investment be most beneficial to investigators in this department?
(Use a priority rating 1-6 with "1" denoting the highest priority.)

<table>
<thead>
<tr>
<th>Equipment Category</th>
<th>No.</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
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<td>Large scale regional/national facilities</td>
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<td>9</td>
<td>9</td>
<td>39</td>
<td>25</td>
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<td>Major shared-access instrument systems ($50,000 - $1M)</td>
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<td>10</td>
<td>13</td>
<td>24</td>
<td>19</td>
<td>6</td>
<td>10</td>
<td>100</td>
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<tr>
<td>Upgrading/expansion of equipment within the department ($10,000 - $50,000)</td>
<td>51</td>
<td>22</td>
<td>16</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>100</td>
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<tr>
<td>General enhancement of equipment and consumables in the department</td>
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<td>33</td>
<td>19</td>
<td>21</td>
<td>7</td>
<td>1</td>
<td>3</td>
<td>100</td>
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<tr>
<td>Technical and workshop personnel to build, develop and maintain research equipment</td>
<td>15</td>
<td>15</td>
<td>33</td>
<td>22</td>
<td>10</td>
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<td>100</td>
<td></td>
</tr>
</tbody>
</table>

The Australian Physicist, Vol. 24, 1987-Page 146
The Institute of Physics should be alarmed by the results of this survey. It gives a picture of physicists in academic institutions as inward looking, unceptive to new ideas, unadventurous. The impression we would like to give is the opposite. We would like to be thought of as enthusiastic to try new methods, to teach them to our students, to apply them in Australian industry.

While the Department of Science is very prepared to work for Australian participation in international facilities it must be guided by the desires of its constituents. While, I suspect, it was as much surprised as I was by the results of the survey, it is forced to give a much lower priority to international facilities for Australian use.

While this will not alter the access of scientists of my generation to the new facilities it will mean that we are unable to send students. It is these students who, having seen the capabilities of these instruments at first hand, will use them in our industries just as they are being used by US and European industries.

The Physics community must deserve the famous description of us by the Hon. Barry Jones.

References

T.M. Sabine

Peter Mason Obituary

I wish to express my disappointment with the Obituary to Professor Peter Mason as published in the May issue of The Australian Physicist.

I take particular exception to the tenor of the second, third, fourth, and penultimate paragraphs, all of which meant to convey a derogatory tone irrespective of the spirit in which they were perhaps written.

The slighting reference to the School of Physics at Macquarie University was unnecessary, and to my mind, merely aids in the perpetuation of the myth of 'lower-quality' education at that institution. Furthermore, the fact that the syllabus and course structure of the school was not moulded to fit the ideals of Peter Mason is a tribute to the man, worthy of emulation by the heads of other Schools of Physics rather than damnation by faint praise. Nor is the possession of social and political ideals which were and, regrettably, remain unconventional sufficient grounds for cavalier dismissal of Peter's work. I submit, for example, that most of us would prefer the visions of J.B.S. Haldane and J.D. Bernal to the socio-pathic support of S.D.I. evinced by E. Teller.

On the other hand, it is very unlikely that the (late?) Boris Hessen would have claimed Peter's whole-hearted support. Peter was surely aware of Hessen's bondage to a dogma, but he would no doubt commend to us the insight provided by Hessen's flawed analysis - that research, regardless of its inspiration, is amenable to direction by the State (i.e. the source of funds).

The diminution of Peter's contribution to the positive image of physicists is regrettable, as was the inconspicuousness of many members of the Sydney physics community at the Memorial Service held on May 1st at Macquarie University.

I hope I have spoken for many people in this attempt to redress the disservice done to one of our best.

Bradley James Powe.

Arkady Lipkin

The physicist, Arkady Lipkin and his family, are now free, and have left the Soviet Union. Lipkin was thrown out of his job as a result of his request to leave, and had to spend several years as a coal stoker to support himself.

Will the many members of the Australian Institute of Physicist who lent their support to the campaign to have him released accept my own, and especially Lipkin's sincerest thanks.

I have enclosed a letter I received yesterday from Lipkin, now in Italy, to be published with this letter.

Geoffrey I. Opat.

Dear Prof Opat,

It is impossible to measure my gratitude to you for helping us to win our freedom.

It is simply wonderful! I hope in the nearest future to be able to thank you personally.

Yours sincerely,
Arkady Lipkin.

Workshop on uses of Synchrotron Radiation.

University of Melbourne, Saturday August 29 and Sunday August 30, 1987.

Aims: To provide information on recent developments in the use of synchrotron radiation for research. To inform the local scientific community on possibilities for using synchrotron radiation and to help develop proposals for accessing overseas synchrotron radiation facilities.

Overseas Speakers include:
Prof M. Ando, Photon Factory, KEK, Japan.
Prof M. Hart, FRS, Univ. of Manchester & SERC Facility, Daresbury, U.K.
Prof J. Harada, Univ. of Nagoya, Japan.
Prof P. Suorri, Dept. of Physics, Univ. of Helsinki, Finland.

It is expected that several other leading workers from the principal SR facilities and local speakers will also be contributing.

Details from:
Dr Stephen Wilkins,
CSIRO, Division of Materials Research,
Locked Bag 33, Clayton, VIC 3168.
Ph: 03 542 2918
FAX: 03 544 1128. Telex: AA32945.
Improving the Research Performance of Australia's Universities and Other Higher Education Institutions.

T. F. Smith, Past President A.I.P.

The title of the report is unfortunate in that it indicates a certain prejudice from the outset. It is also inappropriate as no attempt is made to make a value judgement of the present quality of the research or reclassification of the research being undertaken in the higher education sector. In actual fact, there is a great deal in the report that is supportive of higher education research, particularly in the Universities. The report opens with a clear statement of the role of the Universities in the conduct of basic research. It highlights the lack of flexibility in the present system of funding, which is primarily tied to the teaching function, and the inadequate level of directed funding through grants (paragraph 3.5).

Regrettably, on reading the report and its recommendations, it is too easy to form the impression that the report is highly critical of University research management, particularly in the distribution or research funding, staffing policies related to the balance of research and teaching and interaction with external organizations. Yet, the report does recognise that many Universities are already using internal assessment procedures for the distribution of Special Research Grant and equipment grant funds (paragraphs 6.16, 6.20). Thus, the recommendations in these areas could be seen more as endorsing and encouraging the wider adoption of these initiatives.

Unfortunately, the report fails to emphasize these positive aspects of University management. Nor does the report provide any quantitative evidence to support the recommendations. How many Universities follow strict formula funding? How many Universities have consulting companies or alternate schemes to foster external interaction? Just how cost effective are the consulting companies?

Undoubtedly, the most contentious issue in the report for academic staff is that of the division between research and teaching. While the report endorses the CTEC view, expressed in its 'Review of Efficiency and Effectiveness in Higher Education', that there should be more variation in the fraction of time devoted to teaching and research, it implies that the choice should be voluntary and not enforced. The recommendation (R5, paragraph 4.21) specifically refers to the establishment of staffing practices to encourage staff to choose between research, scholarship and teaching. Nevertheless, it is to be expected that this will be interpreted as opening up the situation in which some academic staff will be prevented from undertaking research.

It is suggested that improved flexibility in the distribution of research funds would be achieved if it was recognised that not all staff wish to undertake research or may be competent to do so. However, merely designating staff as 'non-research' does not allow the imputed research component of their salary to be utilised elsewhere. The 14.4% increase in student load, as measured in terms of EFTS, with a corresponding decline of 8.4% in staff/student ratio has already placed the staffing in the Universities under great pressure and it is unlikely that any reclassification of academic staff could lead to a reduction in its numbers.

While it is true that redistribution of teaching and research responsibilities would allow more time for those engaged in research to pursue it, it would not provide additional funds. The level of funding potentially available for redistribution is modest. Given the probably extreme situation in which 20% of existing academic staff are reclassified as 'non-research' and there is a 5% reduction of these, if 25% of non-salary expenditure could be made available through improved management and was allocated to the top 25% of researchers the amount involved would be approximately $6000/researcher.

The more active role in research management by CTEC is advocated (paragraph 4.10). However, the report does not indicate how this may be achieved other than by a review of a University's published research strategy. At the same time the report does recognise the lack of evaluation of assessment procedures in the Australian context (paragraph 4.8). It is therefore far from clear how CTEC would exercise an evaluative role.

The proposal for the establishment of an Australian Research Council (recommendations 6a-d) with the broad responsibility of co-ordinating and promoting the research effort in the higher education sector is a major positive step towards improving the level of directed research funding, provided that the level of funding required is made available. A cosmetic change in the title and terms of reference for the ARGC without the additional funding would achieve nothing constructive. There is great concern that such a move would merely result in areas of research requiring relatively modest levels of funding being sacrificed to meet the demands for more expensive research, and that young researchers would be seriously disadvantaged. Given that it is proposed that the ARC support research in the Social Sciences and Humanities, in addition to the Natural Sciences and Engineering the level of funding requested is too modest, particularly when compared with that provided through the NH & MRC.

In view of the magnitude of the Government research effort conducted through CSIRO and the recommendation (R7) for stronger links between CSIRO and the University Sector, it is surprising that there is no specific recommendation for formal consultation between the ARC and the Board of CSIRO for the determination of national research priorities. As it stands, it is quite possible that the two major areas of Government funded research could set individual priorities that are counterproductive to an integrated national research effort.

It may also be argued that the funding of basic research conducted by CSIRO should be subject to the same competitive assessment as the University sector.

The recommendation (R9), that there should be an independent review of the role of the Institute of Advanced Studies at the ANU in the national research effort and its relationship to the state Universities, is welcome, though it could well be asked why ASTEC was not prepared to address this question in the present review.

The establishment of the ANU as a major institute for postgraduate studies occurred at a time when there was relatively little research effort in the University. That situation has now changed and it can be questioned whether the rationale for the level of recurrent support for the Institute is justified. With the increased emphasis on competitive funding and a greater level of direction and accountability advocated in the report, it would be appropriate for the Institute to be subject to the same conditions as the other Universities for the provision of its research funding.

The report recognises the importance of postgraduate training in the conduct of University research, but only superficially addresses the problem of the difficulty of recruitment of higher degree candidates in science and engineering, the only broad disciplinary areas for which the number of Ph.D. graduates has been declining over the past decade. Nor does the report consider that there is a significant impact that overseas students are now having on the conduct of University research.

The report does not address the potential demand for higher degree graduates in specific areas of science and engineering that must inevitably result from a growth in the industrial R&D effort and closer links between the University and the private research sector. In recommending an independent review of the level of the Commonwealth Postgraduate
Research Award stipend (R8) ASTEC bypasses the question of whether there should be different levels of stipend according to area of research.

Overall, in spite of the negative context in which the recommendations are made, the report offers positive support for research in higher education. Doubtless, the report will be seen as unpalatable by some, but its recommendations are more attractive than some of the proposals being voiced elsewhere in Government.

Jobs for Physicists in 1986
John R. Prescott, Physics Department, University of Adelaide

This is the latest in a series of surveys of the employment prospects for physics graduates which began in 1978 and is carried out by the author for the Employment Committee of the Australian Institute of Physics (Prescott, TAP 1980, 81, 82, 83, 84, 85, 86). Those positions that are advertised in the "Weekend Australian" or the Higher Education section of the "Australian" on Wednesdays are recorded. The criterion for selection is that the position shall be suitable for a holder of a degree or diploma in physics or applied physics. Positions in geophysics are also recorded separately. Geophysics is usually grouped with the earth sciences in Australia but advertisements frequently state that a physics qualification is suitable.

When the surveys first began the coverage extended also to the major metropolitan newspapers. These carry roughly as many additional advertisements: these are usually for positions for which a first or generalist degree would be suitable or for positions in State government organisations. The original survey showed that most of the positions requiring an honours or higher degree in physics or applied physics appear in "The Australian". Limited checks since then support this finding and so the survey continues on this basis. Last year the Editor of "The Australian Physicist", who lives in Western Australia, remarked that Western Australian jobs appeared to be under-represented. It is possible to check this by using the "Skilled Vacancy Surveys" published quarterly by the Department of Employment and Industrial Relations. These relate to all "skilled" jobs, not just those for tertiary graduates. The three-year average shows that 10% of all skilled jobs in Australia are advertised in W.A. In the present survey 6.5% of positions were for jobs in that State. Even on a limited sample this is a statistically significant difference. Examination of the detailed figures shows that no positions in Commerce and Industry were advertised in "The Australian" in 1986 and that there were few such advertisements in either of the previous two years.

Residents of WA should take note. Thanks are due to the Editor for drawing my attention to this anomaly. When allowance is made for "Defence", which is concentrated in South Australia and Victoria, other States appear to be about right. Possibly Victoria is also a little low on Commercial/Industrial ads.

The results of the 1986 survey are shown in the table where they are compared with previous years. The total number of positions remains high, sustaining last year's increase. Elsewhere in the table a number of small changes can be noted. Recruitment for the Commonwealth Government as a whole is steady. Permanent research positions at CSIRO are down proportionately, although the total recruitment for the organisation is steady. Defence recruiting is up. The survey has previously noted the difficulty in recruiting into the Defence Science and Technology Organisations. This year, for the first time, cadetships to pay for Ph.D. training with a job to follow with DSTD were advertised, with a salary starting at $15,021 and rising to $17,676. This is more than competitive with ESP scholarships. The Organisation also placed general (non-specific) recruiting advertisements at regular intervals throughout the year as well as those for specified posts.

Permanent positions at Universities continue at a very low level: only nine posts were for "straight" physics and three of these were Chairs. However, the number of temporary academic/research positions remains in the 90's as it was last year. A shift of emphasis in the recruiting to technical positions in tertiary institutions was noted. About half the posts were for short-term "research assistant" or equivalent positions. This is a definite change from previous years and presumably results from the way money is being made available by the ARGO. Positions in the CAE's remain up. Twenty four of these were permanent teaching positions.

Two sensitive indications of general economic activity are down, viz. Commercial and Industrial sales and Geophysics. These two have rather faithfully followed general employment trends over the whole period of the survey when compared with the National Bank and DEIR surveys. This year we have stopped listing "scientific computing" separately but have listed the posts with the appropriate general area.

For the past two years the Employment Committee has made available to Careers Officers in the tertiary institutions and other interested enquirers a list of actual posts advertised in the previous year. This has been well-received. However, it is likely that time and resources will mean that this cannot be done for the 1986 data.

Particular thanks are due to Sam Keany and Elaine Gregory for much work in collating the data.

<table>
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<tr>
<th>Advertised Positions in &quot;The Australian&quot;</th>
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<tbody>
<tr>
<td>All jobs advertised in &quot;The Australian&quot;, for which a degree in Physics, Applied Physics or diploma in Applied Physics provides a suitable starting point.</td>
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<tr>
<td>All subdivision figures are percentages.</td>
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<td>Total positions</td>
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<td>690</td>
<td>740</td>
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<td>3.6</td>
<td>6.1</td>
<td>4.2</td>
<td>5.4</td>
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<td>TOTAL %</td>
<td>100.0</td>
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<tr>
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<td>94</td>
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<td>99</td>
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BOOK REVIEWS


This concise book is far more than the technical guide its self-effacing title suggests. A lot of physics and engineering is crowded into its 227 pages. Inevitably, the treatment has to be uneven, ranging from admirable rigour in the derivation of mass, momentum and energy balances to good old-fashioned engineering empiricism and dimensionless groups galore, all in the one chapter.

There are a few glitches, e.g., the degree Kelvin is mentioned on page 1 and, more seriously, the table of fixed temperature points (Table 1.5) should have been updated to IPTS-68 (75) and EPT-76. The references, especially for the earlier chapters, are rather dated.

At $23.50 the book is a real bargain by today's prices and a useful primer for those who must occasionally dabble with heat transfer problems. There is an honest attempt to review the physics underlying the engineering solutions, making it an appropriate text for undergraduate classes on thermal physics and heat transfer, irrespective of the discipline. It would be a worthwhile addition to most personal libraries.


These two volumes contain 39 chapters on various aspects of this exciting and relatively new research field, contributed by some of its leading exponents. Each chapter has its own reference list, and a comprehensive subject index is provided at the end of Vol. 2. There is no obvious difference between the two volumes in the selection or treatment of the subject matter; a single volume would have been inconveniently heavy.

The editor has certainly succeeded in his aim of providing an overview of the status and direction of this diverse field. It is generally considered to have begun with the discovery in 1973 of the metallic properties of polymeric (SN)x, accelerated sharply in 1975 when it was found that (SN)x becomes superconducting at low temperature, and finally taken to the air in 1977 when the organic material polyacetylene (doped with controlled amounts of halogen or halogen compounds) was found to have a dc conductivity only about three orders of magnitude less than copper at room temperature. The strong interdisciplinary nature of the field today is certainly reflected in these two volumes, ranging from the synthesis and characterization of new organic polymeric compounds, through the wide range of measurement techniques which have been applied to them, to the novel concepts which have been applied to explain the data. In this latter context I found the idea of charged solitons in a quasi - one dimensional conductor particularly fascinating. I should also mention the strong emphasis on potential future application, e.g., in rechargeable batteries and electrochromic display devices. Note, however, the word 'potential' in the preceding sentence; I was intrigued by the statement (near the end of Ch.13) 'It is projected that, unless significant commercial markets are developed or are likely by 1987 or 1988, these materials will most probably revert back to simply being academic curiosities'. Those who are considering clambering aboard the bandwagon, take note!

There is a consistent fluency of style and clarity of expression throughout the two volumes, and the relatively generous space allocation has allowed the contributors to avoid the terseness so frequently found in multi-author specialist publications, e.g., conference proceedings. Several of the chapters contain well-written summaries of essential background material, e.g., the discussion of the electronic structure of organic compounds, and the associated terminology, in Ch.1.


The reader looking for a general discussion of the numerical analysis of the n-body problem will be disappointed with this book. It tells us nothing about the problems of simulating condensed matter, plasma or galaxies, and there is no discussion of the relative merits of monte carlo and molecular dynamics techniques. It is concerned solely with a narrow class of gravitational n-body problems which involve the motion of a small number of bodies (less than seven) treated as point masses. Most of the book describes in detail the classical initial value algorithms for ordinary differential equations which are available elsewhere (for example Burisch and Stoer's Introduction to Numerical Analysis, Springer Verlag). There are lengthy comparisons between different methods but the results are problem dependent and therefore of doubtful value. For example, the specialist will search in vain for an account of regularization (for close encounters) which may have an important bearing on the choice of algorithm. I was disappointed to find no discussion of techniques for large n-body problems and bored with the description of conservation algorithms which can be obtained more elegantly, and with greater generality, using discretised variational principles. I doubt if any physicist would find the purchase of this book worthwhile.


There always seems to be an unending stream of first year physics texts coming on to the market, and although each one generally has something different to offer, something to make it different from its competitors, the differences are not great enough to make it worth changing from the established text already in use.

Ohanian has written a book which, in many areas, is again just one more variation of the established theme, but which has three additional features which set it apart from its competitors. The treatment of Mechanics, Waves, Thermal Physics, and Atomic Physics is of the same standard and in the same mould as books such as those by Halliday & Resnick, and Weidner & Sells, but the treatment of Electromagnetism is refreshingly different in that it covers all the physics of dielectric and magnetic media covered in the other books, yet manages to do so without introducing any quantities other than $\mu$, $\varepsilon$, $\varepsilon_0$, dielectric constant, and magnetic permeability. All the physics is there, but the confusing (to first year students) plethora of electric and magnetic vectors and susceptibilities is absent. The result is a clear and superior presentation of the major segment of any first year Physics course, and it alone warrants a close look at this book.

However, the feature which really sets this book apart from its competitors is the inclusion of twelve segments, referred to as Interludes, interspersed among the chapters. These
BOOK REVIEWS

interludes deal with topics of major interest in present day physics which cannot be properly taught at first year level but which never-the-less enthral most students. These include topics such as Elementary Particles, the Big Bang, General Relativity, Fission and Reactors, Superconductivity, and Lasers, just to mention a few. They lend a tremendous atmosphere of excitement to this book and give students a taste of the real excitement of Physics in years to come. They do not constitute part of the formal presentation of the subject but they give the whole book such a lift that it really does stand apart from all the traditional texts.

This feature should be enough to tempt lecturers to adopt this text, but there is more to come. There is an accompanying study guide, which consists of summaries of the main ideas introduced in the chapters together with both worked and guided problems. The study guide is an ideal source of material for use in tutorial sessions, or may be used as a teach yourself guide to problem solving. The two books together constitute an approach to teaching and learning first year Physics which, in my experience, has no equal.

PHOTONS, GALAXIES AND STARS. R. Hanbury Brown, Indian Academy of Sciences, Bangalore, 1985, ix + 426 pp. Reviewed by R.A. Minard, School of Physics, The University of Sydney.

This book is a selection of papers written by R. Hanbury Brown in collaboration with several other scientists. It documents most of his career with the exception of some work on radar during World War II. The main topics covered by the collection are the discovery of intensity interferometry and its application to radio and optical astronomy. There is also a series of papers of historical interest, written at Jodrell Bank between 1959 and 1961, on the radio emission from normal galaxies.

Conventional radio amplitude interferometry requires the distribution of a common local oscillator to both receivers. R.H. Brown and R.Q. Twiss proposed intensity interferometry to make this distribution unnecessary. Difficulties associated with the distribution were soon overcome so that a new technique found little use in radio astronomy. However it was realised that intensity interferometry could be applied to low baseline optical interferometry. Two decades were to pass before the technological constraints of optical amplitude interferometry could be met. During this period a stellar intensity interferometer was constructed at Narrabri, N.S.W. under the auspices of the University of Sydney. Its design and operation are described in a four paper series included in the collection, as are important papers presenting the results of angular diameter and effective temperature determinations for 32 stars.

The transition from radio to optical interferometry was far from smooth. A controversy resulted because some physicists felt that intensity interferometry, which relies on the wave-like properties of light, would not work with photons. Several papers discussing the problem are included in the collection and make interesting reading.

The value of a book containing a collection of already published papers is somewhat questionable, especially in the case of this book since nearly all of the papers are available in readily obtainable journals. However, the collection of twelve of the most significant papers on the Narrabri intensity interferometer should be useful for someone encountering the subject of stellar intensity interferometry for the first time.

This book would be a worthwhile acquisition for people with a personal interest in the development of either radio astronomy or intensity interferometry.

WEIGHS AND MEASURES IN VICTORIA (A HISTORY AND SURVEY), S.J. Proctor, Magenta Press Pty Ltd, 1983. 80 pp. $6.95 (paper).

WEIGHS AND MEASURES ADMINISTRATION S.J. Proctor, Magenta Press Pty Ltd, 1983. 104 pp. $6.95 (paper)

Reviewed by J.H. Haworth, Geologist, Mining Services, Perth, W.A.

As both these books cover essentially the same territory I propose to review them side by side. firstly the History and Survey is a short review of the development of current laws and administration of Weights and Measures in Victoria. The author was Superintendent of the Department of Weights and Measures in Victoria from 1949 to 1975 and has a very good grounding in the subject. The book is hard to read being very stilted and disjointed, however, with patience the reader can gain information covering a range of topics from the equipment required for measuring volumes, weights and measures to the administration of a W.M. department. The book is mainly concerned with the Victorian department and involves a description of the problems when establishing themselves in the Observatory building. This is probably the only light part of the text.

Weights and Measures Administration is designed to be coupled with the previous book to give a reference text for officials or administrators of W.M. departments. This book is more involved in the establishment of a department and covers legislation, standards to be used, methods of discerning and employing good officers, and even a section on getting government finance. While the majority of the author's time was spent in the imperial system, he was actively involved and contributed to the re-organisation of the standards when metrication occurred beginning in 1970.

Both texts will give the reader a good reference library for the varying responsibilities and measuring required in this department. As the author points out under 'getting government finance', it is a little-known subject which covers nearly all aspects of daily life including packaging, weighbridges, farm milk tanks, sports and all forms of equipment used in measuring volumes, weights, time, temperature and length for commercial, scientific and sporting applications.

In summary both texts are designed for people actively involved in Weights and Measures and such readers will gain much information from them. Details of all aspects are given and while the text of the "Administration" book is more readable than "A History", both will contribute to your knowledge of this department. So, for researchers - if you ever wanted to know who is responsible for calibrating and adjudicating all measuring equipment - the answer is in these books.

WEIGHS AND MEASURES ADMINISTRATION
WEIGHS AND MEASURES IN VICTORIA

Two books by S.J. Proctor B.Sc., A.R.A.C.I., formerly Superintendent, Weights and Measures (Victoria) and Member, National Standards Commission; wide metric conversion work.

Metrology in fair trading, law and consumer protection.

$5.95 per copy at Campion Books, 83 Franklin Street, Melbourne, 3000, Victoria, Australia. Posted $6.95 (Australia), $7.50 elsewhere (Australian currency), prepaid unless account held with Campion Books.

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NEW PRODUCTS

ETP OXFORD

Light Beam Chopper
MACAM Photometrics of Edinburgh Scotland has released their model 230 Light Beam Chopper.

The chopper is a durable, stable device that has a range of 3Hz to 3kHz. It includes 3 spring steel, chopper blades 73mm diameter, making the chopper head suitable for mounting in tight places.

The control cable is attached to the side of the head to conserve mounting space. The control unit sets the chopping frequency by means of a 10 turn potentiometer. An external voltage may also be input to control the chopping rate. A reference output is included and is a 5 volt square wave.

The chopper head drive motor is an 11-pole DC motor capable of running up to 6,000rpm. The head may be mounted by 12.7mm horizontal or vertical hole and a milled head screw.

Ultra-High Field Magnets
OXFORD INSTRUMENTS has extended the maximum field available from its range of High Field Superconducting Magnets.

The most recent advances in the manufacturing process together with optimised filamentary superconducting materials, have enabled fields in excess of 18 Tesla to be achieved with the magnet operating at a temperature of 2.2K. This field level is believed to be the highest, commercially available, using a compact magnet with all sections of the magnet working in series mode, allowing "persistent mode" operation at negligible power and low liquid helium consumption.

These new magnets have the low field noise, hysteresis and remanence characteristics that are expected from "filamentary magnets" and should be particularly welcomed by those researchers working in solid state, semiconductor or ultra-low temperature physics where the availability of stable fields around 18 Tesla, and above, represents a major advance.

A comprehensive booklet giving details of Oxford Instruments range of superconducting magnets is available, on request.

To obtain this booklet/further information contact:
Fred Blake,
ETP Oxford Pty Limited,
31 Hope Street,
ERMINGTON, N.S.W., 2115
Phone: (02) 858 5122

QUENTRON OPTICS

Radon Sniffer
The affordable Radon Sniffer from Thomson and Nielson Electronics Ltd of Ontario Canada is a revolutionary handheld instrument designed primarily to measure - quickly and accurately - radon daughter products inside enclosed spaces - buildings or mines. The Radon Sniffer samples air and collects airborne radioisotopes on a Millipore filter. The alpha particles emitted by the sample are then counted using a semiconductor detection system and the count is displayed immediately on a digital readout - no computer analysis is needed. This count is a measure of the level of daughter products in the air sampled. You can use it to calculate the working level or the Working Level Month.

The exclusive technology developed by Thomson and Nielson Electronics for measuring radon working levels makes the 'Radon Sniffer' instrument smaller, lighter and more cost-effective than anything else on the market today.

To find out more about this innovative new product contact:
Peter Douglas,
Quentron Optics,
P.O. Box 147,
Five Dock, NSW 2046.
Ph: (02) 712 3111

DATA ELECTRONICS

As a novel integration of hardware and software in sophisticated problem solving, data logger has won world markets for Melbourne based Data Electronics. The company exports its Datataker range of microprocessor-based data acquisition equipment to 21 countries. Major users include universities, hospitals, research organisations, government departments, mining, oil and manufacturing companies. The largest single user in Australia is CSIRO.

Using the Datatakers, scientists and engineers can record information about the physical world, store it in memory and transmit it to a computer or printer. Virtually any sensor or computer can be used with the unit which can monitor up to 56 inputs.

The Datataker automates data collection, reducing staff required for monitoring experiments. Novel design and sophisticated software have been combined in the Datatakers to produce a powerful data logger at low cost. This has brought computerised data acquisition within the reach of most researchers. Data collected is stored in computer compatible form and can be directly input to a computer.

A field version of the Datataker with a stainless steel case is available for use outdoors. An industrial version developed for use in manufacturing and mining industries has gained wide acceptance with engineers. All units have an operating range of -20°C to +65°C and are tolerant of mechanical vibration and electrical noise. Low power CMOS circuitry enables the units to be powered from mains, batteries or solar cells.

For further information contact:
Tony Schauble,
Marketing Director,
Data Electronics,
46 Wadburth Drive,
THE UNIVERSITY OF WESTERN AUSTRALIA
Department of Physics

1. SENIOR TUTOR
(REF: A23/07 50)
Appointment is for an initial period of three years and may be extended.

2. SENIOR TUTOR
(REF: A 24/87)
Appointment for three years only.

Applications are invited for these two positions, both of which are available immediately. The main research interests of the department lie in atomic, molecular and surface physics, gravitational physics and in theoretical physics. Specific interests include scattering phenomena involving electrons, ions and atoms, laser and X-ray spectroscopy, spin polarized electron studies, electron density determinations, gravitational radiation detection, gravity gradiometry, cryogenic technology, and theoretical studies in co-operative phenomena, chaos in nonlinear phenomena, plasma physics and astrophysics. The positions are appropriate for recent PhD graduates with experience in any of the above areas.

A genuine interest in the undergraduate teaching programme is essential and in addition to conducting undergraduate lecture and laboratory classes appointees will be expected to participate in the supervision of postgraduate and honours students.

The department has its own extensive modern computing facilities, helium liquefier, and well-staffed and up-to-date mechanical and electronic workshops. In addition it has access to CYBER, DEC10 and PRIME mainframe computers and to the facilities of the University’s Electron Microscopy and X-ray Crystallography Centres. Further information is available from the Head of Department, A/Prof R. S. Crisp on Ph. (09) 380 2738.

Closing Date: 24th July, 1987

Benefits include superannuation, fares to Perth for appointee and dependent family and removal allowance.

Applications quoting reference number, stating full personal particulars, qualifications and experience and the names and addresses of three referees should reach the Appointments Officer,
The University of Western Australia,
Nedlands, W.A. 6009 by the closing date.

Conditions of appointment will be specified in any offer of appointment which may be made as a result of this advertisement.

EQUAL EMPLOYMENT OPPORTUNITY IS UNIVERSITY POLICY.

UNIVERSITY OF QUEENSLAND
RESEARCH FELLOWSHIP
DEPARTMENT OF PHYSICS

Applications are invited for a Post-Doctoral Research Fellowship in the area of Experimental Laser Physics/Quantum Optics. Laser equipment operating in the sub-millimetre, infra-red and visible regions of the spectrum is available. Topics in these areas currently being researched include:

1) Output frequency and power characteristics of optically pumped submillimetre wavelength lasers driven by pulsed and CW CO₂ lasers.
2) Non-linear optical properties of materials in the 10 μm wavelength region.
3) Two-photon spectroscopy using a 380 D tunable dye laser and atomic H and T vapours. The successful applicant would be expected to collaborate in at least one of these projects, and would also be encouraged to develop a new project in the general area.

The appointment will be for one year initially with the expectation of extension for up to three years. The salary will be in the range $A24,013-$A27,507 per annum, with a contribution made to air fares. Applications close on 31 July 1987. Reference No. 23887.

Additional information and application forms are available from the Director, Personnel Services, University of Queensland, St Lucia 4067, Queensland, Australia.

WE ARE AN EQUAL OPPORTUNITY EMPLOYER

SCHOLARSHIPS FOR STUDY IN NEW ZEALAND
ANZAC FELLOWSHIPS

A small number of Fellowships will be offered by the New Zealand Government to Australians for 1988. These awards are intended to give men and women who have achieved distinction or who have shown potential in the professions, primary and secondary industry, education, commerce, public service or the arts, the opportunity of training, studying or furthering their professional experience in New Zealand.

Conditions
Candidates must be Australian citizens, preferably under the age of 45 years. Fellowships are tenable for periods of between 3 and 12 months.

Benefits
Maintenance allowance NZ$20,075 p.a. ($NZ525 per day).
Allowances for dependants whether or not they accompany the Fellow, Medical Insurance, Return air fare, Approved internal travel costs, tuition and other fees.

Applications
Further information and application forms may be obtained from:
Secretary,
Anzac Fellowship Selection Committee,
Department of Education,
PO Box 826, Woden, ACT 2606.

Closing Date: 17th July 1987.
ANSTO
(Australian Nuclear Science & Technology Organization)

Legislation establishing ANSTO to replace the Australian Atomic Energy Commission (AAEC) came into force on 27/4/87.

The creation of ANSTO will provide a new direction for nuclear science and technology. It will shift the focus of research away from work on the nuclear fuel cycle, and in particular power generation - which was the basis of the AAEC's original chart - towards other peaceful and socially-beneficial uses of radionuclides.

In particular ANSTO will concentrate on radiation and radioisotope applications in the medical, industrial, agricultural and scientific fields, and will operate in a more outward-looking and commercially oriented manner than its predecessor.

ANSTO will be allowed to undertake non-nuclear research where this constitutes an efficient use of resources and does not duplicate work undertaken by other Commonwealth bodies. The legislation creating ANSTO expressly prohibits the Organisation from undertaking any research into the design or production of nuclear weapons or other explosive devices.

Professor R. E. Collins, Professor of Applied Physics at Sydney University, has been appointed Chairperson of ANSTO; Mr B.J. Hill, Deputy Secretary of the Department of Resources and Energy, has been appointed Deputy Chairman while Mr R.J. Fynmore, Executive General Manager of BHP, Mr H.M.J. Meyer, ACTU Representative, Dr J.G. Morris, Director of Nuclear Medicine, Royal Prince Alfred Hospital, and Dr P.M. Robinson, Group General Manager, Metals Manufactures LTD have been appointed members of the Board.

New Safety Review Committee

Three appointments have been made to the new Safety Review Committee, established by the Act, which will review and assess the effectiveness of the standards, practices and procedures established by ANSTO.

The Committee will be chaired by the Director of the Australian Radiation Laboratory Dr K.H. Lokan. The Deputy Chairperson will be Dr J.D. Harley, Acting Regional Director, NSW Department of Health, Mr P.J. Herborn, Assistant Planner, Sutherland Shire Council, has also been appointed to the Committee and the Government is presently considering several other possible appointments.

Progress on Nuclear Non-Proliferation

The major elements of legislation to give effect to Australia's international nuclear non-proliferation obligations, and to place strict controls on all nuclear materials and associated items in this country, have been proclaimed to come into effect as of 1/4/87.

The Nuclear Non-Proliferation (Safeguards) Act 1987 is an important demonstration of the Government's commitment to preventing the further spread of nuclear weapons and working toward disarmament.

The object of the Act is to give legislative effect to relevant obligations under:

• the Nuclear Non-Proliferation Treaty;
• Australia's safeguards agreement with the International Atomic Energy Agency (IAEA);
• Australia's bilateral nuclear safeguards agreement with 10 individual countries and the European Community's nuclear agency Euratom; and
• the Convention on the Physical Protection of Nuclear Material (to be ratified by Australia in the near future).

The Act will bring all nuclear material - defined as uranium, plutonium and thorium - and associated items in Australia under strict control in furtherance of the Government's non-proliferation policies. A system of permits is established for the possession and transport of nuclear material and other associated radioactive physical items.

The Act also deals with the possession and communication of sensitive information about nuclear technology. Information in this category is carefully defined so as to avoid unnecessary restrictions and, essentially, is confined to information directly applicable to proliferation sensitive stages of the nuclear fuel cycle such as enrichment and reprocessing, and the design of nuclear weapons.

The legislation will be administered by the Australian Safeguards Office (ASO) which is part of the Department of Resources and Energy. Most organisations, companies and individuals having material or items in their possession which may fall within the ambit of the Act will already have been contacted by the ASO. Others should get in touch with ASO as soon as possible and ASO will supply them with the necessary application forms and, provided applications are lodged promptly, will ensure that permits and authorities are granted before the offence provisions come into operation.

The Australian Safeguards Office will be happy to assist with any queries in relation to the operation of the Act. The address of the Australian Safeguards Office is PO Box KX 261, Kings Cross, NSW, 2011, telephone (02) 358-6255.

Ranger Mine Water Management

The Government is totally committed to ensuring the complete environmental protection of the Kakadu National Park and guaranteeing that it is not damaged in any way by the Ranger uranium mining operation.

The Government has now decided upon a plan of action for the long-standing problem of water management at the Ranger mine which should make unnecessary the need to consider release of water of any kind from the mine's restricted release zone (RRZ) in the foreseeable future.

The Government has considered a Technical Working Group's report on water management for the Ranger uranium mine but is not fully satisfied that any of the options canvassed in that report is fully acceptable.

The Government has decided:

• to refuse permission for the release of any water from the mine this year;
• to require Ranger to proceed immediately to deepen, by the end of 1987, the existing retention pond (RP2); and
• to instruct the Supervising Scientist for the Alligator Rivers Region, in consultation with Ranger, to develop further practicable and environmentally acceptable options aimed at ensuring that Ranger water management is fully consistent with protection of the environment.

The Technical Working Group (TWG), comprising representatives from the Office of the Supervising Scientist, the Northern Territory Government and the Ranger Uranium Mine, was set up by the Minister for Arts, Heritage and Environment in 1985 to report upon Best Practicable Technology (BPT) for the management of the mine's accumulations of run-off water (not tailings or process water, which is separately contained).

In reaching its decision the Government has paid close regard not only to the scientific and technical issues considered in the TWG Report, but also to the range of social and other issues addressed in the Report of the House of Representatives Standing Committee on Environment and Conservation (Ranger Uranium Water Management System) tabled in the House of Representatives on 16th October 1986. It also took fully into account the views of the Northern Land Council.
and concerns that have been expressed by other community groups about the release of mine water.

Three options for the management of Ranger run-off water were considered in detail by the TWG. These involved, subject in each case to a full chemical and biological control regime, probabilities of release of runoff water in:

- "2 years in 5" (involving no additional storage),
- "1 year in 10" (involving the deepening of RP2), and
- "1 year in 30" (involving the construction, over the next 2 years, of a new 30-40 ha storage pond).

The TWG concluded, and the Government agrees, that the third (or "1 year in 30") option is environmentally unacceptable in the form in which it has so far been proposed as it would involve the construction of another large and unsightly evaporation pond, of approximately 30-40 ha in size, which would itself cause environmental damage through erosion and siltation, and make still more difficult the task of rehabilitating the mine-site after mining operations have ceased.

The TWG identified the "2 years in 5" option as BPT (subject to social considerations), and also endorsed as scientifically and technically sound, although in its view unnecessary, the "1 year in 10" option.

The Government, after considering not only scientific and technical issues but also the social factors which are a necessary component of BPT, has decided that no system which involves the probability of water release nearly every second year is appropriate, and that Ranger should be required to enlarge its existing RP2 storage to reduce this probability, at least in the first instance, to one year in ten. This excavation can be accomplished during the forthcoming dry season, with the new system being in place by the 1987-88 wet.

The Government will not permit any of the water presently in RP2 to be discharged to the Magela Creek. This year's wet season, now effectively over, has not been heavy, and it will be possible - for the purposes of excavation - to drain any remaining water in RP2 into the tailings dam.

At the same time the Government has decided that another major effort should be made to develop further practical options aimed at reducing to a still greater degree the need for water release ever to be considered.

Australian Academy of Science Pursuing Public Information Project

The Australian Academy of Science is currently planning an innovatory project aiming at promoting public understanding of science and technology and is seeking funds for its early establishment.

The President of the Academy, Professor David Curtis, said that the proposed Australian Science and Technology Information Service would encourage visible and closer links between scientists and technologists on the one hand and the general public, secondary schools, politicians and public servants on the other. In all, 15 specific projects are planned for the Service. The scientific community is acutely aware of its responsibility to enhance the well-being of the nation in economic and cultural terms. At all levels of the community (in industry and commerce as much as in the public service) there is a need for improved perceptions and understanding of the crucial contributions which can be made through research and development.

The first step towards an appreciation of the importance of applying science and technology to national recovery will be taken if there is frequent exposition of what researchers are doing, if there is a clear explanation of what they have achieved and if there is informed debate about the problems entailed in reaching their goals.

The Academy sees the generation of a nationwide commitment to science and technology as a long-term priority. Australia not only lags behind its competitors in the proportion of GDP spent on research and development, but also spends almost nothing on promoting informed understanding of the science and technology underpinning R&D.

Reaching the public

The Information Service would start by gathering a "databank", representative of working scientists and technologists in research institutions throughout Australia who are prepared to assist in communicating with the public, with schools, with politicians and with public servants. It is anticipated that many hundreds will volunteer to help in launching the Information Service.

One major project of the Information Service would be directed to the community at large by serving the day-to-day needs of reporters and producers in the media for authoritative information and comment on the wide range of expertise in Australian science and technology.

Reporters from around the nation would be able to ring "toll-free" a central office which would arrange rapid access to informed and articulate speakers. (This project is adapted to Australian conditions from two highly successful "media resource services" in the USA and UK which handle thousands of calls each year - the Australian service will exchange information with its counterparts overseas.)

Serving the schools

Through its textbook publishing operation the Academy has long had a commitment to improving the quality of science education. This work would be extended through the Information Service by helping to increase the frequency of direct, personal contact between scientists and the pupils and teachers in schools. A nationwide bureau of experts would be established who would visit schools and who would arrange for school parties to visit their laboratories and plants.

Advice for politicians

Another strategic group to be served by the Information Service are politicians and public servants. The Information Service will offer a "one-stop referral shop".

Budget

The Information Service has been planned by a working party convened by the Secretary (Physical Sciences) of the Academy, Dr R. Crompton. The budget is $268,000 in the first year.

Dr Crompton said the Academy is seeking $100,000 from government sources as a "seed" commitment which would enable it to approach other possible supporters, especially institutions and industry with an involvement in R&D, to make up the remainder.

Contributing organizations would secure access for experts in their employ to the "databank" and would be offered a range of nationally-coordinated services to assist them in their own information activities.

The detailed plans have been drawn up by Dr Peter Pockley, a member of the working party who visited the UK last year as part of the preparations.

For further information contact:
Dr Crompton [(062) 49 2403]
or Dr Pockley [(02) 697 2866 or (02) 660 6363].

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Conferences and Meetings

1987

Aug 8-10  Neutron Scattering Symposium, Sydney.
          The Secretary - ANBUG, Cl- AINSE, Private Mail Bag, P.O., Sutherland, NSW 2232.
Aug 10-14  7th EPS General Conference, Helsinki.
          EPS Secretariat, PO Box 69, CH-1213 Petit-Lancy 2, Switzerland.
Aug 12-30  XIV Int. Congress and General Assembly, UC, Perth.
          Dr E.N. Maslen, Crystallography Centre, The University of W.A. Nedlands, WA 6009.
          Dr J.H. O'Donnell, Department of Chemistry, University of Queensland, Brisbane, QLD 4067.
Aug 17-21  ICAME87 - International Conference on the Applications of the Mössbauer Effect.
          ICAME87, Department of Physics, Monash University, Clayton, VIC 3168.
          E.H. Nickel, Division of Minerals & Geochemistry, CSIRO, Private Bag, Wembley, WA 6014.
          Dr. S.W. Wikins, CSIRO, Division of Chemical Physics, P.O. Box 160, Clayton, VIC 3168.
          The Hon. Organising Secretary, ANZAAS Congress, James Cook University, Townsville, QLD 4811.
          Dr J.H. O'Donnell, Chemistry Department, University of Queensland, Brisbane, QLD 4067.
          Prof. J. Rose, 5 Margaret Rd, Lytham St Annes, Lancs. FY8 3EG, U.K.
          Conference Secretariat, The Institution of Electronic and Radio Engineers, 99 Gower Street, London WC1E 6AZ.
Sep 14-18  14th Int. Conf. on X-ray and Inner-Shell Processes, Paris.
          Secretariat 187-Pierre Lagarde, LURE, Bâtiment 209 d, Université Paris-Sud, 19140 ORSAY Cedex, France.
Sep 26-29  General Physics Meeting, Physical Society of Japan, Tohoku University.
          Physical Society of Japan, Room 211, Kikai-Shincho Building, 3-5-8 Shiba-Koen, Minato-Ku, Tokyo 105, Japan.
Sep 30-Oct 3  Elementary Particles Meeting, Physical Society of Japan, Utsunomiya University.
          Physical Society of Japan, Room 211, Kikai-Shincho Building, 3-5-8 Shiba-Koen, Minato-Ku, Tokyo 105, Japan.
Oct 6-9  Int. Conf. on Electrical Machines and Drives, Adelaide.
          Conf. Manager EECS7, Institution of Engineers, 11 National Circuit, Barton, ACT 2600.
Oct 14-16  International Conference on Modelling and Simulation, Melbourne.
          H. Saleen, Swinburne Institute of Technology, PO Box 218, Hawthorn, VIC 3122.
Oct 14-17  ASPEN Physics Education Conference, Kuala Lumpur.
          Secretary, Dept of Physics, Universiti Kebangsaan, Malaysia, 43600 UKM Bangi, Selangor, Malaysia.
Nov 4-6  5th Conference Nuclear Techniques of Analysis, Lucas Heights.
          J. Watson, Lock Mail Bag No. 1, Menai, NSW.
Nov 12-13  Annual Conference of the Australian Acoustical Society, Hobart.
          Mr S.E. Samuel, ARRB, PO Box 156 (Bag 4), Nunawading, VIC 3131.
Nov 15-19  International Conference on Lasers, Xiamen, China.
          Professor Deng Xi Ming, P.O. Box 8211, Shanghai, China.
Dec 6-9  12th Aust. Conf. on Optical Fibre Technology, Surfers Paradise.
          Conference Secretary, IEEE, Unit 3, 2 New McLean Street, Edgecliff, NSW 2027.
Dec 7-11  13th Int. Conf. on Lasers & Applications, Lake Tahoe.
          Lasers '87, P.O. Box 245, McLean Va 22101, U.S.A.
          Dr B. Bibby, Physics Dept, Victoria University, Private Bag, Wellington, New Zealand.

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Jan 2-16  Session A and
Jan 16-30  Session B, AIDC National Science Summer School, Canberra.
          Executive Director, School of Applied Science College of Advanced Education, PO Box 1, Belconnen, ACT, 2617
          Dr S. Collocott, CSIRO Division of Applied Physics, PO Box 218, Lindfield, NSW 2070.
Apr 5-8  International Non-Ionizing Radiation Workshop, Melbourne.
          T. Boal, PO Box 4057, Melbourne, VIC, 3001.
Apr 10-17  7th International Congress on Radiation Protection Practice, Sydney.
Aug 8-12  5th Marcel Grossmann Meeting, Perth.
          Dr D. Blair, Physics Dept, University of W.A., Perth, WA 6009.

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