

Jeremy

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“Enlightening physicists since 1985”



Jeremy shares the spirit.

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Editors: Chris Barton, Edward Boyce, Amy Dickings and Kiran Krishna.

Should Australia Go Nuclear?

by Kiran Krishna

Trusting the imagination of my worthy reader to supply the answer to that question, I will presently present my reasons for arriving at the answer thus supplied, attempting always that impossible ideal of impartiality.

Let us strike the key-note before pursuing our tune. It is estimated that, by the year 2050, our consumption of energy will, even allowing for major improvements in efficiency in conversion and end-use, at the very least, double. At the same time, as might be expected, it is looking highly unlikely that this energy can be supplied by fossil fuels. Moreover, we have to consider the likely environmental impact of our choices.

It has been estimated that carbon dioxide forms about half of the human-induced increase in the greenhouse effect (which term I trust my reader has heard frequently enough to allow me the luxury of leaving it undefined), about 9% of which comes from electricity generation. Our other major contributions are methane, CFCs, and nitrous oxide.

That in mind, let us now proceed to examine our various choices. Currently, the world derives about 39% of its energy from coal. Australia derives about 80% of *its* energy from coal. The rest of the world's energy comes from nuclear plants (17%), gas (15%), oil (10%), and hydroelectric plants and other sources (19%).

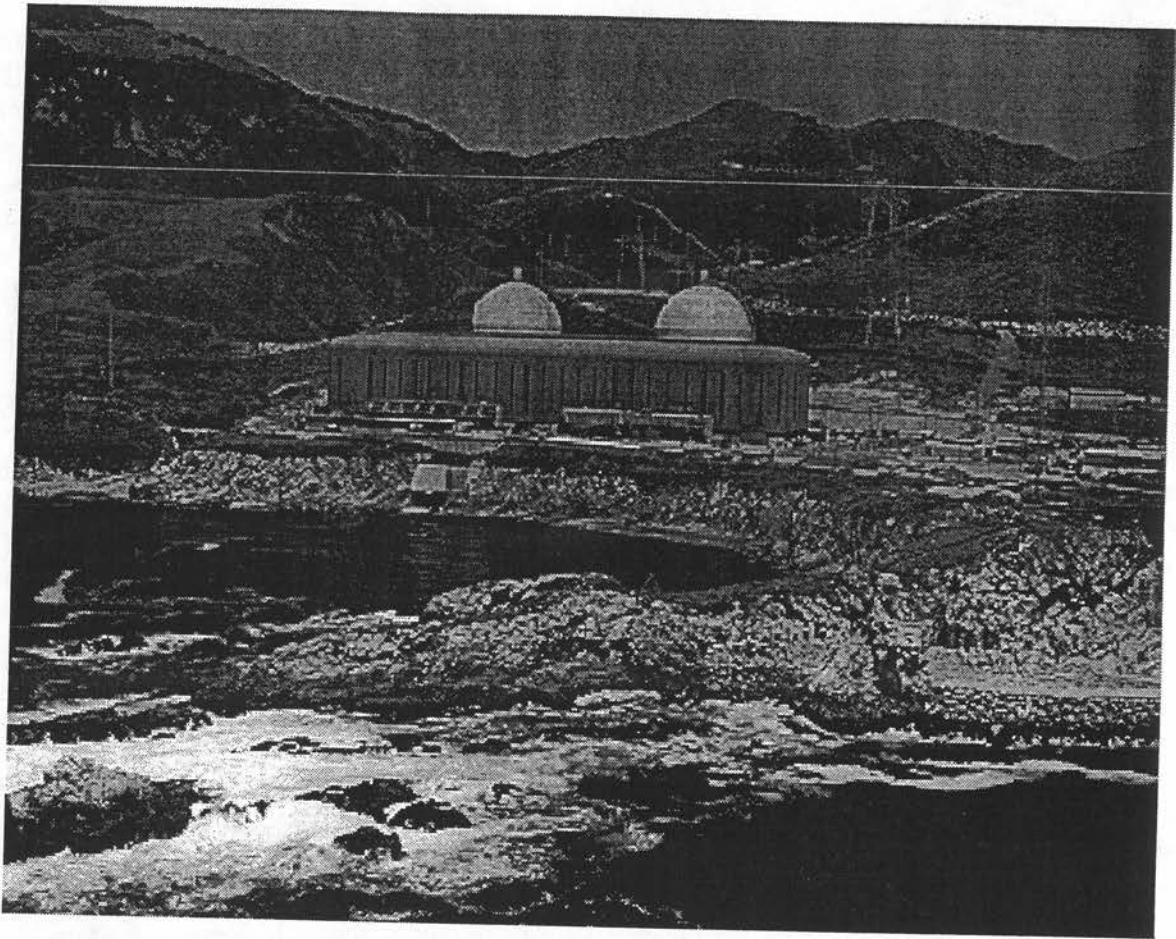
A 1000-megawatt electrical coal-fired power station operating at 80% capacity has a typical fuel requirement of 3.2 million tonnes of black coal every year. Coal-fired power stations worldwide consume over 1600 million tonnes of black coal annually. This requires the mining of about 4500 million tonnes of coal every year. So much for long-term reliability. 45% of the 20,000 million tonnes of CO₂ emitted worldwide comes from coal-fired plants. A 1000-megawatt electrical coal-fired power station produces, annually, about 8 million tonnes of CO₂, 200,000 tonnes of SO₂ (depending on the type of coal used), and about 200,000 tonnes of solids, mostly flyash containing several hundred tonnes of toxic heavy metals such as arsenic, cadmium, lead, vanadium and mercury, which remain toxic forever. The combustion of coal may also release radioactive heavy metals (uranium and thorium) contained in it, though these are mostly retained in the flyash. Though the radioactive pollution resulting from such release is negligible, and rarely effects a significant increase in background radiation levels, it is often much greater than what can reasonably be expected from nuclear power generation. Further, though (highly expensive) methods exist for removing SO₂ and N₂O, and flyash is generally captured and dumped in a landfill, there is no economically feasible way to remove, or reduce greatly, the amount of CO₂ released by the burning of coal. The transport of coal from areas where it is mined is also a major source of greenhouse gas emissions.

Oil, which is used for the production of about 10% of the world's electricity presents us with much the same problems, being a limited resource as a fossil fuel, and is responsible for about 40% of the carbon dioxide we release each year.

Thus, the only way to deal with this crisis is to shift towards existing, and emerging, non-fossil fuel sources. While most of these (wind, nuclear fusion, solar power, etc.) are either being studied, or are variable, intermittent, or limited by geographical and other considerations, power production from nuclear fission is already a well developed (and developing) science, and nuclear power plants can be relied upon to provide a constant output throughout the year. Several major engineering companies from around the world are able to construct such plants with the highest standards of operations and safety. How, then, does it compare with the competition?

A 1000 MWE nuclear power plant, operating at the same capacity as its coal-fired poor cousin, has an annual requirement of only 25 tonnes of fuel, requiring the mining of 45-70,000 tonnes of typical Australian uranium ore. Globally, nuclear power plants use just 76,000 tonnes of uranium oxide every year to provide about 17% of our electricity (2300 TWh in 1996), and are therefore extremely efficient compared to coal-fired plants. This means that only about 10 million tonnes of uranium ore needs to be mined every year throughout the world. Indeed, there is as much energy being generated in the world today by nuclear power, as from all sources worldwide in 1960.

Isn't nuclear power supposed to be environmentally damaging? Governments can get it wrong, but surely, Greenpeace can't! Well, again, looking at 'nothing but facts', here is what we see. Most of the emissions that occur at coal-fired plants occur at nuclear power stations, where virtually all the wastes are contained in the spent fuel, and aren't released into the environment. The total amount of spent fuel resulting from all the nuclear power stations in the world is about 14,000 tonnes per year, which, after reprocessing, is reduced



to about 3% high-level nuclear waste, the balance being recycled as fresh fuel. Handling of nuclear waste, contrary to public opinion, has been (profitably, one might add) undertaken by several countries, without incident, for several decades. This involves the storage of nuclear waste to allow for the decay of the products. The nuclear power industry is indeed the only energy-producing industry that takes full responsibility for all its wastes. Of course, nuclear power plants do produce some greenhouse gases. However, a detailed study by Weis, Kienle and Hortmann in the former West Germany concluded that the energy used in preparing fuel for German reactors is about 0.7% of the energy produced by that reactor, and CO₂ emissions were about 0.5% of those from a coal-fired station of the same capacity. Both of these figures are much lower now, thanks to technological improvements. U.S. Senator (USS) P.V. Domeneci (Republican, New Mexico), in a keynote address to the American Nuclear Society, made the point that nuclear energy allowed a reduction in greenhouse gas emissions from electric utilities by 25%. He concludes, in a speech that can be found on the Internet, that, if expanded, the nuclear power industry could allow the U.S. to meet its greenhouse gas emission goals without the imposition of economically harmful measures such as taxes or other limitations on the use of carbon-based energy forms.

It is often asserted that uranium mining leads to methane emissions. However, the information available indicates that the vast majority of uranium is produced with negligible associated methane emission. Though methane emissions might be associated with isolated mines (The Lisbon mine in La Sal, Utah, which is no longer in operation, seems to be the only such mine listed by The Uranium Institute), methane emission is entirely negligible in most cases.

In 1996, the contribution of nuclear power to electricity supplies was about 2300 terawatt-hours, which was then about 17% of the world's electricity consumption, which prevented the emission of about 2300 million tonnes of CO₂ that year, assuming that this energy would otherwise have been supplied by coal. This represented, then, about 30% of all human CO₂ emissions. By 2050, with a modest growth of nuclear capacity, the role of fossil fuel in the production of energy could be greatly reduced. On the other hand, if nuclear power was completely phased out, as the 'Greens' (One thinks of H.G. Wells) would have it, CO₂ emissions are set to rise by about 40%.

Perhaps my reader thinks I am being unduly dismissive of the problem of waste disposal. Indeed, the

high-level nuclear waste produced by the nuclear power industry must be disposed of. This waste (about 750 kg per year for a 1,000 MWe reactor) is first stored in liquid form, and subsequently solidified. Following reprocessing, the liquid high-level waste is calcined to produce a dry powder, which is then incorporated into Pyrex glass to immobilise the waste. The glass is then poured into stainless steel canisters, each holding 400 kg of glass. A year's waste from a 1000 MWe reactor is contained in 5 tonnes of such glass, or about 12 canisters 1.3 metres high and 0.4 metres in diameter. These can be readily transported and stored, with appropriate shielding. The final disposal of these wastes is the next step, and it is planned that it will be buried, in containers of corrosion-resistant metals such as copper and stainless steel, in stable rock structures, deep underground. (I request my reader's excuse if this deep tract sounds like a description of the Greenpeace Headquarters, but any such resemblance is purely coincidental.)

'But,' interjects my nameless interlocutor, a large-headed dwarfish individual with a smoke-bleared aspect, 'Chernobyl *did* cause much more damage than any fossil fuel accident!' The problem with that statistic, blinking its infant eyelids at the artificial lighting it mistakes for the harsh glare of a hostile world, is that, if we base our judgements on modern nuclear power stations solely on Chernobyl, consistency would require that we judge fossil fuel mines on the basis of those at the beginning of the Industrial Revolution. Such judgements would be unfair because technology has advanced enormously since the time spoken of, and because they would assume that no lessons have been learnt from the accidents in question. At any rate, in all the incidents in question, in case of nuclear power, they have resulted from grave errors in handling of an enormous source of power. To take the example that is freshest in our minds, the accident at Japan's JCO facility occurred because the workers added about seven times the stipulated amount of uranyl nitrate to a precipitation container. Such accidents can be minimised by education of the workers, and strict enforcement of regulations.

In the history of nuclear power, returning to a statistic (mine more mature, serene still, having learnt to care not a pin for the world's doubts about its existence), the number of accidents and deaths resulting from nuclear fuel sources has been lower than with just about any other major source of power. Though accidents such as those at Three-Mile island in the U.S., Chernobyl in the former USSR, and the incident at Japan's JCO uranium facility have alerted a lot of people to the dangers involved in the harnessing of nuclear power, with the exception of Chernobyl, no nuclear accident has had major consequences on anyone other than the staff involved in the accidents concerned. Though these should be (and have been) noted, and the possibility of such accidents reduced, such accidents are inherent in the production of energy, and a greater number of deaths have been caused by fires and collapses of coal mines (to name but a representative couple of an enormous multitude) than by nuclear power. Moreover, the incident at Chernobyl was caused by an obsolete design. At the risk then, of being accused of 'seeing just figures and averages, and nothing else,' as an external judge, I must conclude that fossil fuels are much more dangerous to humankind than nuclear power.

With the development of subcritical (or accelerator-driven) fission, the possibility of a major accident due to nuclear power plants is almost entirely eliminated. This development would also make waste transmutation much more efficient. Perhaps the strongest argument in favour of nuclear power is the speed with which the industry is developing.

Here, another of that mighty troop (rising, a mist, a light, an image), objects that fossil fuels are not the sole alternatives to nuclear power implying that I have ignored hydroelectric plants. Well, then, let us consider the environmental implications of this 'clean' source of power. It is a fact often forgotten that the construction of a hydroelectric plant would require, among other things the construction of a dam, and move on to consider our very own Snowy River project. It is a well-known, and conventionally ignored (What creates the intense pleasure of not knowing? A sense of independence, of power, from the fancy's creating a world of its own by the sense of probabilities.), fact that this project, for all its benefits, has led to an enormous decrease in the amount of water flowing in the river itself. Let us also remind ourselves that the construction of dams requires the submergence of forests as ancient as the hills they behold, defaced by the projects. In many cases, as has been recently pointed out, this also means an additional release of greenhouse gases into the atmosphere from the decay of these trees, which environmental damage it is very hard, if not impossible, to reverse. So much for its being clean. It also should be noted that hydroelectric power cannot be harnessed by everyone.

I hope I have not disappointed those of my readers who expected to be let into the whole secret, from first to last, of everything that they needed to know about nuclear power itself, but to satisfy those who were curious as to my opinions about the question of Australia going nuclear, I return to the fact that we currently produce about four-fifths of our energy from fossil fuels. Australia holds a quarter of the world's uranium resources,

and it can supply energy for electricity with less greenhouse gas emissions than virtually any other country. Yet, we are struggling to meet internationally set standards of greenhouse gas emission. Australian uranium used overseas displaces coal sufficiently to result in a reduction of CO₂ emission by about 300 million tonnes every year, while for every kWh of electricity we use in Australia, we emit about a kilogram of CO₂ into the atmosphere, resulting in a total annual emission of about 160 million tonnes. It is almost criminal to allow ourselves to get away with environmental damage on this scale.

What benefits could an investment in nuclear power bring us? Consider the case of France. Having been a net electricity importer for most of the 1970s, it is now the world's largest electricity exporter, exporting nearly 65 TWh of power in 1997, valued at about \$A 3.7 billion. Australia, which exports about 900 tonnes of uranium oxide to France, thus helping in the production of almost 77% of its electricity, could learn from the example.

Some insist that Australia should get out of the nuclear fuel cycle entirely, and should not only refuse to derive a profit from waste storage, but also tone down, and gradually stop entirely, the mining and export of uranium. Apart from this being an economically irresponsible proposal, it is guided, for the most part, by hysteria and activism rather than any environmentally sensible argument. Though we have a greater amount of uranium than Canada, we supply only about 16% of the world's uranium, while Canada supplies one third of the market. If anything, we could profitably increase our involvement in the nuclear fuel cycle, satisfied with ourselves at having done the world a good deed by reducing the environmental damage caused by energy production.

The Australian Conservation Foundation says that nuclear power is no longer an issue in Italy. They must also recognise that Italy is one of the largest importers of electricity in Europe, and whether they like it or not, they are getting their energy from France which produces about 77% of its electricity from nuclear power. Much has been made of the German government's supposed withdrawal from nuclear energy, but in reality, only one plant has been shut down, and that could be attributed to operational reasons. Any 'environmental' justification could only have been found after the event. Much is also made (I am again borrowing phrasing from the 'Australian Conservation Foundation', whom I wish a lot of success in their efforts to conserve their own ignorance, which, after all, is a valuable resource to some.) of 'people' not wanting nuclear power. The reality, however, is that most people really don't care if their energy is coming from nuclear sources, and the only people who oppose nuclear power are the activists, who do not realise the potential benefits of what they are opposing, and who by their actions are fashioning a fictitious opposition from willing allies. In Germany, for example, a poll carried out after the election in October 1998 which brought Gerhard Schroeder to power showed that 77% of the people supported the use of nuclear power, while only 13% wanted the immediate shutdown of nuclear power plants. The support is actually higher now than it was in 1991 (61% in support of nuclear power).

I have to apologise to the House, who will, I trust, pardon me, not often in the habit of intruding upon their indulgence, for so long attempting to engage their attention. The tumult of protest having dwindled to a convinced calm, I conclude that every reflecting mind must allow that nuclear power is the only way ahead for Australia and the world. QED.

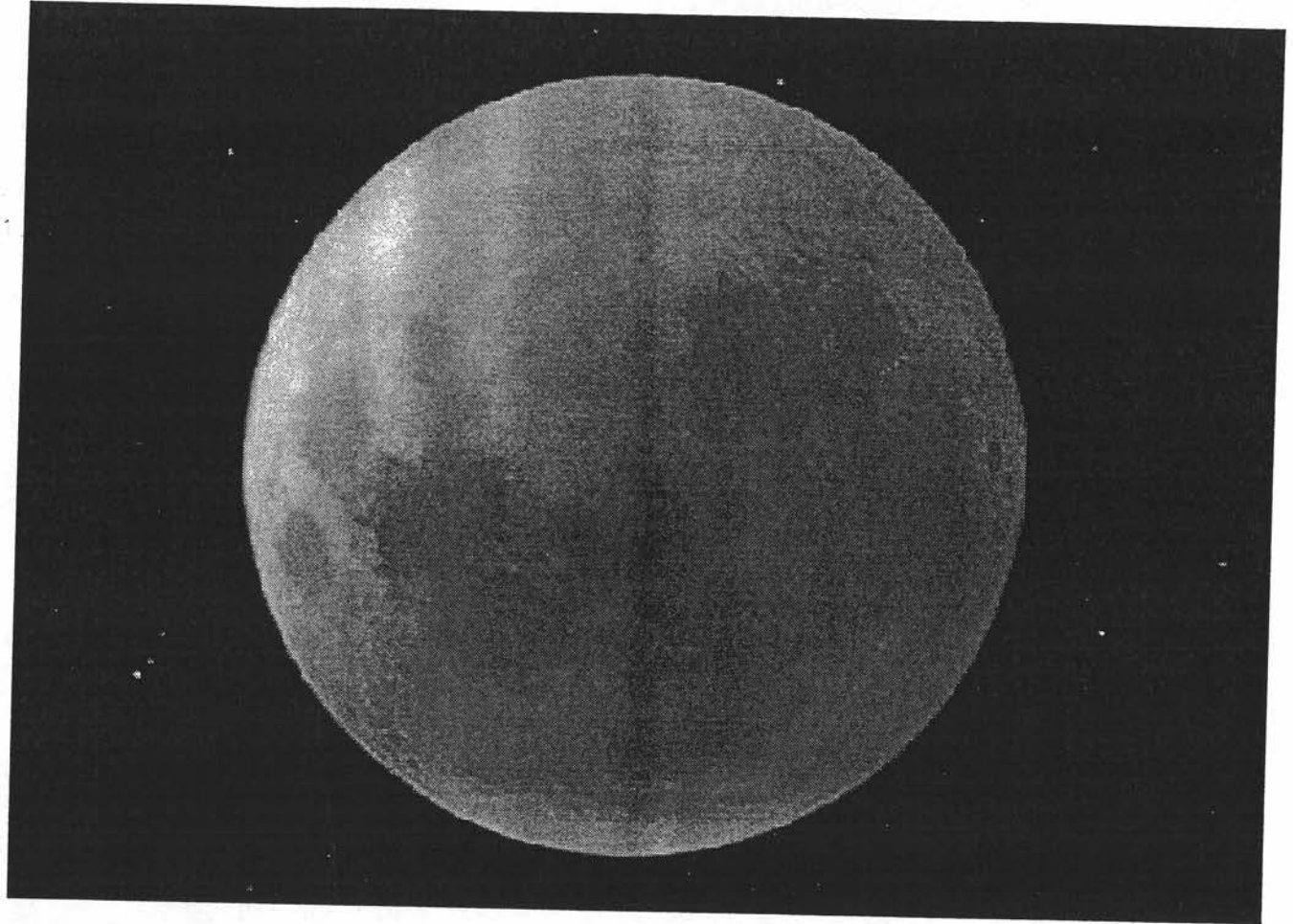
*I request the reader's excuse for the fact that all my figures are slightly out of date, but point out that they represent much more conservative estimates of the problems we face with fossil fuels than are normally used.

Figures (and some of the accompanying phrasing) from the Uranium Institute, and the Uranium Information Centre. I request the reader's patience with me if I have forgotten to list any of my sources.

Note: The views expressed in this article are the author's own, and no inference should be made about the opinion of three-quarters of the board of editors of *Jeremy* based on this.

A Memorable Eclipse

by Amy Dickings



In the last hours of July 16, people everywhere turned their gaze to the heavens, hoping for even a small glimpse past the clouds. Enthusiasts revelled in the opportunity to personally test several predictions. Grandparents told stories about the first time they saw the Moon slip into Earth's shadow. Couples shared a romantic evening by moonlight. As tendrils of white cloud drifted across the red orb, Swans fans sought to capture the 'Swannie Moon' on film. And children everywhere marvelled at the big orange ball in the sky.

Such was the sense of wonder invoked by the longest-lasting lunar eclipse of our time. This sense of wonder crossed over backyard fences, through the generations, and across the city's phone systems.

So, why is it that we find our own shadow so fascinating? Throughout the ages, we have sought answers to the enigmas of the skies, with the nature of both solar and lunar eclipses being one of the main focal points. Watching the very start of the eclipse, I couldn't help but be reminded of numerous depictions of such events as the Moon being 'swallowed up'. Indeed, even before there was any hint of reddening in evidence, it was clear, even to the casual observer, that this was no ordinary 'lunar shadow', with the illuminated portion being crescent-shaped from the very beginning.

But even the skeptic, insisting that the flickering images on 'the box' were more interesting (or, perhaps, simply moving faster) couldn't help but gasp as a glance out the window revealed a hole in the clouds, with an eerie red orb peeking through. It would seem that no 'first timer' of this eclipse had quite anticipated "that red" - and no Sydneysider with recollections of the weather during past eclipses could have anticipated such spectacular defiance of eclipse => 100% cloud cover for the duration.

Of course, there was frustration over the encroaching clouds in some parts of the city. But it is still certain that an eclipse that lasted as long, and was as visible from Sydney suburbia as the lunar exclipse of July 2000, will last in the memories of many for years to come.

Results of the Physics Competition

by John O'Byrne

The Physics Competition was held on Saturday, 20th May, and was very successful, attracting 60 entries, 37 from primary schools, 15 from secondary schools and 8 in the Open division. Prizes were awarded in each division.

Rather embarrassingly, the 3 finalists in the Open Division were all from Applied Physics. In the end Chris Dey won the final "shoot out", followed by Manfred Lenzen and Dick Collins (whose device was operated in his absence by Shauna Murray). It should be noted that when all the scores were added for these three, they actually had the same overall success rate. Several of the primary entries were not far behind!

Thanks to the helpers on the day - Joe Khachan, Brian James, Dick Hunstead, Damien Buie, Edward Boyce, Daniel Mitchell, Jocelyn Laurence (I hope that's everyone) - plus of course Dr. Karl who kept up a lively commentary.

Helpers Needed for Courses and Careers Day

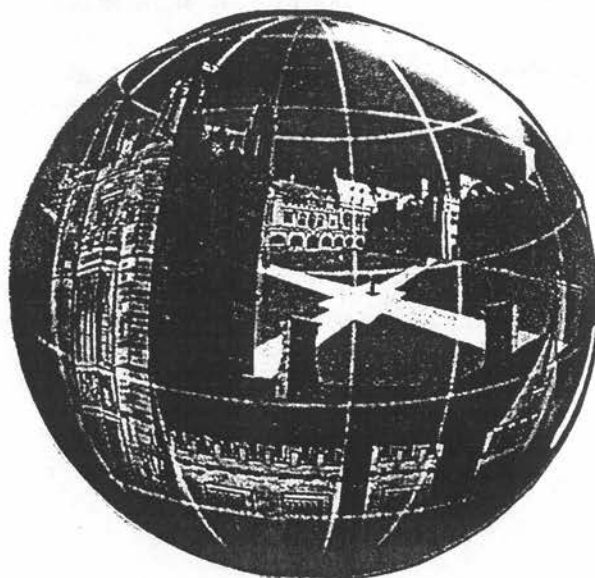
The University's Courses and Careers Day will be held on Saturday 26th August from 9:30 to 4:00. As usual the School of Physics will try to run 4 activities:

- student advising in the Great Hall
- Physics demonstrations in the Chemistry building
- a talk about Physics (already arranged)
- a telescope looking at the sun outside the Great Hall

To manage this we need the staff and students of the School to help. It would be especially good if we could get current students along to talk to prospective students. Set up on Friday afternoon and take down on Saturday afternoon also need a few hands.

Student advising clearly requires some knowledge of the School's courses, and the Faculty and University have information sessions to help with this. Helpers at the demonstrations and the telescope can refer questions to the Great Hall desk if necessary, so anyone can do it.

If you are available, please volunteer to help. Contact John O'Byrne at room 311, phone: 9351 3184, email: j.obyrne@physics.usyd.edu.au



Quotes

[The Klein paradox] is the true meaning of life - at least it's testable.

Enough of sport. Let's move on to something much more interesting - properties of the Dirac Equation.

Yes, hydrogen is a hydrogen-like atom.

We haven't really mentioned the word positron yet - I know I've said it a few times...

Dr. Peter Robinson, Physics

This is where we prove that physicists can't draw.

Dr. Kevin Varvell, Physics

I haven't yet set the paper. So, it's not too late to contribute to the Tim Bedding Retirement Fund.

In practice, you probably don't have the patience to take your source over to infinity...

Dr. Tim Bedding, Physics

I have not assumed you know anything about mass to start off with.

A/Prof. Chris Durrant, Mathematics

You do these sorts of things when you move on to higher things in mathematics - physics and so on.

It's a good idea to avoid a bit of elbow grease and chalk dust and so on.

It's one of those things that's so obvious, 50% of you won't get it.

Dr. Ron James, Mathematics

[You probably don't want to use the trapezoidal approximation] unless you have a real problem.

Even botanists know that one over big is small, or perhaps they don't.

We want to show that there's no hand-waving there.

It's a little bit orthogonal to the way I want to go.

The idea of being good mathematicians is to be right more than half the time.

It takes longer to write this thing out than to see that it's true.

Suppose this butterfly started running out of energy in a monotone sort of way...

Dr. Adrian Nelson, Mathematics

What this tells us is - we are very confused.

Dr. Daniel Daners, Mathematics

Have you performed a Bayesian analysis on [the assertion that coffee thrown across the table won't burn people]?

I read a very depressing statistic in the newspaper this weekend. The chances of your dying before the results of a lottery draw are out are much much greater than your chances of winning first prize. But, if you win first prize, you'll be so surprised you'll die anyway.

Dr. Howard D'Abrera, Statistics

Yes. Tolstoy's Anna Karenina has references to [the revolution of February 1917]

Helen Stewart

[Editor's note: Leo Tolstoy died in 1910]

Java doesn't have friends, but C++ doesn't have packages, so it all balances out.

Sam Holden, Computer Science

You don't need to be a rocket scientist to put a satellite into a high elliptical orbit.

Chris Bozhuizen, 4th Year

Things are only obvious to people who already know.

Applied Mathematics has real problems.

I'll try to think.

Jonathan Dixon, 2nd Year

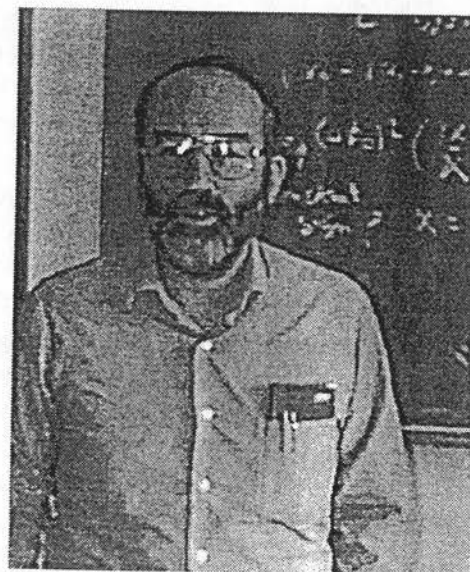
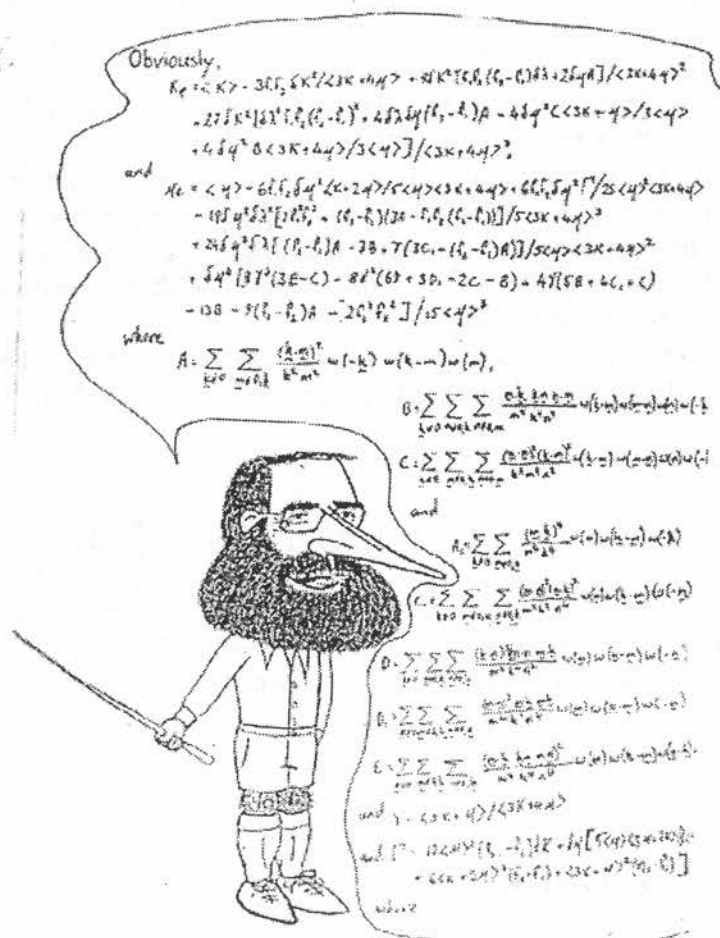
It's near the end point, at the end point.

Amy Dickings, 2nd Year

New Jeremy Feature - Then and Now

It's always fascinating to see how the staff of the School of Physics have changed over the years. For the next issue, we'd like to include some pictures of lecturers from some time in the past, to compare with a current picture. We'd like any cartoons or photos that you might be able to find.

To start the ball rolling, here is a then (left) and now (right) clip of Prof. Ross McPhedran.



Jeremy Competition - New Particles

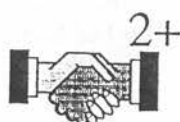
Has science found all the subatomic particles yet? Here at Jeremy, we don't think so. We'd like to hear our readers' ideas for new particles, such as the introduciton, a new exchange particle shown below. Please drop any names, symbols, diagrams, etc. into the Physoc mailbox or email them to physoc@physics.usyd.edu.au by Friday 8th September. There will be a \$50 prize for the best entry received on or before this date.



Photon



Electron



Introduciton

A Hellish Exam

The following is an actual question given on a University of Washington chemistry mid term. The answer by one student was so "profound" that the professor shared it with colleagues, via the Internet, which is, of course, why we now have the pleasure of enjoying it as well.

Bonus Question: Is Hell exothermic (gives off heat) or endothermic (absorbs heat)?

Most of the students wrote proofs of their beliefs using Boyle's Law, (gas cools off when it expands and heats up when it is compressed) or some variant.

One student, however, wrote the following:

First, we need to know how the mass of Hell is changing in time. So we need to know the rate that souls are moving into Hell and the rate they are leaving. I think that we can safely assume that once a soul gets to Hell, it will not leave. Therefore, no souls are leaving. As for how many souls are entering Hell, let's look at the different religions that exist in the world today. Some of these religions state that if you are not a member of their religion, you will go to Hell. Since there are more than one of these religions and since people do not belong to more than one religion, we can project that all souls go to Hell. With birth and death rates as they are, we can expect the number of souls in Hell to increase exponentially.

Now, we look at the rate of change of the volume in Hell because Boyle's Law states that in order for the temperature and pressure in Hell to stay the same, the volume of Hell has to expand proportionately as souls are added. This gives two possibilities:

1. If Hell is expanding at a slower rate than the rate at which souls enter Hell, then the temperature and pressure in Hell will increase until all Hell breaks loose.
2. Of course, if Hell is expanding at a rate faster than the increase of souls in Hell, then the temperature and pressure will drop until Hell freezes over.

So which is it? If we accept the postulate given to me by Ms. Teresa Banyan during my Freshman year, "...that it will be a cold day in Hell before I sleep with you.", and take into account the fact that I still have not succeeded in having sexual relations with her, then #2 cannot be true, and thus I am sure that Hell is exothermic and will not freeze.

The student received the only 'A' given.

A Lofty Exam

The following question appeared in a physics degree exam at the University of Copenhagen:

Describe how to determine the height of a skyscraper with a barometer.

One enterprising student replied: "You tie a long piece of string to the neck of the barometer, then lower the barometer from the roof of the skyscraper to the ground. The length of the string plus the length of the barometer will equal the height of the building."

This highly original answer so incensed the examiner that the student was failed immediately. The student appealed, on the grounds that his answer was indisputably correct, and the university appointed an independent arbiter to decide the case.

The arbiter judged that the answer was indeed correct, but did not display any noticeable knowledge of physics; to resolve the problem it was decided to call the student in and allow him six minutes in which to verbally provide an answer which showed at least a minimal familiarity with the basic principles of physics.

For five minutes the student sat in silence, forehead creased in thought. The arbiter reminded him that time was running out, to which the student replied that he had several extremely relevant answers, but couldn't make up his mind which to use.

On being advised to hurry up the student replied as follows:

"Firstly, you could take the barometer up to the roof of the skyscraper, drop it over the edge, and measure the time it takes to reach the ground. The height of the building can then be worked out from the formula $H = \frac{1}{2}gt^2$ (height equals half times gravity time squared). But bad luck on the barometer.

"Or if the sun is shining you could measure the height of the barometer, then set it on end and measure the length of its shadow. Then you measure the length of the skyscraper's shadow, and thereafter it is a simple matter of proportional arithmetic to work out the height of the skyscraper.

"But if you wanted to be highly scientific about it, you could tie a short piece of string to the barometer and swing it like a pendulum, first at ground level and then on the roof of the skyscraper. The height is worked out by the difference in the gravitational restoring force ($T = 2\pi\sqrt{\frac{L}{g}}$).

"Or if the skyscraper has an outside emergency staircase, it would be easier to walk up it and mark off the height of the skyscraper in barometer lengths, then add them up.

"If you merely wanted to be boring and orthodox about it, of course, you could use the barometer to measure air pressure on the roof of the skyscraper, compare it with standard air pressure on the ground, and convert the difference in millibars into feet to give the height of the building.

"But since we are constantly being exhorted to exercise independence of mind and apply scientific methods, undoubtedly the best way would be to knock on the janitor's door and say to him 'I will give you this nice new barometer, if you will tell me the height of this skyscraper.'"

The arbiter re-graded the student with an 'A.'

A Chain Letter

Dear Fellow Scientist:

This letter has been around the world at least seven times. It has been to many major conferences. Now it has come to you. It will bring you good fortune. This is true even if you don't believe it. But you must follow these instructions:

Include in your next journal article the citations below.

remove the first citation from the list and add a citation to your journal article at the bottom.

make ten copies and send them to colleagues.

Within one year, you will be cited up to 10,000 times! This will amaze your fellow faculty, assure your promotion and improve your sex life. In addition, you will bring joy to many colleagues. Do not break the reference loop, but send this letter on today.

Dr. H. received this letter and within a year after passing it on she was elected to the National Academy of Sciences. Prof. M. threw this letter away and was denied tenure. In Japan, Dr. I. received this letter and put it aside. His article for Trans. on Nephrology was rejected. He found the letter and passed it on, and his article was published that year in the New England Journal of Medicine. In the Midwest, Prof. K. failed to pass on the letter, and in a budget cutback his entire department was eliminated. This could happen to you if you break the chain of citations.

1. Johnson, S. (1991). Micturition in the canid family: the irresistible pull of the hydrant. *Physics Quarterly*, 33, 203-220.

2. Anderson, R. (1990). Your place or mine?: an empirical comparison of two models of human mating behavior. *Psychology Yesterday* 12, 63-77.

3. David, E. (1994). Modern Approaches to Chaotic Heuristic Optimization: Means of Analyzing Non-Linear Intelligent Networks with Emergent Symbolic Structure. (doctoral dissertation, University of California at Santa Royale El Camino del Rey Mar Vista by-the-sea).

4. Boyce, E. (2000). Observing in all Weather: A Survey of ultra low redshift Hydrated Nebulae. *Monthly Notices of the Royal Astrological Society*, 302, 88-91.

Some Non-SI Units of Measurement

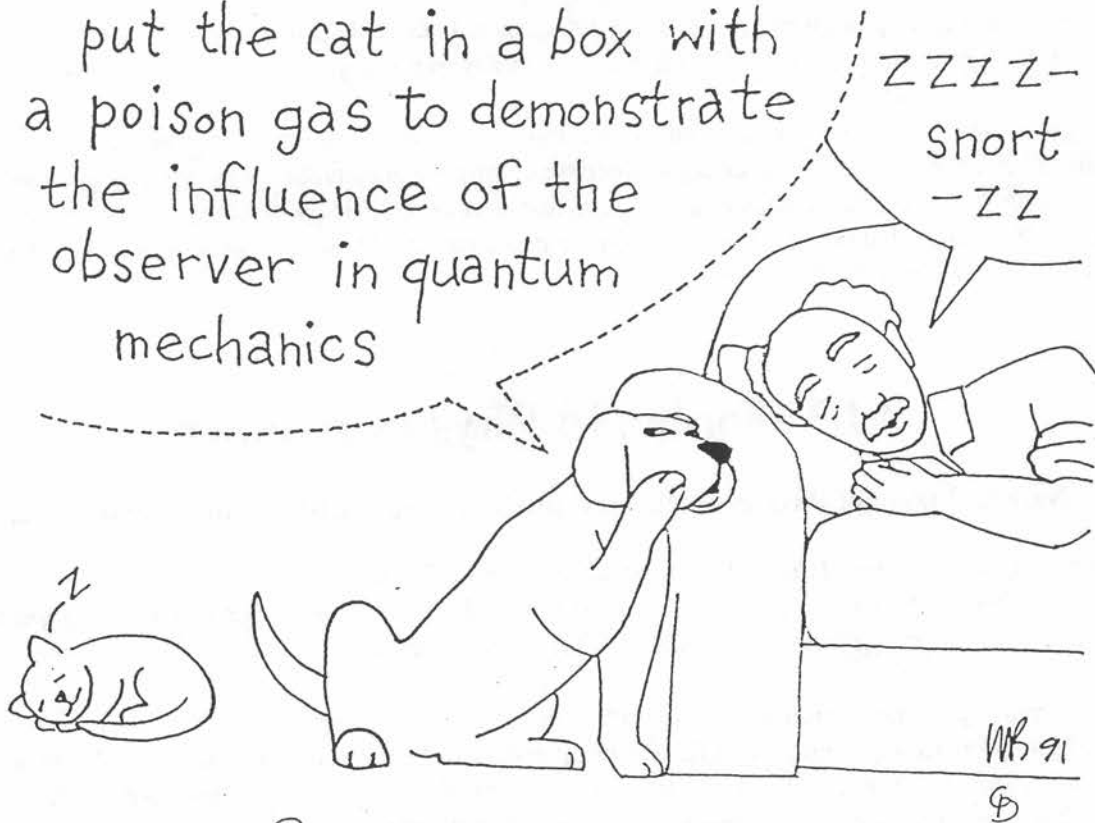
1000 grams of wet socks: 1 literhosen
Time between slipping on a peel and smacking the pavement: bananosecond
Ratio of an igloo's circumference to its diameter: Eskimo Pi
2.4 statute miles of surgical tubing at Yale University Hospital: 1 I.V. League
2000 pounds of Chinese soup: Won ton
1 millionth mouthwash: 1 microscope
Speed of a tortoise breaking the sound barrier: Mach Turtle
Time it takes to sail 220 yards at 1 nautical mile per hour: Knot-furlong
365.25 days of drinking low-calorie beer because it's less filling: 1 Lite year
16.5 feet in the Twilight Zone: 1 Rod Serling
Half of a large intestine: 1 semicolon
1,000,000 aches: 1 megahurtz
Weight an evangelist carries with God: 1 billigram
Basic unit of laryngitis: 1 hoarsepower
Shortest distance between two jokes: A straight line
A Half-Bath: 1 demijohn
453.6 graham crackers: 1 pound cake
Given the old adage "a journey of a thousand miles begins with a single step," the first step of a one-mile journey: 1 Milwaukee
1 million microphones: 1 megaphone
1 million bicycles: 2 megacycles
365.25 days: 1 unicycle
2,000 mockingbirds: two kilomockingbirds
20 cards: 2 decacards
1 kilogram of falling figs: 1 Fig Newton
1 millionth of a fish: 1 microfiche
1 trillion pins: 1 terrapin
1 million billion picolos: 1 gigolo
10 rations: 1 decoration
100 rations: 1 C-ration
10 millipedes: 1 centipede
 $3\frac{1}{3}$ tridents: 1 decadent
10 monologs: 5 dialogs
5 dialogs: 1 decalog
2 monograms: 1 diagram
8 nickels: 2 paradigms
2 wharves: 1 paradox
76 Senators: Not 1 decision

Advertisement - Artistic Discussion Group

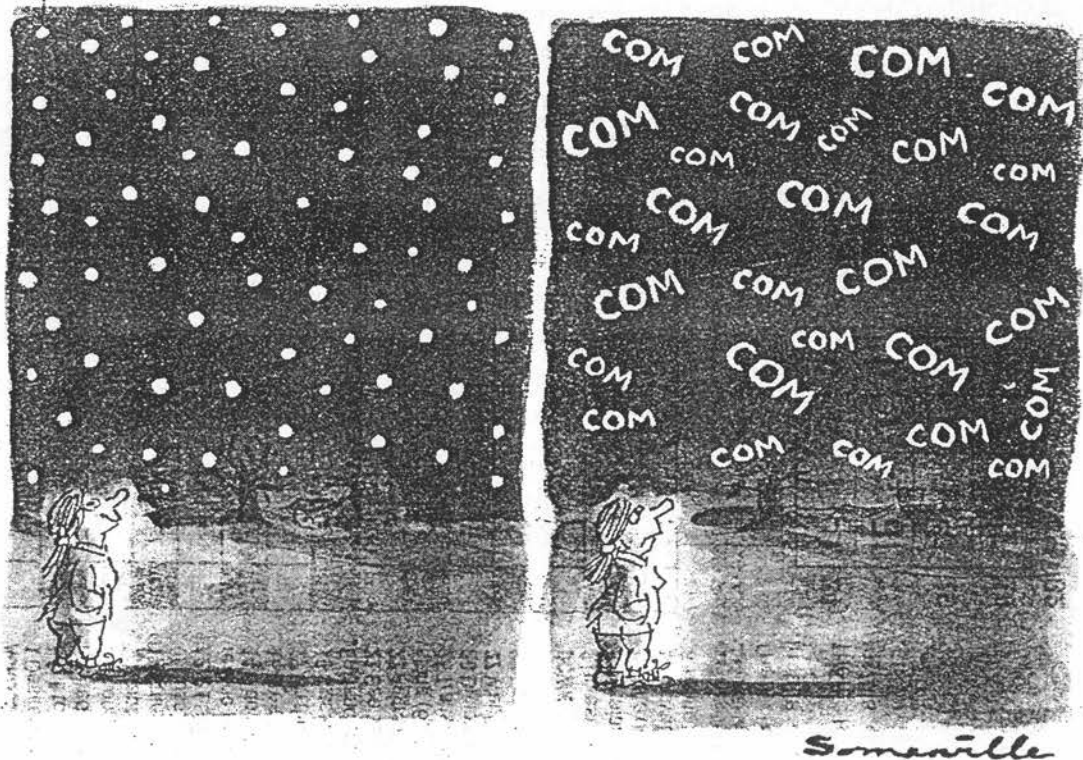
Are there any cultured physicists out there? If so, Kiran Krishna is interested in setting up a group of people to discuss/exchange ideas on twentieth century art (Picasso/Bartok/Stravinsky/Joyce/Beckett/Burgess/Nabokov etc.). If you are interested, please contact Kiran.
email: kiran@physics.usyd.edu.au

Cartoon Page

psst, Erwin, buddy...
put the cat in a box with
a poison gas to demonstrate
the influence of the
observer in quantum
mechanics



SCHROEDINGER'S DOG



AIP Talk

The Physics of Sport

Time & Place: 6.00 pm, Tuesday 15 August 2000, Slade Lecture Theatre.
Speaker: Professor Rod Cross, School of Physics, University of Sydney.

The physics of sport is a broad topic covering almost any activity and any sport. For example, if you walk faster than about 3 m/s, you become airborne since the centripetal acceleration $a = v^2/R = g$ when v is about 3 m/s (assuming your centre of mass is at $R = 1$ m above your feet). How far can a yacht lean over before it capsizes? Where and what are the sweet spots on a bat or a racket? These and other interesting questions will be answered and will also be demonstrated.

AIP Women in Physics Lecture

Nanotechnology: Physics, chemistry and biology unite at the ultra-small scale.

Time & Place: 6:00 pm, Monday 21 August, Slade Lecture Theatre.
Speaker: Dr Michelle Simmons, Queen Elizabeth II Research Fellow & Manager, Centre for Quantum Computer Technology, School of Physics, University of New South Wales.

Nanotechnology is the emerging field of building materials and devices atom by atom to harness the small-scale quantum properties of nature. This field unites physicists, chemists and biologists in order to understand how nature works at the atomic level and how we can control it. By going to this small scale (one nanometer is about one millionth of a centimetre or 5 atoms side by side) the properties of materials change from obeying classical physics to the more unfamiliar quantum physics. It is expected that the ability to manipulate individual atoms and molecules will revolutionise the 21st century in much the same way that the invention of the transistor led to the Information Age.

Today's manufacturing methods at the molecular level are very crude - it's like trying to make things out of lego blocks with boxing gloves on. In the future nanotechnology will allow us to take the boxing gloves off. This lecture will trace the history of how nanotechnology has developed and what tools we require to observe and manipulate atoms. In particular the lecture will highlight the new and exciting international research program in Quantum Computing that has recently been established in Australia. The ability to build a computer from the atomic level upwards will allow us to exploit quantum physics with the aim of building a new generation of computers. It is expected that these computers - quantum computers - can perform computations that all the computers on the planet linked together could not complete before the end of the universe.

PHYSOC BBQ

It's on again! Celebrate the start of semester (only about 7 weeks after the semester actually started) with one of the great Physoc BBQs.

Place: Back Grassy Knoll (use the door near the front foyer)

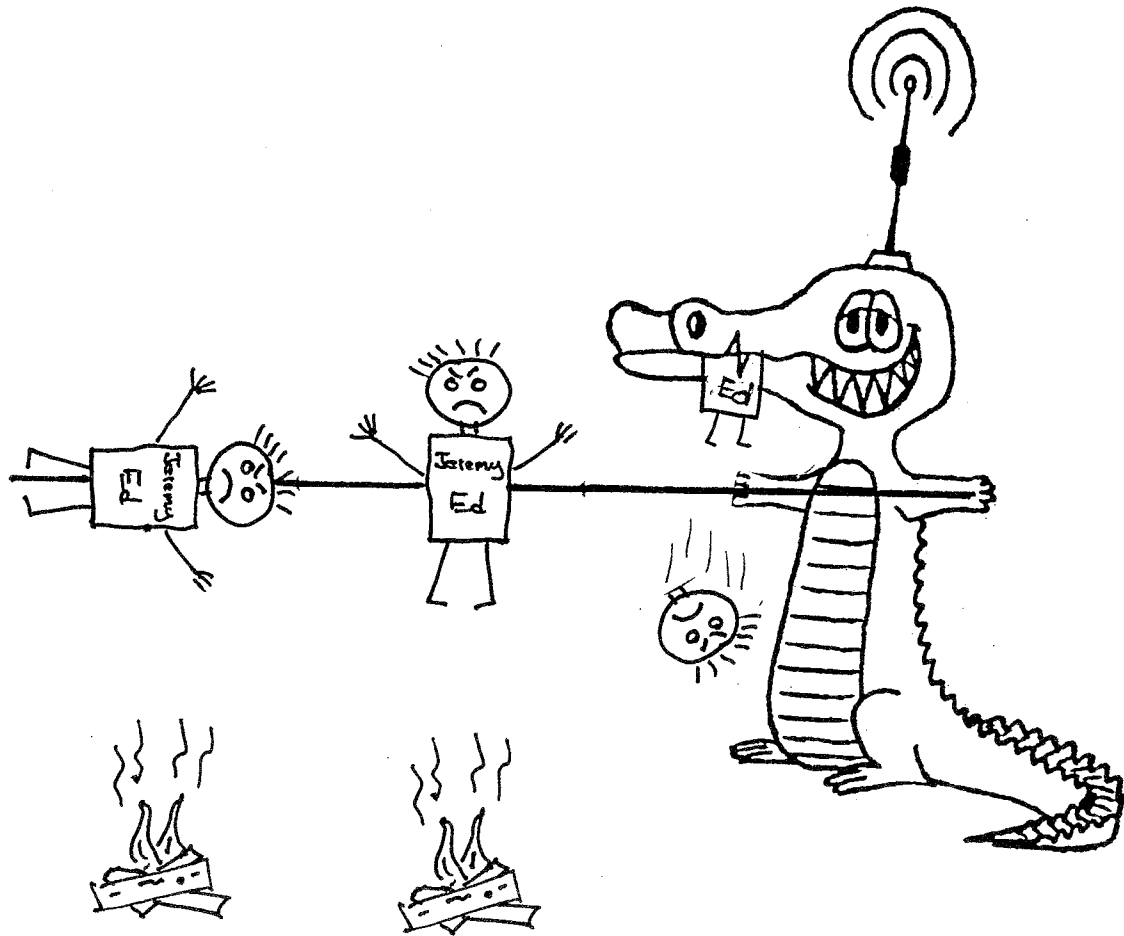
Date: Thursday 17th August

Time: 12pm - 2pm

Cost: \$2 for non-members, *free* for members

JEREMY

Journal of the Sydney University Physics Society



BOOK OF PREVENTING THE EXODUS

And the LORD spake unto Moses saying, Jeremy sucketh! And thou shalt go forth unto the people of PHYSOC and writeth a new Jeremy. And the new Jeremy shall number four pages, and the new Jeremy shall be funny and not at all serious, and it shall be formatted according to the covenant that I hath given thee. These are the commandments, which the LORD commanded Moses, for the children of PHYSOC upon the Solar Roof.

Jeremy takes a Urine Test

Volume 16, Number 3, supplemental August 2000

BOMBS AWAY!

A thoughtful response to the article "Should Australia go Nuclear?"

In a recent article by Kiran 'I own shares in a Uranium mine' Krishna, he outlines an argument as to why Australia should go nuclear. However, we feel that he did not really go far enough and that there are many other good reasons for establishing nuclear power in Australia.

Increasing bio-diversity. Since the 1788 a huge number of Australian native species have become extinct. However if Australia were to begin dumping radioactive waste into the environment this would cause a much higher level of mutations in the existing species and in the long term enhance Australia's ability to create new species. This would have a positive effect on tourism.

Tanning Parlours. There is the possibility of making new high speed tanning parlours. No need to wait around why you slowly cook. Direct exposure to the core could bake you just toasty in milliseconds.

In addition to save on light bills, we could offer to expose people until they glowed in the dark.

With greater exposure to radiation in the general community we could weed out the weak and build a more radiation resistant population. This would have the effect of making Australia amongst the best prepared nations in the event of a nuclear war.

AN AMAZING INVENTION: THE LEVITRON ANOTHER PEARL BY KIRAN KRISHNA

IT'S AN EXTRAORDINARY SIGHT -- a magnetic top spinning, bobbing and weaving in space for two minutes or longer. It remains levitated two or three inches above a larger base magnet. The top is not touching any other object, and no strings, electricity or other devices are used.

Levitation is one of mankind's oldest dreams, and it has now been achieved using just a few dollars' worth of ordinary permanent magnets and some pieces of plastic.

Anyone with even a casual interest in physics has to be amazed. For more than 150 years, such levitation was "known" to be impossible. An 1842 paper by the Rev. Samuel Earnshaw in an English scientific journal had effectively proved mathematically that stationary levitation would never be achieved using only ordinary permanent magnets. "Earnshaw's theorem" is stated in many college textbooks on electricity and magnetism. But this hasn't stopped thousands of people (including yours truly) from spending countless little hours trying to achieve such levitation anyway. (Earnshaw's theorem does not deny the possibility of levitation using "diamagnetic" materials, superconductors or active electromagnetic circuits. The big surprise is the achievement of levitation using just ordinary permanent magnets.)

When I first saw a levitating magnet in a store in 1984, I had to have one -- and I didn't mean tomorrow! No scientist had even suggested, let alone proved, that a spinning magnet could levitate in apparent defiance of Earnshaw's theorem. And even after seeing it done, it is not trivial to reproduce it. The toy comes with a set of brass and plastic washers to adjust the weight of the spinning magnet. The weight must be experimentally adjusted to within one-tenth of a gram -- less than the weight of a single postage stamp. Also, the base magnet must be carefully leveled. The top will not levitate unless the weight is right, and you cannot be sure the weight is right until the top levitates. Moreover, you cannot even begin to adjust the weight and

leveling until you have learned how to spin the magnetic top while fighting the strong resisting force of the base magnet. It was remarkable that someone had made the idea work initially without knowing that it was possible.

So I promptly contacted the physicists who had patented the invention, Bill Hones in Seattle and his father, Ed Hones, in Los Alamos, N.M. But despite spending a total of 50 minutes on the phone with these two gentlemen, I never really got an answer to the question, "How did you first do it?" The best I could gather was that they had had faith in their dream that it could be done plus extraordinary patience and determination.

For four years, I showed this remarkable toy to anyone who exhibited the slightest interest -- plus many who didn't -- expressing my admiration for Bill and Ed Hones for their remarkable discovery.

Meanwhile, in New Mexico, a couple named Mike and Karen Sherlock had been so excited when they first saw a levitating magnet that they had established a mail-order business devoted exclusively to selling these amazing toys. Knowing the difficulty that a newcomer encounters when first trying to make the device work, the Sherlocks also produced an instructional video featuring "The Inventor," Bill Hones. As a result of their advertising on the radio and on the Internet, the Sherlocks were soon selling hundreds a day, each shipped with a copy of the video.

It was only after the fact -- after this levitation phenomenon became known -- that several physicists wrote papers to explain it. There is still more work to be done on this. A complete proof that such sustained levitation is possible appears to be a difficult mathematical challenge.

But there was something else of interest in the published papers. Several of the authors asserted that Bill and Ed Hones were really not the inventors -- Bill Hones had allegedly learned how to levitate a magnet from a man in Vermont named Roy Harrigan, who had patented his "Levitation Device" in 1983.

When Mike and Karen Sherlock heard and confirmed this story in 1997, they were shocked; they stopped selling the toy and they reported the reasons on their Website.

Wanting to meet the inventor said to be responsible for the amazing scientific discovery, my wife and I visited Roy Harrigan in March. Harrigan and his wife live in an isolated house on a hill near Manchester, VT. When we got there, the drive way was under 18 inches of snow. Harrigan would rather invent than shovel.

The only place to sit in Harrigan's living room is the couch. Every other chair, the table, the desk plus much of the floor is covered with magnets, motors, a radiometer, a spark coil, a van de Graff generator, various Harrigan inventions, ideas and drawings plus other devices under construction.

Harrigan, 57, is a high-school graduate who also spent an unsatisfying year and a half in college. He said he has thousands of inventions, and he showed us several of them. Sixteen patents are registered in his name. He doesn't have the money to patent everything, he explained. None of his inventions has brought him either fame or fortune.

To me, Roy Harrigan's most exciting device was the levitating magnet, although he does not consider it his most important invention. He had attempted magnetic levitation as a child. Then more than 20 years ago, he got the idea of spinning the smaller magnet. Experts assured him that such levitation was impossible. But Harrigan didn't know Earnshaw's theorem. So he just kept trying until one day, after perhaps a thousand attempts, the magnet floated in space.

After seven years of hassles, Harrigan was granted U.S. patent No. 4,382,245 for the invention in May 1983.

But Harrigan had had bad experiences with purported backers of earlier inventions; and he had become suspicious of anyone who claimed to be helping him. This soon became true for the magnetic invention also. So he did not market it, and his patent remained unnoticed. Any scientist or engineer who might have run across it probably assumed that the idea would not work. It wouldn't have been the first patent awarded for an idea that doesn't work. The patent that failed its invention by Rod Driver first published on Sept 23, 1999 in The Providence Journal Standard of two parts.

In 1993, Seattle entrepreneur Bill Hones ran across a 10-year-old U.S. patent describing a device for levitating a spinning permanent magnet. Hones contacted Roy Harrigan, the inventor, to ask about it. Harrigan assured him that the magnet really does levitate. To prove it, he sent Hones a videotape showing an actual working model.

But Hones, who had been trying for six years to levitate magnets, was skeptical. He thought there might be hidden strings or wires holding up the spinning magnetic top.

So in September 1993, Hones traveled to Vermont to see for himself. He quickly became a believer, and he spent two days with Harrigan learning about levitation, and hearing about some of Harrigan's other inventions. There is little room for doubt about what happened during those two days because Harrigan, having been burned in prior dealings with developers, videotaped their meetings.

Today, in the light of subsequent events, that videotape is a remarkable document. On the tape, Hones says that, after years of unsuccessful efforts, only now -- thanks to Harrigan -- does he realize that a magnet might levitate if it is spinning. For a long time, Hones practices the technique under Harrigan's guidance until he finally gets the magnet to levitate. Then he talks enthusiastically about a partnership with Harrigan to produce and market the invention. He offers Harrigan 5 percent royalties -- probably a fair offer. And he says that Harrigan's patent number 4,382,245 and a write-up about Harrigan will appear on every package.

But Hones was unable -- or unwilling -- to make even a \$1,000 down payment, and Harrigan declined to sign a contract. Before leaving, Hones pressed Harrigan to lend him the prototype for further study. With the camcorder still running, Harrigan's working model was packed in a box for Hones to take back to Seattle. Hones assured Harrigan that "you don't have to worry about somebody disappearing in the night with it."

In the following months, Bill's father, Ed Hones, used computers at the Los Alamos National Laboratory to study the prototype. Then, he and Bill Hones made some minor changes in the design and got a patent in their own names. They entered into an agreement with a manufacturer in China to produce the "Levitron," and they marketed it as their own invention. Bill and Ed Hones sold as many as half a million of these levitation devices, giving Harrigan neither a penny in royalties nor a word of recognition!

In radio, TV and print interviews Bill Hones has told the audience -- or let someone else tell the audience -- that only after many years of failure did he discover the secret of spinning a magnet to levitate it.

In New Mexico, Mike and Karen Sherlock had established a business marketing "Levitrons." And they were producing an instructional video, featuring Bill Hones, to help their customers learn how to work the toy. During the taping in January 1996, Hones looked into the camcorder and declared "I am the inventor of the Levitron." He seemed to have come to believe his own fantasies. It is a shock to watch videotapes of Hones's performances in 1996 in comparison with the videotapes of his 1993 visit with Harrigan.

Later, when the Sherlocks learned what had happened to Roy Harrigan, they were dismayed; and in August 1997, after confirming the story, they stopped selling the levitation device and explained why on their "Levitron.com" Web site.

Bill and Ed Hones responded with a lawsuit charging the Sherlocks with defamation and trademark infringement, and seeking to shut down the Web site. In April 1998, seeing how absurd their case was, Bill and Ed Hones withdrew the defamation complaint, leaving only the trademark-infringement charge. Despite abundant evidence that the term "Levitron" was being broadly used generically, a federal judge ruled in July that the Sherlocks had to turn over their "Levitron.com" Web site address to Hones. (The Sherlocks will soon re-post their story at another Web address.)

The Sherlocks want to continue marketing levitation devices, but they don't want to continue helping Bill and Ed Hones profit from the discovery. So, for two years, while defending themselves against the lawsuit, the Sherlocks tried to enter into a licensing agreement to produce and sell Roy Harrigan's invention. But Harrigan distrusted virtually everyone, including his own hard-working lawyer. So no agreement was reached.

But there will be new levitation devices on the market. It turns out that in 1984 an inventor in Delaware named Joseph Chieffo, who knew nothing of Roy Harrigan at the time, made the same remarkable discovery -- namely, it is possible to levitate a permanent magnet by spinning it.

Chieffo tried unsuccessfully to interest manufacturers in his invention. Then, in December 1988, he placed small classified ads in Popular Science and Popular Mechanics offering plans and parts to achieve "genuine free flight with ordinary magnets." The instruction booklet was only \$5 postpaid, but the response was so poor that Chieffo soon canceled his ads. Just a handful of people had become aware of Chieffo's invention.

So today, having failed to make a deal with Harrigan, the Sherlocks are collaborating with Chieffo to produce alternatives to the Hones's product, which they intend to market in May 2000, when Harrigan's patent expires. After hearing this story, people wonder why Harrigan's patent didn't protect Harrigan's rights. The answer is a lesson for all patent holders: A patent only protects its owner as long as the owner enforces it.

Harrigan is a creative and ingenious inventor, but he is hopeless at pursuing business or legal problems. And he now distrusts anyone who tries to help him.

A further reason that Harrigan failed to market his levitation device after 1983 was his preoccupation with another invention -- a simple instrument about the size of a telephone handset for resuscitating victims of cardiac arrest. Harrigan keeps one of these nearby at all times, and wears it in a holster on his belt when he leaves the house. But that is a story for another article.

ANNOUNCEMENT :: STOP PRESS
JEREMY Eds SEEK PERPATRATORS OF REBEL EDITION.
MOSES TURNS UP THE FIRE! ... DING THEY'RE DONE!

HELPERS NEEDED FOR COURSES AND CAREERS DAY

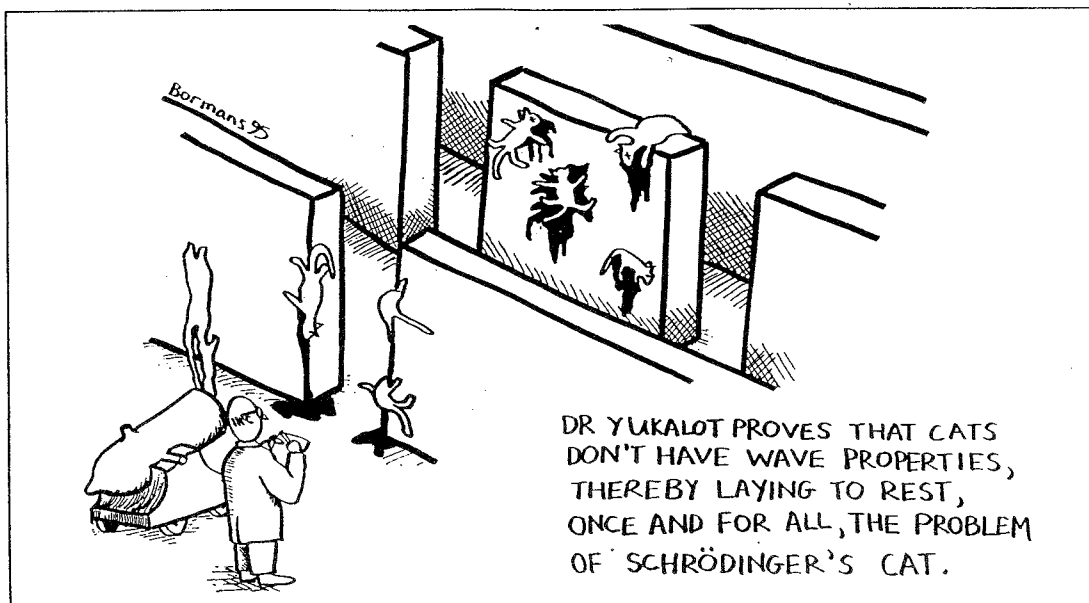
The University's courses and careers day will be held on Saturday 26th of August from 9:30am to 4pm. As usual the School of Fiziks will try to run four activities:

- Geek physicists scaring off prospective non-geek students.
- Physics demonstrations in the Chemistry building?
- A talk about physics (already arranged).
- Burning your retina outside the Great Hall with a huge fork mounted parabolic mirror.

Essentially you must have WAM of 90+ and HD average to even be considered. And it would be desirable if you had no practical aptitude, no drivers license and atrocious written and verbal communication skills.

If you are available please volunteer to help. Contact JOB™ on 9351 3184.
Email j.obyrne@physics.usyd.edu.au.

NB : If you mention this add you could win a copy of Feynman's last lecture



" = QUOTES = "

"Choose a small flat volume"

Dick Collins

"I've made enough mistakes without having to worry about trivial ones."

Don Melrose

"I had a dream about Dick Hunstead"

Ben Chan

"It is a hairy chested fluid"

Ian Johnston

"Nobody knows what a circuit is - but its just bits of wire."

Bob Hewitt

"When I was young I always wanted to grow up to be an engineer and be happy!"

Lawrence Cram

"I'm going to wave my hands and I don't want you to write it down"

G. Fergus Brand

"If you are a physicist and by finite you mean greater than zero then I am not even going to talk to you"

Chris Cosgrove

"Assume it's a charged mosquito in an electric field"

Manju Sharma

"This is a picture and it's not official"

Ross McPhedra.

My Personal Reflections on the Eclipse of the Millennium



Late in the evening of July 16. I went out into a chilly winter's night to see what had been billed as the greatest astronomical event of the Millennium. Above the full moon gleamed its pearly radiance across the night sky. And then it began to happen. Slowly spreading from the edge of the sky a thick bank of cloud began to roll across until it obscured the entire disc of the moon.

I had seen a total eclipse of the moon, but it didn't turn red, it just vanished behind a heavy bank of cloud. Truly I had witnessed a remarkable event a rare double eclipse. The moon eclipsed not only by the earth but also by the clouds. Something I will treasure forever and tell my grandchildren about.

* * New Jeremy Feature : Past and Present * *

Its always fascinating to see how the staff of the school of physics have changed over the years. For the next issue we would like to include some pictures of lectures from some time in the past, perhaps in a comprising situation, to compare with a current picture. We'd like any cartoons or photo's you might be able to find. To start the ball rolling, here:



G. Fergus Brand - circa 1907



G. Fergus Brand - 2000

ADVERTISEMENT : FARTISTIC DISCUSSION GROUP

Are there any uncultured physicists out there?

If so, I am interested in setting up a group of people to discuss and exchange 20th Century metabolic excretion techniques (silent/reverberant/egg/SBDs/lift/ring burn/fluff etc...)

If you are interested please contact PHYSOC@arty-farty.co.uk