Microbiologists test promising vaccine

MONASH microbiologists, in collaboration with the Commonwealth Serum Laboratories, are conducting a pilot trial of a promising new vaccine to protect dairy farmers and abattoir workers against the serious occupational disease, leptospirosis.

Leptospirosis is caused by a spirochete, a spiral-shaped bacterium, which, in southern Australia, is usually transmitted to humans through the urine of infected cattle and pigs. It is almost exclusively a disease of dairy farmers, abattoir workers and veterinarians. It varies in severity from a mild influenza-like illness to a severe infection involving liver and reversible kidney damage.

There is no reliable information on the prevalence of the disease in Australia, but it is believed to be comparable to that in New Zealand, where about three per cent of dairy farmers are infected in any one year.

As there are two common and two less common strains of the disease in Australia, and natural immunity lasts only five to 10 years, a farmer can contract the disease several times in his working life.

Dr Ben Adler, a lecturer in the Monash microbiology department, who is working on the vaccine with Professor Solly Faine and M.Sc. student Wayne Christopher, says the Monash trial, if successful, may be followed by a large-scale field trial in Northland, New Zealand, involving about 3000 dairy farmers.

Last year Adler attended a seminar on leptospirosis in Whangarei in Northland and had talks with the region's health advisory committee. The committee expressed keen interest in the proposed trials.

Adler says that, at present, there are no human leptospirosis vaccines licensed in Australia.

Vaccines have been prepared in the past from spirochetes cultured in a growth medium containing animal protein or serum, he says, but they have been unsuitable for human use because of their toxic side-effects. The foreign protein in the growth medium may trigger a severe allergic reaction in the person immunised.

"The big advantage of our vaccine," Adler says, "is that, for the first time, we have been able to grow the organisms in a protein-free medium. And we have been able to grow them in sufficiently large numbers to make a commercial vaccine feasible."

"In our early trials about eight years ago we had to grow a litre of culture to produce one dose of vaccine. Now we can get one dose of vaccine from a millilitre of culture."

The CSL and several pharmaceutical firms have expressed interest in the vaccine, which contains both main strains of leptospirosis — the pomona strain, which affects pigs, and the hardjo strain, which affects cattle.

Animal studies have shown that the vaccine stimulates antibodies against both strains. Adler is confident that the clinical trial will show a similar effect in humans.

Once it has been shown that the vaccine stimulates the production of antibodies in humans, the next step will be to demonstrate that the antibodies, so produced, protect against the disease.

As human volunteers cannot be used in the "protection" part of the research, it will have to be done on laboratory animals. It cannot be done in Australia as the only
Aborigines used fire to conserve food?

There is general agreement among climatologists that over the past 10,000 years southern Australia has had a climate less variable than it experienced earlier in the Quaternary (the most recent geological time interval).

Over this 10 thousand year period, it has been argued, the Aboriginal population of south-western Victoria increased significantly, particularly within the last 2000 to 3000 years.

According to one view, which is based largely on the archaeological evidence, the increase in population density was the result of changes in energy harnessing techniques.

These included the use by Aborigines of large-scale artificial drainage systems, the intensified use of fire as a hunting tool, and intensified methods of harvesting plant food.

However, Monash geographer Lesley Head points out that while artificial drainage systems may be "archaeologically visible," the hypotheses of increased burning and harvesting are "not testable in the archaeological record alone".

In an attempt to test these hypotheses, Head, a Ph.D. candidate in the geography department, has conducted a palaeoenvironmental study of swamp sites at Discovery Bay, which stretches about 50km along the far south-west Victorian coast to the South Australian border.

The Discovery Bay area is of particular interest to archaeologists because it contains more than 400 archaeological sites, most of them shell middens, and provides a record of human occupation spanning more than 11,000 years.

Head analysed pollen and charcoal samples from Boomer Swamp and Bridgewater Lagoon, which form part of a string of freshwater lakes and swamps extending virtually the length of the bay. She also carried out sediment stratigraphic studies on cores from the two sites.

The study gives a palaeoenvironmental picture of the area, dating back 6000 to 7000 years when the swamps are believed to have been established.

Timing modifications

Although her work does not necessarily refute the "intensified burning and harvesting" theory, Head suggests some modifications to its supposed timing. She believes that the appearance of the swamps as an important resource about 6000 to 7000 years ago may have been more significant than any changes in exploitation patterns since that time.

At Bridgewater Lagoon, she says, swamp plants have probably been harvested for the last 8800 years "with no visible intensification of exploitation or apparent diminution of the resource base in that time."

"There is no palaeoenvironmental evidence that population densities increased to the point of straining the available resources."

Head says the charcoal record at both Boomer Swamp and Bridgewater Lagoon indicates continuous low-intensity firing from about 8000 years ago until the arrival of the Europeans.

"Insofar as the pollen and charcoal provide evidence," she says, "continuous low-intensity firing has occurred without altering the regional vegetation."

All of the peaks in the charcoal curve, except some at Boomer Swamp, have been interpreted as representing burning on the swamps themselves, she says.

If intensification occurred within the period, she says, it affected neither the charcoal record nor the vegetation, and could only have been minor.

She believes the swamp burning indicated by the charcoal record relates to conservation measures practised by the Aborigines, who probably harvested the swamp food plants, Triglochin procera (Water-Ribbons) and Typha sp. (the Bulrush) for their roots and tubers, firing Typha yearly to facilitate harvesting and promote new growth.

The removal of Aboriginal influence, she says, may have permitted these plants to return in large numbers and encroach on Bridgewater Lagoon, as they do today.

Apart from a layer of swamp sediments during the early life of Bridgewater Lagoon, open water prevailed there until the arrival of the Europeans, she points out. Today, the core site has been colonised by swamp plants, including Typha.

Swamp system disappeared

The swamp areas and surrounding vegetation at Discovery Bay may have changed very little in composition over the past 6000 years, but their extent appears to have been considerably diminished.

Head says the accumulation of peat deposits on the beaches suggests that about 4000 years ago the sea must have been some distance away, probably separated from the present coastline by at least one dune ridge, which has since eroded away.

Discovery Bay appears to have witnessed the disappearance of a whole swamp system, possibly as extensive as the present system.

Head says the most immediate implication of her work is for the archaeological record itself.

Since archaeological sites that were on the foredune between 6000 and 3000 years ago no longer exist, she says, any argument that suggests changes in population density solely on the basis of the number of archaeological sites, at least in coastal areas, must be considered tenuous.

"If allowance is made for sites having disappeared," she says, "overall trends may still be apparent, but the rates and timing of such changes, and therefore their causes, could be quite different."

A paper outlining the research has been prepared for publication in the journal Archaeology in Oceania.

Head's research is supported by a Commonwealth Post-graduate Research Award and the Monash geography department.

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New vaccine

suitable animal is the hamster and hamsters cannot be imported into the country. Adler has an NH & MRC grant to complete the work in New Zealand where hamsters are available.

Adler points out that as well as being a serious health problem, leptospirosis can be economically crippling for the dairy farmer.

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Monash geographer Lesley Head, who has conducted a palaeoenvironmental study of swamp sites at Discovery Bay on the south-west Victorian coast. Photo: Rick Crompton.
War books promoted ANZAC legend

SOON after dawn on April 25, 1915, the men of the 3rd Brigade of the First Division of the AIF stormed ashore at Anzac Cove on the Gallipoli Peninsula.

The Australians and New Zealanders who comprised the ANZAC force at Gallipoli clung precariously to their positions for nearly eight months.

When they were finally evacuated on the nights of December 18 and 19 they left behind more than 10,000 dead. Thousands more were wounded.

Out of what was in fact a military defeat arose the modern myth of the swashbuckling Australian fighting man—a myth propagated by the profusion of war books that arose from this "baptism of fire".

In sharp contrast to the European and American Great War books, the Australian product yields an anachronistic, almost "archaic" picture of war, according to Mr. Robin Gerster, a Ph.D candidate in the Monash English department.

Gerster, who is working on a doctoral thesis: "Australian Prose Literature of the First and Second World Wars," has been awarded a grant-in-aid and post-graduate research scholarship by the Australian War Memorial Trust.

The scholarship gives him access to an enormous amount of documentary material held by the Imperial library in Canberra.

"The protracted agony of the Western Front trenches, and the heavily mechanised, 'impersonal' nature of modern warfare tended to mock the traditional view of battle as a kind of test of the valour and virtue of both man and nation," Gerster said.

"Thus in Europe and America the major Great War writers conceived themselves with the disclosing of the awful truth about war. They were motivated by the desire to Jebunk the legend of the battlefield as an arena for heroic, 'manly' endeavour.

"In contrast, in Australian Great War literature, the rabidly anti-war spirit of a novel such as Remarque's All Quiet on the Western Front, if not absent altogether, is by no means as strong."

In most cases unabashedly chauvinistic, the Australian writer publicised the courage and buoyant spirits, the dedication to the mateship ethos and the battle prowess of the man of the First AIF as a "reflection of the heroic manner in which the Australian character emerged from its first real test of battle".

Gerster says that "this race of 'new men' is portrayed somewhat paradoxically as embodying many of the qualities of classical heroism. In this sense, Gallipoli's proximity to the Trojan battlefields of Homer's Iliad, is fitting".

Furthermore, the themes of the "sacrificial destruction of a victimised generation and the passing away of the old values of an ailing civilisation, so characteristic of British First World War books," are replaced in those written by Australians by the "celebration of the birth of the Australian nation, albeit a rather bloody one".

Examples of works in which this theme — integral to the official war histories of C. E. W. Bean — is prominent include William Baylebridge's An Anzac Muster and Leonard Mann's Flesh in Armour.

Gerster says that in The Anzac Book, edited by Bean, it is astutely asserted that "Australia was discovered not by Captain Cook ... but by Mr. Ashmead-Bartlett," the English war correspondent whose dispatches first informed the public at home of the exploits at Anzac Cove.

"If this is true, then the Great War writers were Australia's indefatigable promoters. Even those works which are trenchantly critical of the running of the war and which do not shirk the task of exposing the horrors of battle, such as Flesh in Armour and The Desert Column (a Light Horse memoir by Ion Idriess), are infused with an enormous pride in both Australian nationality and emerging nationhood. And what comes across is not so much the horror, but the thrill, of the fight."

Included among the genuinely anti-war Australian Great War books, Gerster says, are J. P. McKinney's Crucible and John Lyons Gray's Red Dust, an autobiographical narrative in which the angry anti-war sentiments are leavened with praise for the democratic and adventurous nature of the AIF. Angela Thirkell's Trooper of the Southern Cross provides an illuminating, satirical portrait of the Australian male at war, while Martin Boyd's memoir A Single Flame and his novel When Blackbirds Sing are both strongly pacifist in mood. Significantly, Boyd fought in the British Army, and considered himself alien to the mainstream Australian "tradition".

More world-weary and cynical than their First World War predecessors, Australia's Second World War writers continued however to employ, with variations, the heroic image in characterising the antipodean warrior. Gerster says. The Anzac legend was more revamped than totally rejected.

Those works arising out of the 1939-45 conflict which stand out are T. A. G. Hungerford's The Ridge and the River, a novel of jungle warfare in the Pacific islands, and Eric Lambert's The Twenty Thousand Thieves. Ray Parkin's trilogy on existence as a prisoner of the Japanese, Peter Ryan's autobiographical Fear Drive My Feet and
Documenting our fossil record

For the past 60 million years Australia's terrestrial mammals have evolved in virtual isolation from the rest of the world.

Only South America approaches Australia in the degree of isolation of its mammals during the Cainozoic Era, the period in Earth's geological history from 60 million years ago to the present day.

Terrestrial placental mammals (mammals in which the foetus is nourished within the maternal womb until development is well advanced) were always an important part of the South American fauna during the Cainozoic. And in the late Cainozoic there was a widespread interchange between South and North America with the establishment of the Panamanian landbridge.

In Australia, there was probably little interchange after the marsupials evolved in the Cretaceous Period, which began about 135 million years ago. With the exception of bats, Australian terrestrial mammals were made up solely of monotremes (e.g. the platypus) and marsupials until the appearance of the rodents about five million years ago.

This isolation created a natural experimental situation, which enables scientists to compare marsupial evolutionary patterns and rates with those of other animals in the rest of the world.

Besides Australia's marsupial fossil record, the vertebrate fossil record generally is substantial and dates back more than 450 million years to the Ordovician Period.

The Australian and New Zealand fossil record has been summarised and published by Monash University as a 759-page book, The Fossil Vertebrate Record of Australasia, edited by Dr Pat Rich, of the Monash earth sciences department, and Mrs Betty Thompson, of the National Museum of Victoria.

The many contributors include the two editors, Rich and Thompson, and Monash scientists Dr Larry Frakes, Mr John Long and Dr Gordon Sanson; Dr Tom Rich, of the National Museum of Victoria; Dr Ralph Molnar, of the Queensland Museum; Dr Anne Warren, of La Trobe University; and Dr Jerry van Tets, of CSIRO's Division of Wildlife Research, Canberra, among others.

The book, designed for students and professional palaeontologists, brings together for the first time what is known of the fossil history of Australian and New Zealand fishes, amphibians, reptiles, birds and mammals.

According to co-editor Pat Rich, Australia's vertebrate fossil record begins with the discovery in the Northern Territory of jawless fossil fish which date back to the Ordovician Period — about 435 million to 500 million years ago.

The fossil fish record is a long one, she says. It stretches from the Ordovician Period through the Devonian Period, about 300 million years ago, known as the "Age of the Fishes", to the present day, and, as well as being of evolutionary interest, is useful to...
The Mesozoic Era (about 240 million to 65 million years ago) was the "Age of the dinosaurs". The locations of Australian Mesozoic vertebrate fossil finds are shown in the above map.

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scientists for determining the age of rocks and local ecology.

Some of the best known and most important occurrences are in Devonian rocks of eastern Victoria and at Gogo in north western W.A. Fish from these localities correlate well with those known in Europe and China and indicate that some of the armored fish preserved in these localities may have originated in the Australasian and Oriental realms and dispersed from there into Europe and North America.

Amphibians

The first vertebrates to successfully invade the land were the amphibians.

Until 1972 the earliest known fossil remains of these prehistoric amphibians were the skeletal remains of Ichthyostega, which were found in Late Devonian sandstones in East Greenland. Because of this find it was thought the amphibia had their origins in the northern hemisphere.

That theory, however, had to be rethought with the discovery in 1972 of the tracks of a tetrapod (a four footed amphibian) in the Late Devonian Genoa River beds of Eastern Victoria by the late Mr Norman Wakefield, then head of biology at Monash Teachers' College, and Professor Jim Warren of the Monash zoology department. The subsequent discovery of a fossil jaw near Forbes in NSW confirmed the belief that the Australian labyrinthodont fossils perhaps predated the Greenland find.

Just as interesting is the fact that the labyrinthodont amphibians survived longer in Australia than anywhere else, extending into the Jurassic. Elsewhere in the world the group was extinct in the Triassic Era.

Dinosaurs

Without question, one of the most spectacular of prehistoric animals is the dinosaur, which pounced and pirouetted on Earth in the Mesozoic Era (about 240 million to 65 million years ago). The Australian record, however, is fragmented, and, although of evolutionary interest, is not particularly useful yet, according to Rich, for determining the age of rocks or for biogeographic purposes.

Some of the most impressive of the Australian dinosaur fossils described by Molnar in the Monash book are the tracks of a large dinosaur and those of more than a hundred small dinosaurs, which were brought to the attention of scientists by local residents south of the Queensland town of Winton during 1971. The tracks were later excavated and studied by Tony Thulborn and Mary Wade (University of Queensland and the Queensland Museum).

Preliminary results suggest that the prints could have been made during a stampede of about 130 small dinosaurs (ornithopods and theropods), which were frightened by a large form, probably a large theropod whose tracks are overlain by those of the stampede.

The tracks appear to be Cretaceous in age, made about 135 million to 65 million years ago, at a site which was probably near a river or water hole.

Birds

Fossil birds also leave a rich record in the mid-to-late Cainozoic rocks of Australia.

Feathers are known from 130 million year-old rocks near Koonwarra in Gippsland, Victoria. But, just as with the marsupial record, not much more is known of this group until the Miocene, some 20 million years ago. Most of the birds of this age belong to modern bird groups (families), except that many are quite primitive within those families. But others such as the flamingoes and dromornithids (mirungas) leave no living relatives in Australia.

Flamingoes inhabited and nested in the permanent shallow lakes of central Australia from Alice Springs to Marree until perhaps a few tens of thousands of years ago, and evidently became extinct as the permanency of water was no longer a certainty.

Some bird groups are excellent biostratigraphic markers, but others are more useful in making palaeoenvironmental reconstructions. It is clear from the fossils of this group that birds have had a very long history in Australia and have come from multiple sources, with the development of many groups in Australia itself.

Mammals

From an evolutionary point of view, one of the most interesting groups, because of our isolation, is the mammals. Nothing is known of the origin of the Australian marsupials, such as the kangaroo and koala, because, unfortunately, the fossil record is restricted to about the last 35 million years, and most fossil finds are those of families as we know them now.

Exceptions are those of some fossils which differ strikingly from modern marsupials. They are Wwynyardia, so-named because it was found near Wynnyard in Tasmania. Ektopodon and Namilamadeta ("Wombaroo") from South Australia.

Tom Rich, who wrote the two mamall chapters in the Monash book, says much of the skeleton of Wwynyardia is preserved, but the teeth have been destroyed. This makes it difficult to compare with other marsupial fossils, which are most often preserved only as teeth.

Another strange fossil marsupial is Namilamadeta which shares characteristics of the wombat and the kangaroo. Perhaps this animal is part of, or related to, the ancestral stock which gave rise to two of the modern marsupial groups, and is more characteristic of the Paleocene and Eocene faunas that are yet unknown from Australia.

Ektopodon, and its relatives, known as fossils in South Australia and Victoria, are the centre of scientific controversy. Some scientists believe Ektopodon is related to the phalangeroid marsupials (e.g. possums), while others suggest relationships to the Phascogaleridae (the koalas). Just what it ate is also a problem. Ideas range from beetles to nuts. Perhaps it was the marsupial answer to the placental squirrel.
Scientists prepare for Halley’s Comet

IN mid-April, 1910, after officials at the Melbourne Observatory caught their first glimpse of Halley’s Comet, The Weekly Times reported with apparent relief: “Now that Halley’s Comet has made itself visible to observers in Melbourne without so far the disastrous results forecasted by some astronomers, people are beginning to regard the visitor with a not unfriendly gaze.” But the newspaper added a note of caution: “According to the astronomers the ‘danger period’ is the latter end of May, when, if some of the seers are right, Halley’s Comet will whisk its tail and the earth will disappear.” Happily, as it turned out, Earth did not disappear.

Preparations are now in train for the return of Halley’s Comet, which will be brightest during the first three weeks of February, 1986.

In early 1985, Halley’s Comet will cross the orbit of Jupiter and by the end of the same year the accelerating comet will have passed the asteroid belt, the orbit of Mars, and arrived again for its once-in-a-lifetime visit to the neighborhood of Earth. Scientists hope that a detailed study of the comet will yield clues to the origin of the solar system and, perhaps, life itself.

Comets and planets probably formed from the same reservoir of gas and dust. However, the birth records of planets and their satellites are obscured by thousands of millions of years of evolution during which external and internal processes have reshaped their interiors and surfaces.

By contrast, comets are among the most primitive objects remaining in our solar system, and may have been a major source of organic materials in the atmosphere of the planets. A study of their composition could provide clues to the nature of the prebiological environment of Earth.

Since the composition of comets appears to be similar to that of interstellar clouds, a detailed study of a comet such as Halley’s may also help solve problems concerning...
Continued from Page 6

molecular formation and the nature of interstellar dust, clouds, and the dark nebulae.

The scientific program will be co-ordinated by the International Halley Watch, which was officially established at last year’s triennial meeting of the International Astronomical Union.

The most important elements in the International Halley Watch are the professional observers and the discipline specialist teams. The latter will co-ordinate observations of the comet.

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**CHICAGO IS TERRIFIED**

Women Are Stopping Up Doors and Windows to Keep out Cyanogen

(Headlines in a New York Times report on Halley’s Comet in May, 1910.)

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Experts have been selected for seven discipline specialist teams which will co-ordinate observations in seven areas of astronomical research — astrometry, infrared spectroscopy and radiometry, large scale phenomena studies, near-nucleus studies, photometry and polarimetry radio science, spectroscopy and spectrophotometry.

Monash professor of chemistry, Professor Ron Brown and Dr Peter Godfrey, senior lecturer in chemistry, are members of a discipline specialist team which will co-ordinate radio science observations in the southern hemisphere. Brown and Godfrey are the only Australian scientists on any of the committees.

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Brown says Halley’s Comet spends most of its time deep-frozen far from the sun. Only as it approaches the sun — once in every 76 years — will the gases and solids of the comet’s nucleus start to burn, releasing dust and gases to form the tail and coma (the gaseous “halo” around the nucleus).

Observations by powerful radio telescopes of radio frequency spectral lines from molecules in the coma may provide important information about the composition of the comet’s nucleus, he says.

Detailed analysis of the sublimation processes as the nucleus starts to burn could provide important information also on the conditions under which comets are formed, the nature of interstellar grains and gas, and (more speculatively) the early stages of chemical evolution and the origin of life.

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**Satellite probes**

Some of the most interesting results in the International Halley Watch should come from the satellite probes.

The European Space Agency (ESA) plans to send its Giotto spacecraft past Halley’s Comet on March 13, 1986. The Soviet Union and Japan plan to send spacecraft past the comet about the same time.

The ESA spacecraft should go within 500km of the comet’s nucleus and should penetrate its coma and tail. It will carry instruments to measure the chemical composition of the coma and a camera to photograph the nucleus itself.

Unlike its last appearance in 1910 when it blazed across the sky, the return visit of Halley’s Comet will be something of an anticlimax for the casual observer because of the comet’s alignment with the Earth and the sun.

It will be brightest during the first three weeks of February, 1986, when it is nearest the sun (closest approach occurs February 9). Unfortunately, it cannot be observed from the ground then because the Earth will be on the other side of the sun.

However, if you have binoculars and you can find a spot away from city lighting, the comet should be a rewarding sight in November and December of 1985 and at its best in March and early April of 1986.
Where science and philosophy meet

FIFTY years ago the theory of quantum mechanics shook the foundations of physical science.

It swept away many old ideas about the nature of matter, replacing them with a theory (quantum mechanics) which was baffling but which worked.

With the emergence of the new physics, subatomic particles, like the electron, became somewhat "fuzzy". They retained some particle-like characteristics, but quantum theory also accorded them wave-like behaviour.

Most baffling of all perhaps, the "certainty" of classical physics was dethroned at the subatomic level and replaced by the concept of "probability".

Quantum mechanics asserts that the results of measurement in the subatomic world cannot generally be predicted with certainty. Only predictions about the probability of any particular outcome are possible.

Today, despite its baffling concepts and its somewhat esoteric mathematics, quantum mechanics is the foundation stone of modern physics. Much of modern physics — lasers, the electron microscope and recent developments in micro-electronics, for example — depends upon the state the particle is in. This is true of chemistry also and even of biology — molecular biology, for example.

Heisenberg Uncertainty Principle

Monash theoretical physicist Dr Harry Perlman, who is working on the mathematics that forms the foundation of quantum theory, says the difference between classical and quantum mechanics is illustrated by the often misunderstood Heisenberg Uncertainty Principle.

"In classical mechanics, if you know the state of a particle (its position and momentum) you can predict with certainty the result of a measurement of any observable property," he says.

"In quantum mechanics, if you know the state of the system (the state function), you cannot predict the result of the measurement of an observable."

"However, if you keep repeating the measurement with the particle in the same state each time, you will get a distribution of results which determines the probability that the observable has a particular value."

"The standard deviation (the measure of spread) of the distribution you obtain when you carry out these measurements has nothing to do with experimental error. It depends upon the state the particle is in."

Quantum mechanics asserts that if you measure the standard deviations of, say, a particle's position and its momentum, the product must be equal to or greater than a constant $h$, known as Planck's constant. This is a measure of the uncertainty in the measurements.

"It means that if the standard deviation (the spread) of, say, the momentum is very small, the standard deviation of the particle's position will be correspondingly large," he says.

Uncertainty measurement

Perlman says that some think that this uncertainty is due to the fact that the measurement of one (say, position) upsets the measurement of the other. That however is not the case.

"Indeed," he says, "if I did a set of measurements of a particle's position in Melbourne and a set of measurements of a particle's momentum in London and multiplied the standard deviations together I would get a figure equal to or greater than Planck's constant."

Perlman's contribution to quantum theory is to extend a technique, which, to the layman, appears to involve some odd features, but to the physicalist, is a very useful device in solving problems in quantum mechanics.

Quantum mechanics employs two basic kinds of mathematical constructs — observable operators (which are associated with constructs such as energy and momentum), and "state vectors in Hilbert space", a highly sophisticated mathematical concept which specifies the states of particle systems.

It turns out that when you attempt to determine the "time evolution" of a particle system (i.e. the behaviour of the system at some subsequent time) it makes no difference to observational results whether you take "state vectors" to be time-independent and blame all the time-dependence on the operators, or whether the operators are regarded as time-independent and the time-dependence is blamed on the "state vectors", or whether the time-dependence is shared between "state vectors" and operators.

"Which approach we use," Perlman says, "will depend on which is the most convenient for the particular problem at hand."

Perlman has done is to generalise this technique of arbitrarily sharing the blame for the effects of "time translations" between operators and "state vectors", to the effects of rotations in four-dimensional space-time.

This permits him to share the blame in such a way that operators which are normally commuting (quantities that have both magnitude and direction) behave like scalars (quantities that do not have direction and are independent of the frame of reference). "This can be of considerable convenience," he says.

Perlman believes his conceptual development could have applications in areas such as elementary particle theory, the relation between quantum theory and general relativity, and perhaps, solid state physics. Work on its application is proceeding.

Modern physics, particularly quantum mechanics, raises profound philosophical questions. Does science, at this level, present to us a picture of reality which becomes clearer as knowledge increases? Or are the physicist's electrons and the like simply intellectual constructs which help us make sense of the world around us?

Approaches to the problem

There are two extreme approaches to this problem — the realist and the instrumentalist.

To the realist, the scientific view of the world, is, in some sense, a picture of reality. Scientific theories, in this view, are either true or false.

The instrumentalist view (which is held by Perlman) is that entities such as particles are convenient fictions and that scientific theories are mnemonics, so to speak, which serve to correlate observations and enable predictions to be made. In this view, scientific theories are not true or false. They are simply successful or tenable, unsuccessful or untenable.

The instrumentalist does not deny that the realist position is appropriate for some theories, Perlman says. He merely asserts that it need not be appropriate to all.

Later this year Perlman will present an elementary lecture on quantum theory to HSC students as part of an "enrichment" series of lectures which have been prepared for the students by the Monash physics department.

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