Astrophysicists simulate interstellar cloud collisions

A computer program developed by Monash astrophysicists to simulate collisions between interstellar gas clouds casts serious doubts on conventional ideas of how stars are formed.

According to the current model of the initial stages of star formation, stars form as a result of the collision and coalescence of cool, dense, rotating clouds of gas and dust, which are found mostly along the inner edges of the spiral arms of the galaxies. Such a stellar nursery within our own galaxy is the Great Nebula in Orion - a vast cloud of luminous gas 17 light years across and 1500 light years away.

The current model of the interstellar medium pictures these gas clouds as cool, stable clouds of gas, several hundred times the mass of the sun, with a temperature of minus 180 degrees Centigrade, moving within a background of hotter, less dense gas.

If there are enough collisions, and the coalescing cloud reaches a critical mass, it becomes unstable, according to this model. Gravity becomes so strong that the cloud starts to collapse on itself. Stars form out of the collapsing cloud.

The Monash research, which is being done by Dr J. J. Monaghan, of the mathematics department, and colleagues, research assistant John Lattanzio, post-doctoral fellow Dr Philip Schwarz, and Ph. D. student Helen Pongracic, shows that this picture of cool, dense clouds "in quiet harmony" with a hotter, less dense gas, is untenable.

The picture that emerges from the Monash research is of devastating collisions with the colliding clouds being ripped apart or "bouncing off" each other.

The colliding clouds are pictured on the computer terminal as 3-dimensional clouds of particles projected on to one plane. The collision process which in reality would take a few million years is reduced by the computer program to a matter of hours.

One exciting result of the Monash research has been the discovery that while most clouds are ripped apart as a result of collisions, the collisions between clouds that are just unstable can lead to a dense core of material which has all the features of an embryonic globular cluster. Globular clusters are highly compact balls consisting of several hundred thousand very old stars found in a spherical halo surrounding the flattened discs of the main galactic masses.

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Continued overleaf
that the numerical technique could, if refined, allow us to tackle a wide variety of important astrophysical problems. "This refinement has continued to the stage that we now have an elaborate computer program which forms a numerical hydrodynamics laboratory. We can take theoretical models, compute their predictions and compare them with observations."

Pongracic is using a version of this versatile program to investigate the theory that an asteroid impact was responsible for the destruction of the dinosaurs 65 million years ago. The theory assumes that dust and debris from the impact blacked out the Earth for a million years.

Pongracic is investigating the effects of an asteroid coming in on arbitrary impact angle, either hitting the land or hitting the ocean.

To develop the cloud collision program the team had to overcome difficult technical problems which only recently have been resolved.

The model is not restricted to symmetrical collisions. It allows for arbitrary three dimensional motion with shock waves, a mixture of materials, gravitational and general gas dynamic effects.

The smallest cloud in the model is given a mass 361 times that of the sun. The largest has a solar mass of 8000. The clouds collide with each other at velocities which range from 30,000 to 40,000 km per hour.

Monaghan says that the only significant assumption made that departs from reality is that the clouds are at a constant temperature. In reality there is heating and cooling taking place. However, he is confident that the temperature approximation used is reasonably realistic. He plans to introduce heating and cooling processes at a later stage.

Omitted from the model are rotary motion of the clouds and magnetic fields. "Frankly, nobody knows how to put in magnetic fields," he says.

"We believe," he adds, "that the results we are getting now are the best that anyone is getting anywhere in the world."

The Monash group now has close links with the astrophysics group at the Max Planck Institute in Munich. The Monash program was run on the Cray 1 computer in Munich early this year to provide the speed and accuracy needed to resolve a contentious problem concerning fragmenting clouds. The technique is also being used at the ANU to simulate galaxy interactions, radio jets and tidal behaviour in pairs of neutron stars.

Results of the research, which is supported by an ARGS grant and a Monash Special Research Grant, were presented to a recent meeting of the Australian Astronomical Society. Two papers presented at the meeting will be published in the Society's Proceedings. A paper with detailed calculations is being prepared for publication.

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Research adds years to a krill's life

ZOLOGISTS are a crucial step closer to estimating the maximum sustainable harvest of krill, as a result of recent work by Monash zoologist, Dr George Ettershank and Dr Tom Ikeda, of the Department of Science and Technology's Antarctic Division. Their research has overturned existing ideas on the life cycle of the Antarctic crustacean.

Krill, perhaps the world's largest untapped source of protein, is being trial harvested on the assumption that it lives for several years, grows larger each year. The larger the krill, the older it is, according to this growth model.

Using age pigment analysis as a measure of physiological age, Ettershank and research assistant Sue Darby have shown clearly that krill have a maximum life-span of seven years — twice as long as previously thought. The crustacean has an adult life of five years, during which it spawns each year.

The technique used to determine the age of krill involves measuring the level of fluorescent pigments, called lipofuscins, which gradually accumulate in cells as a by-product of metabolic processes.

A reliable method of assessing age was necessary as work by Ikeda had shown that the traditional method of determining age by measuring length could not be applied to krill.

Ikeda showed that krill can survive without food for up to seven months by using their own muscle tissue as a source of nutrition. During this period of "starvation", the krill shrink and regress to the juvenile stage. They re-develop to sexual maturity when fed.

The researchers believe this shrinking is an "over-wintering" strategy. The ability to shrink, Ikeda believes, could enable krill to survive when phytoplankton (the single-celled plants they eat) disappear as a result of a lack of light during Antarctic winters.

Ettershank has developed a conceptual model of krill biology which further undermines existing estimates of krill populations.

Presence estimates are based on the assumption that krill swarms are more or less evenly distributed beneath the ice. According to Ettershank's model, they are concentrated along the edge of the ice pack and they are highly mobile.

"Japanese trawlers have tracked one school for over a week," he says. "The krill were travelling at six nautical miles a day and were swimming in a constant direction."

Ettershank says that years ago when the great whales were active they harvested an estimated 150 million tonnes of krill a year. The whales and krill were then in some sort of ecological balance.

"We have hunted the great whales to a shadow of what they were," he says, "so part, at least, of that 150 million tonnes is still available."

"Crab-eating seals, minke whales, penguins and other animals that feed on krill have increased in number since then and consume a substantial part of that 150 million tonnes."

"The balance is available for harvest. That, probably, is as much as you can safely say about the sustainable harvest of krill. Beyond that it is wild speculation."
Modelling the effects of wind and wave

MONASH mechanical engineers are developing mathematical models aimed at predicting the effect of wave forces on fixed or moored structures such as oil rigs and tethered submersibles.

Moored structures like deep-water oil rigs may resonate at the same frequency as the waves that crash up against them. In heavy seas, the structures can oscillate.

If the oscillation is severe it can affect the rig's safety, and in extreme conditions the platform may break loose from its moorings.

The Monash research, which is being done by Associate Professor Jon Hinwood, Dr Deane Blackman, research assistant Simon Cook and postgraduate student Andrew Potts, is part of the Bass 84 project — the largest collective exercise in physical oceanography ever undertaken in Australia.

The Bass 84 project, which involves CSIRO, the Commonwealth Bureau of Meteorology, Monash and other institutions, is concerned with wind, wave, tide and current measurements in Bass Strait and the problem of internal waves in the thermocline. The thermocline is the layer of relatively steep temperature gradient in the sea which separates the warmer upper waves and the colder lower layers.

The Monash part of the Bass 84 program involves three projects — a study of the dissipation of swell, a study of wind, wave and mooring force characteristics, and the collection and correlation of wind and wave data. All three sets of data are necessary inputs for the development of reliable mathematical models.

Two main numerical models are being used.

The first is the wave prediction model which utilises the wind field over the ocean to predict the ocean waves. The model, which was developed with assistance from Jnior Research Fellow Andrew McCowan, predicts the wave heights and periods and permits the propagation of wave energy in all directions to be simulated. This ensures that the "confused sea" state present in storms is reproduced.

The second model uses the wind and wave data to predict the mooring forces and motion of moored objects, including "Scylla" (the Monash floating instrument platform).

To measure wind, waves and forces on moorings, the Monash team will use "Scylla," and will also use a number of wave recorders, especially designed by Blackman, to measure very-long-period waves. Measurement of these waves is not possible with conventional instruments.

Blackman's wave recorders will be placed on the seabed in arrays, so that the directional characteristics of the waves can be measured as well as their size. Wave size is calculated from seabed pressures recorded by the instruments.

The wave recorders conserve energy by operating only when there are waves of a certain size, and they have underwater acoustic release devices which enable them to be retrieved without difficulty.

transmission of a sound, the device releases a weight and the box containing the recorder and its sensors rises to the surface.

Hinwood and Blackman say the resonance effect of heavy seas on moored structures which the Monash team hopes to be able to predict with its mathematical model is a particular problem in Bass Strait, partly because of the paucity of data, and partly because of the geography of Bass Strait.

"We have a unique problem with Bass Strait," Hinwood says. "It is exposed to the waves of the southern ocean which are generated in the roaring forties and travel many thousands of kilometres before reaching Bass Strait."

"By the time waves generated in the roaring forties run into Bass Strait they may build up to swells with periods of 20 seconds or more.

"The swell dissipates to some extent in Bass Strait, but the waves there and at coastal locations are still large compared with typical periods of 8-12 seconds elsewhere.

"If you're putting out a conventional structure, the effect of long-period waves might not matter a great deal. But if you're putting out a moored structure such as a deep-water oil rig (a tension leg platform) the rig may resonate with the frequency of the waves.

"It may become uncomfortable, unsafe or physically impossible to work on it. If the rig is unable to cope with displacements, the platform will break loose."

Hinwood and Blackman point out that it is important for the safety of the rig to know how much force is being exerted on the structure, and where the resonances are likely to occur.

Records that give some idea of wind velocities in extreme conditions are available, they say, but there are no records at all to help the oceanographer determine what the biggest wave is likely to be in eastern Bass Strait.

The only way of obtaining this information, they say, is to build a model that predicts what the wave will be when the wind velocity is known.

In addition to their Bass Strait research, Hinwood and Blackman are conducting similar research with the Monash wave tank. They are testing a model of Woodside Petroleum's North Rankin A rig in a variety of wave conditions. Woodside has given them the model on long-term loan for research purposes. The company has also offered the services of one of its engineers to advise on the actual performance and testing previously done on the model.

Hinwood says the model was built for the American consultants who designed the rig and it was tested in the US before Monash acquired its wave tank.

The Monash tests will provide a valuable check against the American results, he says, but they will also complement the American findings because it is possible with the Monash tank to run larger waves and waves combined with currents. This was not possible with the American tank.

He estimates that it will take 3-5 years, perhaps longer, to complete the project.

Monash research has been supported over the past four years by grants of $80,000 a year from AMSTAC (the Australian Marine Science and Technology Advisory Committee). Support has also come from Monash Special Research Grants and the Victorian Institute of Marine Science.
The role of fats in coronary disease

Researchers at the Baker Institute, which is affiliated with Monash University, have made important progress in understanding the complex relationships which exist between dietary fats and the metabolic factors involved in atherosclerosis.

Atherosclerosis—thickening and hardening of the arterial wall—leads to coronary heart disease and is caused by a build-up of fatty deposits on the artery wall. Another type of lipoprotein, high density lipoprotein (HDL), seems to prevent it by removing excess cholesterol from arterial wall cells.

Dr. Paul Nestel, head of the Cardiovascular Metabolism and Nutrition Research Unit at the Baker Institute which is engaged in the research, says it is now recognised that many environmental factors influence lipoprotein levels.

Many are nutritional: the amount and type of dietary fat, for example, the amounts of cholesterol and fibre, the types of proteins and sugars. Also very important are smoking, overweight, alcohol and exercise.

Recently, the unit found that fish oil in the diet is a most powerful means of lowering blood fats.

Studies in patients, as well as with rats and with isolated living liver cells, have shown how this comes about. The fish oil fatty acids lower blood fats by preventing the liver from secreting lipoproteins into the circulation. Instead, the fatty acids are oxidised or burned.

Another finding relates to cholesterol in the diet and the possible harm it may cause.

Nestel says that in previous research his group had found that about one person in four shows a rise in blood cholesterol levels when eating excess cholesterol (for example, egg yolks). The others compensate by making less cholesterol in the liver or by excreting more.

However, he says, it now appears that even when the blood cholesterol level does not rise the body has to transport the extra cholesterol in a special type of lipoprotein, intermediate density lipoprotein (IDL), which has been found to be potentially atherogenic (that is, can cause atherosclerosis) when tested with isolated cells. IDL has a major role in transporting cholesterol from the liver.

Nestel says another finding of his team may help explain why people become fat.

“Previsously, in studies carried out with Drs Kerin O’Dea and Murray Ester, we found that when thin people get fatter, they increase their heart production by stimulating their sympathetic nervous system,” he says. “In this way, they burn some of the extra energy.

“We now find that young people who have become very fat lack this important compensatory mechanism.”

The amount of exercise needed to raise HDL levels is being studied, he says, but the highest levels ever measured anywhere were in friends of his who took blood samples after climbing in the Himalayas. The blood samples were sent back to the Baker Institute for analysis.

Because of the protective nature of high density lipoprotein, the team measured HDL levels in hundreds of people in Fiji who took part in a World Health Organisation study headed by Associate Professor Paul Zimmet, of the Royal Southern Memorial Hospital.

They were able to show that putting on weight, exercising less and smoking cigarettes all lowered HDL levels. Paradoxically, HDL levels rose as people moved from villages to towns because they increased the amounts of alcohol they drank. “We don’t think however that that will lower their chances of heart attacks,” Nestel said.

He says it is now accepted that lipoproteins, such as LDL, are likely to cause atherosclerosis and heart disease. But other classes of lipoproteins are being discovered that may be equally atherogenic.

Information about these additional atherogenic lipoproteins has come partly from studies with Dr Mike Reardon and Dr Rick Harper on patients at the Alfred Hospital whose blood lipoprotein levels have been related to the extent of atherosclerosis discovered by their coronary arteriograms.

Additional clues have come from studies carried out with Dr Julia Campbell and Reardon with isolated liver cells that are grown in the presence of different lipoproteins. The cells become engorged with cholesterol when the incubation medium contains certain types of lipoproteins.

“While studies such as these help us identify patients who are at high risk of developing heart disease and suggest means of preventing it,” he says, “they tell us little about the disturbed bodily functions that cause lipoproteins to accumulate abnormally in the blood.”

Further fundamental scientific work is being carried out in the unit’s biochemistry laboratories headed by Dr Noel Fidge.

“It’s now clear to us,” Nestel says, “that i, is the protein (and not the fat) part of the lipoprotein that determines how the lipoproteins are removed normally from the blood.

“This takes place on the surface of cells, where special large protein molecules, called ‘receptors’ recognise specific proteins on the lipoproteins.

“Our main interest has been in the receptors that control the interaction between HDL and cells. This is a most important function because it is in this way that HDL removes cholesterol from cells.”

The Baker team has shown that ‘receptors’ or recognition sites for HDL exist on cells and has studied the way in which HDL, a complex molecule, is assembled. They are now examining the functions of the proteins that, together with fats, make up the HDL molecule. One of the HDL proteins which seems to be part of the transport system for dietary fat was first isolated at the Baker Institute.

The research is funded by grants from the National Health and Medical Research Council and the National Heart Foundation.

Dr. Paul Nestel and At. E. (Liz). Faehse, of the Baker Institute’s Cardiovascular Metabolism and Nutrition Research Unit. The Unit is engaged in research on the relationship between dietary fat and the metabolic factors involved in atherosclerosis.
Uranium needed to meet energy demand

INCREASING use of uranium and continued large scale use of coal will be necessary to meet the increasing world demand for electricity, according to a recent paper by Professor Lance Endersbee, Dean of the Faculty of Engineering.

In his paper, presented to the Australian Coal Conference, Endersbee points out that in the past 30 years, world demand for electricity has increased more than eightfold, and, with rising population and gradually improving living standards in developing countries, is expected to increase in the future.

Although high rates of growth in electricity demand may not be sustained in the developed economies, he says, there is strong potential demand in the developing countries.

In 1980, he points out, the average electricity consumption in developing countries was only 381 kWh per capita, compared with 6724 kWh per capita in developed countries — a ratio of one to 18.

"As an upper limit projection, we may assume that world demand for electricity will continue to double every 10 years," he says, "as a lower limit projection, to double every 20 years.

"Either way, the task of increasing electricity production facilities and supplying energy is formidable, and will require all available energy resources — coal, uranium, solar, hydro-power, as well as continued use of oil and gas, for electricity generation." The requirements of capital to double world electricity production are also enormous, he says. But, in proportion to economic output, the funding involved is consistent with what has actually been achieved for electricity investment in the recent past. The main factor leading to this increasing demand for energy and electricity is the continued growth in world population. The population of the world in 1978 was 4.3 thousand million. It is expected to increase to 5.3 thousand million by 1990, to 7.7 thousand million by the year 2000, and to 11.8 thousand million by the year 2020.

Endersbee says the population projections are based on a significant decrease in average population growth rates.

As a result of birth control programs, increasing affluence, increasing urbanisation, and improvements in communications, average population growth rates are expected to decrease from about two per cent at the present time to 1.6 per cent by the year 2000 and 1.2 per cent by the year 2020.

Despite these trends, world population still seems likely to increase by 50 per cent within the next 25 years — a time-span well within the operational life of coal mines and power stations now being built.

In his electricity demand projection, Endersbee points to the historical relationship between electricity consumption in industrialised countries and economic output. This close relationship, he says, has been maintained through two major oil price shocks around the world, through changes in patterns of energy consumption within industries, industrial recession, and recent industrial growth.

Extrapolating from present market trends, he predicts that the use of uranium power will continue to increase into the next century, gradually replacing oil and gas as electricity fuels. It will become comparable with coal as a fuel for electricity by early next century, eventually replacing it.

Coal is expected to retain its present share of world electricity production for the next two decades and then decline. This will mean in absolute terms an enormous increase in the world demand for coal — a doubling of demand within the next 20 years.

Endersbee says the relative costs of electricity generation from coal and uranium vary between countries, reflecting not only supply and power station construction costs, but also the costs of delays and deferrals arising from concern in some countries about uranium power. These days, he says, it is also necessary to take into account the costs of coal pollution control.

He quotes a 1980 study by the US General Accounting Office into the economic impact of delays which states that in the US in the period 1974-78, 184 large electric generating units were cancelled. Eighty were uranium plants and 84 coal-fired plants.

Of 330 units projected to be completed by the early 1990s, the study said, 81 per cent had already been delayed an average of 40 months. Nuclear plants incurred the longest delays in the period 1974-78 — an average of 33 months compared with an average of 10 months for coal units.

As comparative costs favour uranium power in many major industrial countries, Endersbee argues, the use of uranium power is expected to expand. It is already supplying a substantial part of the electricity generation in France (48 per cent), Sweden (39 per cent) and Switzerland (28 per cent).

The environmental effects of coal utilisation (pollution, "acid rain", and increased atmospheric carbon dioxide levels) are already a very serious concern in many countries and are rapidly becoming worse, he says. These problems are expected to lead to increased acceptance of uranium energy.

Discussing alternative power sources, he predicts a great potential for hydro-power development, especially in Africa and South America.

Mini-hydro-power plants (2-10 mW), he says, can be used to extend hydro-power development in industrial countries and to introduce and extend electrification in developing countries. Mini-hydro plants have less environmental impact than large hydro-power schemes and can service a decentralised power system, or be connected to a grid and may be operated automatically.

He sees considerable potential for mini-hydro development in South-East Asia — in the Philippines, for example, some 4800 sites have been identified.

He regards solar electricity from photovoltaic cells as "the joker in the pack." It would require back-up generation or energy storage, he says. But if present research leads to a reduction in installation costs to one-tenth of present levels, solar energy from photo-voltaic cells could provide a significant part of world electrical power generation in the long term.
Probing the structure of matter

IN 1912 the German physicist Max von Laue, an instructor at the University of Munich, had the bold idea of letting a beam of X-rays pass through a crystal to see if it was diffracted like light.

His hunch proved correct. The X-rays, scattered by the lattice of atoms in the crystal, left a pattern of dark spots on a photographic film from which the arrangement of atoms in the crystal could be deduced.

Laue received the Nobel Prize in 1914 for this work.

The experiment demonstrated that X-rays, like light, are a form of electromagnetic radiation.

It was also the beginning of the science of crystallography — the study of the regular atomic and molecular structure within crystals and materials, their bonding properties and the physical and chemical properties that arise from these atomic and molecular arrangements.

Since von Laue’s experiments, gamma rays, neutrons and electrons, as well as X-rays, have all been used to probe the structure of matter. Now a promising new application for neutrons, the uncharged particles that make up part of the core of the atom, has emerged.

Following a theoretical prediction by Dr Stephen Wilkins, of CSIRO’s Division of Chemical Physics, Monash physicists, in neutron diffraction experiments at the famous Institut Laue-Langevin at Grenoble in France, have obtained a diffraction effect known as the Kikuchi effect.

The effect was first observed with electrons and explained by Seisih Kikuchi, a Japanese physicist, more than 50 years ago. However, this is the first time it has been observed with neutrons.

The Monash research is part of a collaborative program with CSIRO’s Division of Chemical Physics and the Australian Atomic Energy Commission.

Professor Fred Smith, who is leading the Monash team, says the Grenoble observations could lead to the use of neutrons as a way of studying the very low energy vibrational states of atoms in a crystal and possibly the “elastic properties of the individual components of a composite material.” The Monash work was done on a single crystal of potassium bromide.

The work at the Institut Laue-Langevin in France (the contributing nations) have first call on its facilities.

Dr C. J. Howard of the Australian Atomic Energy Commission’s Lucas Heights Research Laboratories.

It was Lehmann who paved the way for the Monash team’s use of the much-sought-after facilities of the Institut Laue-Langevin. The institute has an operating budget of more than twice that of the combined budgets of its American counterparts, and scientists in the UK, France and Germany (the contributing nations) have first call on its facilities.

Smith says that in their neutrondiffraction work, they found that when they were looking at the diffraction pattern of the inelastically scattered part of the beam, instead of getting a peak as expected, they were getting a peak with a dip in the middle of it. The peak with the dip was identified by Wilkins as a gamma ray Kikuchi effect.

Following a theoretical study by Wilkins, published in Physical Review Letters, the Monash-CSIRO team then attempted to repeat the effect using neutrons instead of gamma rays.

“It was an exciting possibility,” Smith says, “because neutrons at the wavelength we are using (1-2 Angstrom) have the same energy as the motions of atoms in the crystal.

“Therefore, if the Kikuchi effect could be demonstrated, the position of the lines would give valuable information about the vibrational states of the atoms in the crystal.

“It would allow us to study these very low energy states. This is not always possible with conventional neutron scattering techniques.”

After promising preliminary experiments at Lucas Heights, success came with Town’s neutron experiments at Grenoble. The measurements showed the same dips that had been observed in the gamma ray work.

When electrons are used the diffraction pattern is detected as a pattern of bright and dark lines with conventional neutron scattering techniques.

The team’s next step will be to repeat the experiments using a new form of detector — a position sensitive detector, which will enable them to make whole scans at a time. They hope to do this at Lucas Heights.

If they can use one of these new detectors, Smith points out, much of the tedium of the work will be eliminated. At present, measurements have to be done point by point.

A report on the neutron research is being prepared for publication.

The research arose as part of a project to study crystal lattice instability, funded by the ARGS. A specific grant is now being sought by Smith and Cashion for the study, which will be continued in conjunction with Wilkins and Howard.

The work at Lucas Heights was supported by a grant from the Australian Institute of Nuclear Science and Engineering.
The search for a bowel cancer ‘marker’

MONASH researchers at the Alfred Hospital are making headway in their attempt to understand why some patients with ulcerative colitis develop cancers of the colon or rectum.

They hope to isolate a physiological or immunological ‘marker’ which will enable them to predict which patients are at risk and will need preventive surgery.

The research, which is led by Professor Sir Edward Hughes, is being done in the Monash departments of surgery and pathology and immunology at the Alfred Hospital. Also working on the research are Clinical Associate Professor Frank McDermott, Clinical Associate Professor Eric Pihl, Mr W. Johnson and Mr A. L. Polglase.

Long-term studies of more than 2000 patients with colo-rectal cancer, ulcerative colitis, or both, treated by Hughes over a 30-year period from 1950 to 1980 are being used in the research, together with pathological and immunological studies.

The research is now throwing light on some of the puzzling features of ulcerative colitis.

McDermott says long-term follow-up studies have shown that patients with ulcerative colitis (a severe, chronic inflammation of the colon, of unknown cause) have a much greater risk than normal of developing bowel cancer.

The risk, he says, relates mainly to those patients who have inflammation of the entire large bowel (colon and rectum). They represent about one third of ulcerative colitis patients.

The studies showed that within 10 years about one in eight of these high risk patients developed bowel cancer. Within 20 years the risk was 25 per cent, and it increased with age.

Because of the high cancer risk, McDermott says, it was the practice some years ago to remove both the colon and the rectum of ulcerative colitis patients who had had inflammation of the entire large bowel for 10 years.

This meant providing an artificial opening to the small bowel above the site of inflammation (an ileostomy) through the front of the abdomen. The patient had to wear a bag which collected liquid from the small bowel in the course of the day.

To avoid this radical form of surgery, Hughes pioneered an alternative operation in which the colon was removed but the rectum was preserved. The small bowel, in this case, was linked to the rectum.

This less radical operation enabled the patient to live a much more normal life.

However, when 100 of these patients were examined 15 years later, a number, although apparently healthy, were found to have cancer of the rectum. They were unaware of it because the symptoms of rectal cancer and ulcerative colitis are the same — diarrhoea and bleeding from the rectum.

“They hope to isolate a physiological or immunological ‘marker’ which will enable them to predict which patients are at risk and will need preventive surgery.”

“Obviously, if we are to avoid radical surgery in patients where it is not necessary,” McDermott says, “we need to have some way of knowing which patients are likely to develop cancer.”

The first clues to a possible “pre-malignancy marker” came with a longitudinal study by Hughes. He compared bowel lining samples taken from ulcerative colitis patients in the years 1967-72 with samples from the same patients taken 10 or more years later. It was found that in 25 of the patients there was moderate to severe dysplasia (altered growth) of the lining, which was apparent under the microscope. Of these 25 patients, six eventually developed bowel cancer. None of the 33 patients who showed no dysplasia or only mild dysplasia developed cancer.

Similar results were reported in a study at St Mark’s Hospital in London, but in both the London and Monash studies there were cases where moderate to severe dysplasia had reverted to no dysplasia at all or only mild dysplasia.

McDermott believes that this reversion could be an artifact, caused by errors in sampling.

The dysplasia question is further complicated by a Chicago study, which, McDermott says, “tipped the apple cart upside down.”

In their study of a large group of ulcerative colitis patients who developed bowel cancer, the Chicago researchers found very few cases where there was evidence of severe dysplasia in the conventionally sampled bowel lining.

More important as a cancer predictor, they believe, is the presence of visible changes in the bowel lining which can be detected by examination of the patient with a colonoscope, a telescope-like instrument.

Of 17 ulcerative colitis patients in the Chicago study who developed cancer, 12 had these macroscopic lesions. Very few had severe or moderate dysplasia in the conventionally sampled area.

Although the cause of ulcerative colitis is unknown, immunologists believe that some disturbance of the immune system is involved.

Pihl has detected significant differences in the blood leukocytes (white blood cells) of ulcerative colitis patients. He concludes that the disturbances in the leukocytes (the immune system’s scavenger cells) are secondary to the disease rather than its cause. Similarly, he concludes that changes in the bowel mucosa, although clearly related to the severity of the disease, are also secondary to it.

Pathology studies by Pihl have shown that normal dysplasia assessment techniques are unreliable as they are subject to observer, as well as, sampling errors. To overcome this problem, he is using immunological techniques to obtain a more objective assessment of dysplasia — with some success.

He points out that for some reason cancerous and pre-cancerous lesions produce substances that are normally only produced by the foetus.

An example of this is a foetal glyco-protein which is produced in cancer of the large bowel. This foetal glyco-protein is a primitive blood group-like substance which appears to be a precursor of a normal blood group antigen.

Pihl has found a highly significant correlation between the presence of this primitive substance and the extent of dysplasia.

Unfortunately, he says, there are quite a large number of false negatives — lesions that look dysplastic yet produce normal glyco-proteins.

There is also a high incidence of false positives — lesions that do not appear to be dysplastic, yet produce these primitive bloodgroup-like precursors.

“The presence of these foetal substances will help us in our diagnosis of dysplasia,” he says, “but only future research will really show whether it will be a reliable substitute for a subjective assessment of dysplasia.

“I'm sure that this study will take us very much further than we've been able to go until now.”

Although the cause of ulcerative colitis remains a mystery, a number of risk factors have been clearly identified in relation to colo-rectal cancer.

High on the list is the genetic factor. Colorectal cancer appears to run in families.

People suffering from diseases such as ulcerative colitis and polyps of the large bowel also have a higher than normal risk. However, these three factors account for only a small number of large-bowel cancer cases.

Dietary factors appear to be most important in the causation of colorectal cancer. Anti-oxidants, such as Vitamins A and E, riboflavin and selenium, are probably protective in that they would suppress the conversion of harmless substances to cancer-causing substances. A major risk factor seems to be a diet high in animal fat and protein.

Recent animal studies showed that a high fat diet increased the risk of experimentally induced bowel cancer six-fold.

The animal studies are supported by migrant population studies. Australian studies have shown that migrants from...
Sex hormones affect brain asymmetry?

In recent years the evidence has been mounting that the two hemispheres of the brain are specialised for different functions.

The left hemisphere — the so-called dominant hemisphere — appears to be predominantly verbal and analytical, skilled in linguistic description, logical analysis and arithmetical computation. The right hemisphere is geometric and spatial, superior in pictorial and pattern sense. It also appears to be the musical part of the brain.

This hemispheric specialisation was thought to be a purely human attribute, associated in some way with the development of language. But recent research at Monash and in other laboratories suggests that it occurs also in birds and primates and may have developed very early in evolution.

Rogers, in experiments on chicks, has found that visual discrimination learning, auditory habituation, attention switching and decisions to peck or not peck are activated by the left hemisphere. Visual habituation learning on the other hand is not lateralised.

The right hemisphere appears to play a more important role in the bird's response to novelty, and an imbalance in the activity of the two hemispheres, in favor of the right hemisphere, leads to an increase in aggressive and sexual behavior.

Is this brain lateralisation determined genetically, or does the environment have an influence? Do sex hormones influence brain asymmetry?

Recent research by Rogers suggests that both environment and sex hormones influence brain asymmetry — at least in the chick.

She has shown that the presence of asymmetry in the chick's brain with respect to copulatory behavior can be manipulated by hatching eggs in the dark.

In the egg, she points out, the chick's head is turned upon the left shoulder in such a way that the left eye and ear are shielded. Light and sound entering the egg is "relatively attenuated on the left side of the chick's head." This could mean that the chick's left hemisphere is stimulated to a greater extent before hatching than is its right hemisphere, since inputs to the right eye are processed in the left hemisphere.

She has tested the hypothesis by hatching eggs in the dark. When this happens there is no apparent brain lateralisation for attack and copulation.

Now, in a recently completed set of experiments, using male chicks, she has shown that sex hormones can also affect brain asymmetry.

To determine the effect of sex hormones on brain asymmetry, the birds were tested with one eye covered, since most information entering one eye is processed by the opposite hemisphere. Thus, messages from the right eye end up in the left hemisphere, and messages from the left eye end up in the right hemisphere.

Two groups were used. The experimental chicks were given the male hormone testosterone. The control chicks were given maize oil, which is known not to affect brain lateralisation.

Rogers and research assistant Joe Zappia and Ph.D. student Shane Bullock tested the chicks for copulation daily from Day 6 after hatching.

When the testosterone-treated birds were tested at Day 6 they did not attempt to copulate regardless of whether the left or right eye was covered. There was no apparent dominance of the right hemisphere.

However, within a matter of two or three days, those with the right eye covered attempted to copulate. Those with the left eye covered did not.

This demonstrates dominance of the right side of the brain for copulatory behavior since the birds with the right eye covered are using their left eye system. Messages from the left eye are processed by the right hemisphere of the brain.

"It seems," Roger says, "that during the first week of life the left side of the chick's brain is more developed. During Days 10 and 11 the right side starts to develop."

Controls treated with maize oil showed slight right hemisphere domination, but the effect was marginal. Rogers believes it could be an artifact of the experiment, or it could have been caused by low levels of testosterone already circulating in the chick's blood.

When the control chicks were tested with both eyes open, the left hemisphere (which inhibits copulation) was dominant. When the chicks were given testosterone and tested with both eyes open, the dominance was reversed. The right hemisphere, which controls copulatory behavior, was dominant.

Dominance reversal was also demonstrated in a visual discrimination task in which the chick was required to search for food grains scattered on a background of small pebbles stuck to the floor.

In the control chicks, the left hemisphere (the side that inhibits copulatory behavior) was the one that pecked the pebble task mostly easily. In the testosterone-treated chicks it was the right hemisphere. Under the influence of the sex hormone, apparently, the right side of the brain, as associated with sexual behavior, became dominant for learning.

In female chicks, there is no asymmetry for learning the pebble task. Both sides of the brain learn equally as well.

Rogers says the research demonstrates that male sex hormones have a greater effect on brain lateralisation in the chick. But she cautions against extrapolating from this to human asymmetry, particularly to differences between males and females.

For one thing, she says, high doses of oestrogen, the female sex hormone, produce similar effects in chicks to testosterone.

"It is not surprising that happens," she says. "It is known that, in the brain, testosterone, for most of its actions, needs to be converted to oestrogen to have an effect. High doses of oestrogen are commonly known to mimic testosterone."

The effect of testosterone on brain asymmetry in the chick is an interesting phenomenon, she says. But "are we dealing with something in the real world," she asks?

"We are giving high doses of hormones at a time when they wouldn't be present. What we're seeing is juvenile copulation precociously produced."

"Do we give the hormone at a later date will it have the same effect? We'll have to test older animals to find out and also test other species."

It could be that brain lateralisation in all species is influenced by a combination of genetic, environmental and hormonal factors, she points out. She says, "environmental factors are just as likely to influence brain development as hormonal factors."

"It may be," she speculates, "that puberty is delayed partly to permit the brain to differentiate and establish those processes that lead to lateralisation before sex hormones come in and lock the brain into a particular framework."

The research, which is funded by an ARGS grant, is being prepared for publication in the US journal "Science."

Rogers' research is one of several experimental studies which will be highlighted by the department of pharmacology during Victorian Medical Research Week. The department will be open to visitors on Monday, August 27 from 9 a.m. to 12 noon.

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Ulcerative colitis

countries such as Italy, Greece, Yugoslavia and Poland, where the incidence of bowel cancer is comparatively low, are just as likely as Australians, after 16 years here, to develop the disease.

The Monash research is supported by the Anti-Cancer Council of Victoria and the Alfred hospital.

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