INSECTS AND DISEASE.

Address by Professor Johnston.

Professor Harvey Johnston, D.Sc., addressed members of the Adelaide branch of the Health Inspectors' Association, in the Public Library lecture room on Wednesday night, on "Insect Carriers of Disease." There was a fair attendance. Mr. G. W. Holton (president of the branch) occupied the chair, and in introducing the speaker, stated that the present address would be the last of the series held for the year.

Professor Johnston said his remarks would have nothing to do with the control of the insect, which was recognised as the transmitter of disease. He grouped the various insects responsible for the spreading of diseases into various sections. Speaking of the louse, the professor said that, until the war, people regarded that insect as a very interesting creature; but, as a matter of fact, years before the war scientists found out that the louse was the disseminator of a great deal of disease. It took the war to bring home the fact that the louse brought about the outbreak not only of typhus but also of trench fever. An enormous amount of money had been spent in healing men infested with lice. The louse bred rapidly, and the temperature it liked best was that below body warmth. The disease could be started by scratching the bitten part of the body or crushing the insect. An infected louse would breed young, which would be actually infected also, and be disease spreaders from the start. A peculiar disease recently occurred here, which was not altogether typhus, but was called Bull's fever. It was not known whether lice were the carriers, but it certainly was some sucking insect. Fleas carried plague, which was essentially a disease of rodents, not necessarily rats. It was a disease not restricted to rodents, but was common to larger animals up to kangaroos. The common rat flea carried germs from rat to rat, and did not attack human beings. In summer the plague flea played an important part of rat life in Australia. It was much more abundant in warmer regions, and that was the reason the plague was more prevalent in warm countries. Bugs were also germ carriers. There were two kinds of bugs—the house bug and the one found in some parts of the world. The latter were responsible for sleeping sickness. Bugs were concerned with the transmission of the disease among infants. Another disease was the Busrah sore, which was transimitted by the bed bug. It was quite possible that the bug played an important part as transmitters of leprosy.

The non-biting fly was responsible for the spreading of many diseases, said the professor. They comprised the house fly, the small fly, and the blowfly. The house fly liked all sorts of filth, and it could readily be seen how easily they became infected, and how it was possible for human beings to become affected with various diseases. The common black bush fly was responsible for the eye disease so commonly known as thracoma. The biting fly, such as the tsetse fly, was responsible for the sleeping sickness prevalent in South Africa. Mosquitoes were responsible for many discomforts and for the spreading of three different diseases —dengue and yellow fever, three different forms of malaria, and blood worms. The American people had spent a great amount of money in fighting the mosquito, and with the exception of some parts in Brazil, yellow fever had been successfully combated in the United States and the central parts of South America. He felt safe in saying that the temperature of Adelaide during the summer season was not such as to bring about the introduction of malaria. In conclusion the professor stressed the fact that the two most important insects they had to combat were the mosquito and non-biting fly.

A hearty vote of thanks was passed to Professor Johnston and the proceedings closed.

AGE OF THE EARTH.

5,000,000,000 YEARS.

SCIENCE AT GRIPS WITH THE PROBLEM.

Describing his subject as the longest one in the world, Mr. C. T. Madigan, of the Adelaide University, delivered an interesting address at the weekly luncheon of the Leather Heads' Club on Thursday, on the age of the earth. The chair was occupied by the president (Mr. W. S. Hay), and a large gathering attended.

The lecturer said the problem of the age of the earth, with the many problems associated with it, had been engaging the attention of man from the remotest antiquity. It was not until within the last hundred years, however, that any definite data had been secured. Previously the problem had been dealt with in myths and imagination. The Hebrew chronology had placed the beginning of the earth at 4,004 years before Christ. The writers of antiquity did not differentiate between the appearance of man on earth and the beginning of the earth. The Brahmins held that there was no beginning and no end, and that time was eternal. About 100 years ago the question was tackled seriously by scientists, and estimates were based on calculations of sound reason. A school of "Uniformitarians" was formed, and they showed that the geological processes of the earth could not be crowded into 6,000 years. They proved that sedimentary deposits took a much longer period for formation, and that mountain ranges 20,000 feet high had been worn down and built up again many times, so that 20 times 6,000 years would not cover the time involved. The slogan of the "Uniformitarians" was that the present was the key to the past. They were opposed by the "Catastrophists," who maintained that the question should be dealt with from the point of view of the catastrophes that had occurred in the history of the earth, but geologists, led by Sir Charles Lyell, secured more definite conclusions. Lord Kelvin, on purely mathematical grounds, made an estimate of the age of the earth at 40,000,000 years, which was accepted as incontrovertible for some time. Then the time taken for the deposit of sedimentary rock laid down in the sea by rivers was found capable of accurate measurement. Calculations by that means placed the age of the earth at between 50,000,000 and 100,000,000 years.

The discovery of radium, however, threw a new light altogether on the subject. The time it took for various metals to undergo changes was estimated, and it became a question of simple arithmetic to arrive at a much longer estimate of the age of the earth than anything previously held, running into two thousand million years. The time between the formation of rocks and the time when the earth was a gaseous substance, had to be estimated. Rocks estimated to be 840,000,000 years old, had been analysed by a University student named Mr. Thomas, near Normanville, and south of Broome, in Western Australia. Other investigations gave the age of rocks at 1,260,000,000 years. The disintegration of minerals was thought to be constant throughout all time, but there might be some defect discovered in that theory. Astronomers had also made calculations regarding the age of the earth, and some of their estimates were as high as 5,000,000,000 years since the earth was in a form of incandescent gas, and 2,000,000,000 years since rocks were formed.

Messrs. J. H. Stalte and O. H. Harry thanked the lecturer for his address, and also welcomed Mr. M. H. Pirrie, the vice-president of the Victorian Leather Heads' Club.

SOIL FERTILITY AND ITS CONTROL.

Under the auspices of the Market Growers' Association, Professor J. A. Prescott delivered a lecture on "Soil Fertility and its Control" at the New Market Board-room on Wednesday night.

The lecturer dealt with the nature of the soil under natural conditions, and then as shown up in the laboratory by artificial findings. The most important field character in controlling the suitability of the soil for any particular purpose was what was known as the profile. Alluvial soils possessed no characteristic profile that was uniform in texture and in depth, and were hence suitable for a wide range of market crops and fruit crops. In contrast with these were soils from hilly country where frequently rock was close to the surface. Soils with mature profiles had usually bands of clay in the subsoil, and consequently were not always suitable for horticultural purposes, but might find important use in the case of wheat or even vines. The rice soils of the Murrumsubsoil which made them suitable for bidgee had the characteristic heavy the purpose. The physical texture of the soil was controlled by the relative proportions of sand, silt, and clay. Soils containing a heavy percentage of clay were usually only suitable for cereal crops, particularly wheat. Soils containing a high proportion of sand were suitable for such crops as citrus and fruits in general, and also for tobacco. The hard setting of soils, characteristic of much land in South Australia, was due to the high proportion of fine sand. Apart from the contents of the soil as plant food, there were a number of chemical characters which were only important in respect to fertility. The most common source of infertility in this respect in order and better countries was soil sourness, but except for certain soils in the Adelaide Hills and the swamps at Murray Bridge, South Australian soils were rarely acid. It was necessary to go to Tasmania to find soils which were truly sour. Where the rainfall was less than 20 inches, as was the case in South Australia, soils were found to be either neutral or alkaline. On the other hand, these alkaline soils might frequently give rise to considerable trouble under irrigation. Much of the soil at Renmark was particularly alkaline, and the only corrective known was the use of gypsum. The exact quantities or the most effective methods for the application of this soil were still unknown. The alkalinity had recently been found by Messrs. J. K. Taylor and H. N. England, of the Waite Institute, to be due to the high proportion of reactive sodium and magnesium in the soil. Where soil infertility was due to real acidity, the use of some form of lime was indicated. In South Australia it was due to the presence of salt, commonly known amongst cultivators as magnesia. The only cure for this defect was the leaching of the soil, so as to remove the salt entirely. Unfortunately there was no other remedy.

Professor Prescott spoke of the chemical nature of the soil from the plant food point of view, and the elements necessary for the growth of plants. He indicated how their deficiencies in Australian soils were noted. These deficiencies were determined not only by chemical analyses, but by field experiments. So far the deficiency in phosphorous was the most striking one in Australian conditions. This was remedied by the use of superphosphates. Experimental work was now showing the necessity for nitrogen, particularly for citrus growing, and there was reason to believe that the use of nitrogenous fertilisers was becoming of greater importance in Australia. A special example of soil deficiency was illustrated by the recent work of Messrs. G. Samuel and C. S. Piper, of the Waite Institute, on the manganese deficiency disease of oats in the South-East.

AUSTRALIA AND THE PACIFIC.

W.E.A. Lecture.

A lecture was given on Tuesday evening, under the auspices of the Workers' Educational Association on "Australia and the Pacific" by Mr. A. Grenfell Price, M.A., at the Darling Building, University. The chair was taken by Mr. E. R. Dawes (president of the W.E.A.).

The lecturer traced the growth of human knowledge of the Pacific Ocean, which resulted in the discovery of Australia. The ancients had believed that a vast southern continent must exist to balance the northern land masses, and had drawn maps which showed a huge southern continent containing weird animals and plants. When the Portuguese rounded the Cape of Good Hope, and the Spaniards occupied central America, voyagers, such as Magellan and Drake, crossed the Pacific, and proved there was no great continent in that ocean. The Spaniard Torres, however, passed through the strait between Australia and New Guinea, and nearly discovered Australia.

Meanwhile, the Dutch discovered northern Australia from the Indies, and mapped the west and north coast. Tasman also discovered Tasmania and New Zealand, but the Dutch were interested in commerce only, and did not develop their discoveries. So matters rested until in 1778 Cook was sent out by Britain, examined the whole south Pacific, charted New Zealand, and the eastern coast of Australia, and proved that if there was a southern continent other than Australia it must be comparatively small, and lie in the far south. Cook gave a glowing and inaccurate account of Botany Bay and its sterile shores, and it was this account of the work and influence of the botanist, Joseph Banks, which led to the British occupation of Australia.

The shores of the Pacific were then occupied by four great nation groups, The American, British, Russian, and Far Eastern, and these are struggling for the dominion of the Pacific to-day. The American group was very powerful owing to the vast resources of the United States and her economic influence in South and Central America, which had been immensely increased by the Panama Canal.

The Far Eastern group contained some 500 million people, and its most active member, Japan, was rapidly adopting European civilization and armaments. She had defeated China, Russia, and Germany, and had forced the nations to recognise her as the most favoured nation in regard to China, where she controlled the rich province of Shantung, and was strongly at variance with American trade interests. Her rapidly expanding population was occupying Manchuria, and it was to be hoped that this zone would prove a sufficient outlet. There was, fortunately, great friction between the Japanese and Chinese, as a Japanese control of the huge population and resources of China would make that nation, with its strong war party, immensely powerful.

The Russian group was still disorganized, and the British Empire, although possessing Australia, Canada, and other Pacific possessions, was less strong in the Pacific than appeared, as it was hampered by the vast distance from Britain. England controlled the South American, Australian, and Singapore gates to the Pacific, but until the Singapore dock was finished her main fleet would be unable to operate in its waters, and a second dock was urgently needed in Australia. Australia alone, with practically no navy, and an army which lacked many of the requirements of modern warfare, was quite powerless without Britain, and her main requirement was time to increase her population and to develop her industrial resources until she was safe from molestation, even if Britain had her hands full elsewhere.

What, asked the lecturer, would have been the position of Australia if Japan had been upon the German side in 1914? Although one-third of Australia was desert, and another third tropical country, which was most difficult to develop, the fertile southern and eastern third should contain 20 million people in some 60 years, which should be adequate. It was far more necessary to spend money in these regions than in the deserts or tropics, as it would be the fertile areas which invaders would seek, rather than the tropical north. The Australian problem was one of time, if Australia was to become a great Pacific Power.

THE NEWS

SATURDAY, JUNE 15, 1929

ARBITRATION LABORATORY

(By Harry Thomson)

Lord Bryce spoke more truly than he knew when he described Australia as the laboratory of socialism. From what one remembers of one's schooldays a laboratory is a place where the small boy delights to make noxious smells and miniature explosions, as well as explosions not so miniature. And mainly for the reason that Australian Labor is 20 or 30 years out of date in failing adequately to recognise the absolute interdependence of capital and labor arbitration has not got much beyond the laboratory of the small boy.

Strikes and unemployment and the high cost of living are some of the noxious smells, while arbitration courts and a great deal of ill-considered legislation and government trading are part of the laboratory apparatus. And now the proposal is to scrap a good deal of the apparatus, or rather to use simply the small size test tubes for the experiments instead of alternating with the large size—and seeing what a glorious bang can result.

Counsel of Despair

The latest proposal to scrap Federal and revert entirely to State Arbitration Courts is admittedly a counsel of despair. Granted that the overlapping of State and Federal awards has reduced arbitration awards to the status of a jig-saw puzzle. Granted that the spectacle of a manufacturer in Melbourne who says that his business is subject to one hundred and thirty awards, many of them inconsistent, rightly belongs to Gulliver's Travels. Granted that it is a reductio ad absurdum to have a bewigged and bespectacled judge at £2,500 a year solemnly deciding that every business shall have a first-aid outfit with needle, cotton, and safety pins as per schedule. Granted all these and many more things, is not tinkering with machinery merely playing with externals?

It is very difficult to contend, for example, that industrial laws dealing with seamen should not be Federal in character. On the other hand, there would seem no reason in the world why clerks should not be dealt with by State laws and State awards. The award governing timber workers is Federal. They are on strike in Victoria and are not now on strike in South Australia. Is there any reason to believe that the position would be different if the Victorians were governed by a Victorian award and the South Australians by an award under this State? There will be just as much likelihood of conflict between a Victorian and South Australian award as between a Victorian and Commonwealth. The great advantages will be a geographical line of division between the two courts and the cessation of the old game of playing one court off against another.

False Idea of Money

Unpalatable as it may be to the small boy in the laboratory he has got to learn certain first principles. And the most important of these is that in the long run supply and demand, cost of production, and market price are all members of the same family, and closely connected. Standard of living, however beautifully dressed, is a stranger, even if a welcome guest. It may be a result, but it never is and never can be a primary cause. This may be almost as hard for the small boy to learn as the multiplication table, but it is no less true.

The trouble about most of these things is that our minds are obscured by a false idea of money. Economists who write on exchange deplore the confusion of thought that arises, and almost beg us to talk and think only about goods. In the last resort goods are the only things we produce, and goods are the only things we share. And if we want to help the maker or grower of one sort of goods we can only do it at the expense of another grower or maker or exchanger of goods—for there is nothing else to draw on.

Services do not help, for they are paid for in the last resort by goods—or other services. In Australia, with the one solitary exception of wool, the producer of almost every important article has some time or other asked and generally received a bonus or a subsidy. Wine, dried fruit, meat, butter, and so on—out of what are all these subsidies to be paid?

There is not much good in wheat lending wine, and wine lending meat, meat lending butter, and butter lending wheat, for the result gets back to where you start from, except that you have had a lot of useless organisation and officials and transactions without giving anyone a single extra grain of wheat, ounce of butter, or bottle of wine. And exactly the same thing applies when either capital or labor asks for more than it produces.

Root of Difficulties

Admitted a thousand times that arbitration in Australia has been a failure, the reason has been twofold. The first is that it has proceeded upon wrong economic principles and has attempted to build up an artificial standard of living and prosperity, one direct result of which is the high unemployment rate. And the other is that the scheme has been too ambitious in attempting to regulate all sorts of little details.

Hours and wages may perhaps reasonably be dealt with by courts—but most conditions might much better be left to the circumstances of the particular business unless they are matters of health, when they can be dealt with by the health authorities. And even hours and wages ought only to come before a court in the event of a disagreement in the particular business, the primary rule being that employer and employe should settle their differences direct if they can, the court being called in only as a last resort.

These matters are matters of principle and are at the root of all arbitration difficulties in Australia. Our State masters ought not lightly to assume that a mere transference to the State will bring the millennium. It is by no means certain that a complete withdrawal of the Commonwealth from industrial affairs is the best thing in the interest of building up a mighty Australia. It may be, but a blind insistence on State rights does not prove it.

THE NEWS

SATURDAY, OCTOBER 20, 1928

SUPERSONIC WAVES

(By Prof. Kerr Grant, M.Sc.)

Without subscribing unreservedly to the doctrine which asserts that war is the mother of all inventions, it can yet hardly be denied that the stress of deadly conflict acts as a powerful stimulus to human ingenuity. In this regard the last great war has not proved exceptional.

Terrible as has been the price exacted in the toll of human life, in the destruction of property, in the check to almost every form of beneficent activity, there are still items to be placed on the other side of the ledger which in the long run may in the saving of life, in the promotion of civilising intercourse between nations, and in the furthering of the ends of industry and commerce go some way toward wiping out the appalling deficit.

It is the purpose of this article briefly to deal with one of the minor inventions which were developed during the war for purely military purposes, and to indicate some of the applications which have since then been made of it to civil and innocent ends.

In 1912, instigated probably by the terrible disaster to the Titanic that year, Lewis Richardson, of London, took out a patent on a method of using high-pitched sound beams for the detection of icebergs. Nothing was done, however, toward realising this proposal until 1914, when M. Chilowski, of Paris, in consultation with Paul Langevin, the eminent Professor of Physics in the University of the Sorbonne, made experiments on the production and detection of such beams of sound under water.

Frequency of Vibration

It should be explained that if the frequency of vibration exceeds a certain value—about 20,000 a second for a normal individual—waves falling upon the ear excite no sensation, much as is the case with light waves too short to excite the sense of vision. Such supersonic or ultrasonic waves may, however, be detected in various ways, for example, by modulating their intensity so that it rises and falls with audible pitch.

They possess, further, a great superiority for signalling purposes over ordinary audible sounds—of lower frequency or longer wavelength—in that they can be transmitted in a narrow beam which, like a ray of light, spreads but little in passing from place to place. This obviously renders it possible to maintain perfect secrecy in transmitting submarine signals by this means.

Many different methods of producing such vibrations have been devised, such as steel plates driven by electromagnets jets of high-pressure air or steam, and short metal rods or bars struck by a hammer. But that which has proved to be the most convenient, efficient, and flexible in the variety of the uses to which it may be put is the so-called "piezo-electric oscillator," as devised by Langevin and his coworkers.

This consists essentially of a plate cut from a piece of clear crystalline quartz—so-called "rock-crystal"—excited to vibration by the application of a rapidly oscillating electric voltage applied to metal plates laid in contact with the faces of the crystal plate.

Electrical Oscillations

When the rapidity of the electrical oscillations is attuned precisely to that of the natural rate of vibration of the crystal plate the latter is excited to vigorous vibration, and if immersed in any fluid—air or water, for example—generates therein pressure waves audible or inaudible as sound according to the frequency. Such a beam if supersonic—and frequencies of several hundred thousand a second are commonly employed—can be transmitted through water—a far better medium for sound transmission than air—for distances of many miles.

With moderate powers and crystal plates of only a few square inches in area, ranges of five or six miles are said to be easily attained. If the beam is directed against a submerged reef or rock, the hull of a ship or submarine, an iceberg, or the bottom of the sea, it is reflected and the echo returns to the transmitting ship or station.

"Echo-sounding" by this means has been put into practice by several of the larger navies with signal success. A ship provided with the necessary apparatus can thus make a continuous survey of the ocean depth without the necessity of reducing speed as must be done when sounding by line.

Detecting Icebergs

The feasibility of detecting icebergs by supersonic beams has been tested by one of the chief workers in this field, Prof. Boyle, of the Canadian University of Alberta. He finds that in deep ocean water detection at a mile or more is practicable, but that in shallow water the perception of the echo from the berg is masked by reverberations from the bottom of the sea.

Another application of great potential value to navigation lies in the combination of such submarine signals with simultaneously emitted wireless signals. The latter are, of course, received at practically the instant of emission. The sound signals, on the other hand, are retarded by an interval which is a precise measure of the distance between sending and receiving stations. In this way a ship may at all times ascertain its location with respect to another ship or shore station, even when night or fog occasions complete invisibility.

Laboratory investigations made by Prof. Robert Wood, of Johns Hopkins University, in conjunction with Mr. Alfred Loomis, of New York, a wealthy devotee of scientific pursuits, have brought to light some remarkable properties of these ultrasonic waves.

Using a two horse-power generator they generate waves only a fraction of a millimetre in wave-length in a tank filled with oil or water. Small animals such as fish or frogs placed in the path of the beam are killed almost instantly. Explosives of certain type can be detonated and holes burned in wood or flesh by contact with a glass fibre into which the beam is introduced.

It cannot be doubted that in supersonic waves there has been discovered a new weapon of great utility both for many technical purposes and for scientific investigation.

THE NEWS

SATURDAY, JANUARY 26, 1929

NEW DISCOVERY IN OPTICS

(By Prof. Kerr Grant, M.Sc.)

The scattering or diffusion of light by minute particles suspended in air or water is an appearance observable with very simple means and is, indeed, of familiar occurrence in Nature.

The sunbeams which traverse a darkened room, or on a magnificent scale extend from cloud rifts far upward through the blue, are due to this dispersion of sunlight by motes in the one case and by minute drops of water in the other.

Prof. Tyndall showed that light thus scattered by fine dispersed matter differs in certain peculiar respects from the light of the original beam. For one thing, it invariably contains a larger proportion of blue light—that is, light of shorter wave-length. For another, it, unlike ordinary light, in a high degree "polarised"—that is, the vibrations by which it is propagated are not promiscuously directed, but are confined almost completely to a single plane.

Scattering of Light

An eminent physicist, the late Lord Rayleigh, worked out a complete mathematical theory of the scattering of light, and showed that it was competent to explain the intensity and quality of the blue light of the sky without invoking the presence of either solid or liquid suspensions in the air, simply in virtue of the power of the molecules of gas—oxygen and nitrogen—to disperse a minute fraction of the sunlight falling upon them, that fraction, as already said, being much larger for blue than for yellow or red light.

By careful measurements of the intensity of sky light the Mount Wilson Observatory has completely confirmed Rayleigh's theory, even to the point of evaluating correctly by its application the number of molecules contained in every cubic foot of air.

The present Lord Rayleigh has shown that this scattering of light by pure air or other gas devoid of all suspended matter can even be observed on a small scale experimentally.

At the Indian Institute of Physics in Calcutta, under the direction of Prof. C. V. Raman, an eminent Indian physicist, a thorough experimental study of this phenomenon of light scattering as it takes place in perfectly pure liquids and gases has been in progress for several years. Until quite recently the results have been entirely in accordance with the theories and conclusions of Tyndall and Rayleigh, a cardinal point of these being that there can be no other color or quality or wave-length of light in the scattered beam which is not also present in the original light.

Light Differing in Quality

Last year, however, Prof. Raman and Dr. Krishnan, one of his collaborators, in examining the light diffused by benzine in a direction perpendicular to that of the exciting beam, were led to suspect the presence of light differing in quality from that of the source. By well-designed experiments with glass screens or filters which permit only the passage of light of a particular color, Raman established definitely that this was, indeed, the case.

The most immediate explanation that this new light was due to a florescence of the liquid such as is observed in the surface layers of paraffin or other mineral oil, or in solutions of aniline dyes—ordinary ink, for example—when these are irradiated by sunlight, he showed to be highly improbable.

Raman passed a concentrated beam of light from a mercury vapor arc-lamp through a glass cell containing carefully purified liquid benzine, and received the faint light which emerged from the cell at right angles on the slit of a spectroscope fitted with a camera for recording photographically the constituent colors or, more precisely, wave-lengths of the emergent light.

It should be said that the light of the mercury arc contains only certain specific colors or wave-lengths which would give on such a photograph a few sharply defined lines in definite positions.

Transparent and Colorless

The spectrograph of the scattered light showed all these, and, in addition, new lines equally definite in position were found in the vicinity of the mercury lines. Measurement showed that the positions of these new lines differed from those of the old by distances corresponding precisely to the wave-lengths of the light absorbed by the liquid.

Now, no light is absorbed by pure benzine in the visible region—in other words, it is perfectly transparent and colorless. But in the so-called infrared or heat spectrum benzine, like most other liquids—water, par excellence—does absorb certain definite waves, and these it is which signify their presence by modifying the wavelength of the scattered light.

Many other liquids have been tested by Raman and others. The original observations have been confirmed up to the hilt, and already many new facts concerning the infra-red spectra of organic liquids have been brought to light. Hitherto the only methods of observing infra-red spectra have depended upon the use of highly sensitive instruments for detecting the minute amounts of heat absorbed from a beam passed through the liquid after dispersion of the beam by a prism of clear rock-salt.

Greater Accuracy

Such observations are exceedingly tedious and troublesome. The new method of Raman, although requiring with his original technique very long exposure.

By greatly intensifying the primary light beam, as can easily be done, the time of exposure may be made a matter of a few minutes. All competent workers in this field are emphatic that Raman has found a new effect and a new method of determining a fundamental property of molecules—namely, the rate of vibration of their constituent atoms, which will be of the greatest value in solving problems of molecular structure.

For knowing the frequencies of vibration of the atoms, which constitute its infra-red spectrum, it is possible to deduce not only the arrangement of the atoms, but the distances which separate them and the forces which hold them together.

Raman's interesting discovery is a gratifying illustration of the increasing part which India is now taking in scientific achievement.