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	PAGE		PAGE
<i>Sir C. V. Raman as Physicist and Teacher.</i>		<i>Some Reactions of p-Cymene.</i>	
B. S. MADHAVA RAO	343	JAMES VERGHESE	352
<i>Unesco Book Coupon Scheme</i>	345	<i>Oscar Edward Meinzer</i>	353
<i>Indian Society of Agricultural Statistics</i>	346	<i>Letters to the Editor</i>	354
<i>International Congress of Applied</i>		<i>Director-General of Unesco</i>	367
<i>Mechanics</i>	347	<i>Reviews</i>	368
<i>Winter Rain in the United Provinces.</i>		<i>Science Notes and News</i>	374
S. L. MALURKAR	348	<i>Supplement:—Sir C. V. Raman and Crystal</i>	
<i>University Interchange Between U.K. and</i>		<i>Physics</i>	
<i>India</i>	351	R. S. KRISHNAN	

SIR C. V. RAMAN AS PHYSICIST AND TEACHER*

A BRIEF review of the investigations in the field of crystal physics, carried out by Sir C. V. Raman and his pupils appears in this issue as a supplement.† We only wish to indicate here a few characteristic features of the scientific work of Sir C. V. Raman, his approach to research and his relationships with his pupils.

The most obvious characteristic is his great passion for physics coupled with an intense enthusiasm and volcanic energy. Even the most casual observer cannot fail to miss the fire in his sparkling eyes which seem to radiate this energy, and to be animated by the dynamic force of an active brain. He lives for his work as few men do, and by his exceptional tenacity of purpose and hard work in the pursuit

of research he has set a shining example to others.

He has a deep insight into physical processes, and an intuitive sense of physical reality. He has often shown the ability to illuminate a whole subject with a few crucial ideas. His highest work shows the inevitable simplicity of all great work, and has been achieved by spontaneously taking the significant step at the right moment. He possesses in a remarkable degree the gift of seizing the vital point from apparently trivial observations. This genius for picking out the true significance of what to others would be an unimportant detail, and transforming it into a clue for the understanding of fundamental problems is brought out strikingly in his work leading to the discovery of the Raman effect itself.

Raman is a born experimental physicist, and has been guided by the conviction that

* From the Sir C. V. Raman Sixtieth Birthday Commemoration Volume *Proc. Ind. Acad. Sci.*, Nov. 1948, Bangalore.

† Vide Supplement.

real progress in physics can be achieved only by the application of considerations based on experience and reason to experimental observations of properly chosen phenomena. He has advanced directly and successfully along this straight path without often branching into mathematical physics. Yet whenever occasion arose he has shown that he possessed the mathematical equipment essential to the interpretation of his work. He has also recognised and acknowledged the fundamental importance of ideas of a mathematical or deductive nature. Thus, in the realm of his researches in crystal physics, he has realised the importance of group theory, and the theory of group representations, and encouraged investigations based on such theoretical considerations. He has also shown facility in choosing the right type of mathematical technique needed in his work, and an uncanny faculty for seeing clearly through a mass of complicated mathematical calculations. His theory of the diffraction of light by high frequency sound waves is a striking example of this. Like all great physicists, however, he has placed facts first, and hypotheses always second.

Though the work of Raman and his school has lain in apparently diverse fields it is easy to discern a coherence and unity in them. The central and guiding theme of all his physical research has been optics in all its aspects. His special love has been for crystal physics, and in particular, physics of the diamond, in which subject he is a recognised authority. He has recently struck new paths in crystal physics, and introduced new concepts regarding crystal structure.

Another notable characteristic of Raman's scientific work is its sturdy individualism which is a consequence of the fact that when he started his career he belonged to no particular school of physics, but had to build one for himself. He is thus a true pioneer who has had the vision and courage successfully to explore unknown lands in physics. This circumstance has made him attach great importance to an independent approach to problems, and if his valuable example of striking out new and independent paths of research were to infect other scientific workers in our country, we are assured of a bright scientific future indeed. Further, the fact that he had to start work as an independent investigator without the facilities of an

already well-equipped laboratory has brought out to the full his skill as an experimenter. Most of his experiments have required neither costly machinery nor any type of special techniques, but have been so simply devised as to be easily understood even by a layman. In fact, the apparatus with which he demonstrated the Raman effect is a model of simplicity and by no means a costly one, but nevertheless this simple experiment is one of the important milestones in the world's knowledge of nature.

It is perhaps not so well known that Raman has shown a fine æsthetic outlook in his research work. His choice of topics for investigation, and his way of handling them bring out clearly his innate artistic nature. His love of music, colour, light, vibration, symmetry, harmony, pattern, structure, and architecture is but the result of a deep appreciation of the beautiful in nature. His researches on musical instruments, numerous beautiful phenomena in wave optics, the colour of the sea, colour in the plumage of birds, iridescent shells and mother-of-pearl, vibration in crystals, and above all his studies on the form, symmetry and structure of diamond based on fluorescence, phosphorescence and birefringence patterns are a but few examples of his æsthetic taste in research. He has one of the finest private scientific collections of diamonds and other beautiful crystals, and loves them as only a true artist can.

None who has come in contact with Raman can have failed to notice his very wide and catholic interest in many branches of science besides physics. He has perhaps done as much for chemistry as for physics. His interest in geology based on deep knowledge, especially in the fields of mineralogy and crystallography, has been a stimulant for the geological research of many workers in India. Some aspects of plant life, and animal life, specially birds, have always had a deep fascination for him. He has shown keen interest in and appreciation of astronomical and astrophysical research, both observational and theoretical. Indicative of his wide interests are his plans to build an astronomical observatory, a biological research unit and a mineralogical laboratory in the new Raman Research Institute. In spite of criticism from some quarters, it can be confidently claimed that by his collaboration and encouragement he has given the neces-

sary incentive to studies in mathematics even of the purest type. It is safe to say that there is no branch of science in which he has not encouraged creative and original work, and this augurs well for the development of fundamental research in the country in its new set-up.

Raman is not only a great investigator but also a great teacher in the true sense of the term. His ideas and personality have attracted many young research students, and he has held their loyalty and affection by extending a never-failing friendship to them. He has not only taught methods of physical research to his students, but by his own shining example made them realise the necessity for endurance, steadiness and hard work in the pursuit of knowledge. While giving help and encouragement in plenty, he has always expected and sometimes demanded from his students the best that they can give. The writer of this article has had many occasions to see the great care with which he would supervise the papers of his students, sometimes going to the extent of re-writing whole sections. No paper ever leaves his laboratory until he is completely satisfied with it.

The feelings of respect and admiration which his students have for him can be ascribed to his fairness and even generosity in acknowledging a pupil's ideas or originality. He is very liberal minded and gives away whole lines of research which lesser men would be tempted to keep for themselves. Whenever he discovers any originality in a pupil he will do all he can to develop it. His simplicity and informality are best seen in his discussions with students. Some penetrating remark made by him at such discussions has been the

starting point, as some of his pupils have confessed, of a complete line of investigation undertaken by them later. This has been true, not only in his own special field of research, but in other subjects as well.

Raman has rendered signal service to scientific advance in India as much by his contributions to knowledge as by his training of students in methods of research. He has exerted a profound influence on the work and outlook of not only his students but most of his contemporaries.

Unlike many scientific investigators who are giants in their own laboratories but dwarfs outside unable to take a due share in the national life of their country, Raman has fully participated in several walks of national activity, and is eager to serve the cause of scientific and technological advances in India. Possessing in a rare measure the extraordinary gift of making the most difficult problems in physics appear simple, and with a keen and irresistible sense of humour, he has admirably filled the role of an eminent popular lecturer on scientific subjects. Popularisation of science in the country owes not a little to his gifts of eloquence and exposition.

To have accomplished so much in one's own chosen field of research might have contented many men, but it is not enough for Raman. He has an unquenchable thirst for knowledge, and great energy for exploration, and for him "'Tis not too late to seek a newer world". On this occasion of his Sixtieth Birthday, we heartily wish him many more happy returns of the same with the hope that his vision and wisdom may well and truly serve the cause of science.

B. S. MADHAVA RAO.

UNESCO BOOK COUPON SCHEME

IN a special ceremony at Unesco House on 1st Dec. 1948 the Acting Director-General, Gordon Menzies, delivered approximately \$150,000 worth of book coupons to representatives of thirteen participating countries.

The Unesco book coupon scheme, devised to overcome foreign exchange difficulties, will enable educational and scientific institutions of "soft" currency countries to buy publications from "hard" currency countries, while making payment in their own national currency.

Of to-day's distribution, about \$50,000 will be a donation by Unesco to Austria, China, Czechoslovakia, Greece, Hungary, Italy, Indonesia, Iran, the Philippines and Poland. The

additional \$100,000 worth of coupons will be put on sale in China, Czechoslovakia, France, India, Poland and the United Kingdom.

The coupon scheme, launched on a one-year experimental basis, practically amounts to the introduction of an international medium of exchange, with Unesco supplying the necessary "hard" currency backing to make the project work. Booksellers who accept those book coupons for payment will be repaid by Unesco in their respective national currencies.

The ceremony was attended by diplomatic representatives and guests from participating countries, the press and Unesco officials.