

gressively diminished, it will be noted that the brightness of the yellow sector in the spectrum relatively to the green and the red sectors on its two sides falls off, until it becomes barely recognisable.

The presence of the oxidised form of the heme pigment in notable quantities in the region of the fovea and in a circular area surrounding that region finds a ready explanation if it be assumed that the pigment enters the retina as an exudate from the highly vascular choroid coat immediately behind it. After entering the foveal pit which is the thinnest part of the retina, it would spread symmetrically outwards from it into the surrounding region. If, further, it be assumed that the quantity of the pigment thus made available for vision varies with the demand for it, in other words, on the level of luminosity at which the retina is functioning, the preponderance of the yellow sensation at high levels of luminosity, and its relative weakness or even total absence at low levels of brightness would find a ready explanation. Since the luminous efficiency of the spectrum in the wavelength range from  $600\text{ m}\mu$  to  $500\text{ m}\mu$  is determined jointly by the oxidised and reduced forms of heme, the relative proportion in which these are present would influence the spectral distribution of luminosity in this range of wavelengths. If the oxidised form is present in preponderating measure, the yellow sector would be much more luminous than the green. If it is absent or deficient, the green sector would be far more luminous than the yellow.

The presence of the heme pigment in its fully oxidised form in the retina may be expected to involve as a natural consequence its being accompanied by the same pigment in its ordinary or reduced form. The latter pigment exhibits a wide-band absorption maximum located at  $555\text{ m}\mu$  which is the same wavelength as that at which the luminous efficiency in the spectrum at normal levels of illumination as reported by various observers is a maximum. Thus, the identification of the reduced form of heme as one of the major visual pigments is, apart from all other considerations, fully justified by the actual facts of vision.

The presence in or behind the retina of a biochemical mechanism by which the oxygenated heme pigment in the ferrous state is transformed by auto-oxidation to the ferric form of the pigment would provide the visual pigment needed for the red sector of the spectrum. The identification of the ferric form of heme as that functioning in the spectral range between  $600\text{ m}\mu$  and  $700\text{ m}\mu$  is confirmed by the fact that it exhibits a peak of absorption at  $630\text{ m}\mu$  beyond which the absorption falls off rapidly. This is just what is needed to explain the rapid change of colour from orange to red which appears at  $630\text{ m}\mu$ , beyond which the change of colour becomes extremely slow. Further, the spectroscopic behaviour of the ferric form of heme is precisely that needed to account for the observed features of the Purkinje phenomenon which have been fully described and discussed in an earlier chapter.

## CONFERENCES ON NUCLEAR MAGNETIC RESONANCE

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**T**WO Conferences were held on nuclear magnetic resonance in Europe during September and October, 1964. The first one was the International Conference on NMR and relaxation in solids, organised by the "Colloque Ampere" group at the University of Leuven, Belgium, between 1-5 September, 1964. Nearly two hundred scientists from all over the world attended the Conference. The second one organised by the Italian Physical Society for the Advancement of Science, was held at the Universities of Cagliari and Sassari, Sardinia, between 28th September and 5th October, 1964.

This Conference, attended by well over hundred scientists, was mainly devoted to the application of NMR in chemistry. Among the distinguished scientists was Professor Felix Bloch, Nobel-Laureate, who, having first detected the NMR signals, was, appropriately, present to commemorate the fifteenth year of the discovery of the chemical shifts in nuclear magnetic resonance. It was in his laboratory that Arnold, Dharmatti and Packard observed the very small and extremely significant chemical shifts of proton in ethyl alcohol which were readily identified to the three groups of protons



in that organic compound. This opened up the entire field of high resolution radiofrequency spectroscopy, a finger-print of organic molecules and a powerful tool in the hands of an organic chemist.

At the Colloque Ampere, Professors Knight, Slichter, Jaccarino, Hahn, Benedek (U.S.A.), Solomon (France), and Lösche (Germany) gave review talks on various aspects of NMR in solids thereby covering the entire field. Professor Knight spoke on the experiments in superconductors with particular reference to resonance shifts, spin-lattice relaxation times, the effects of small particles, impurities and superimposed layers of different metals. The phenomenon of magnetic resonance in rotating frame was explained by Prof. Slichter in great detail. This topic dominated the best part of the proceedings. In this frame the effective magnetic field is static and the dipolar interaction between two nuclei is supposed to take place in this static field. This approach simplifies the problem in solids and is equally applicable in double resonance studies, as was shown by Prof. Hahn. The other subject on which a large number of papers were presented was the knight shifts in metals. Professor Jaccarino specifically dealt with NMR and relaxation in transition metals. He attributed the difference in electronic properties between transition and non-transition metals to the narrow unfilled d-band at the fermi surface with a large density of states and correlated the specific heat and susceptibility with NMR data in transition metals. From his analysis, it became evident that the NMR results would offer important clues to the details of the complex band structure in transition metals and alloys. Prof. Benedek (U.S.A.) explained the significance of studying NMR in solids under high pressure which changes both the hyperfine coupling and the exchange constants in ferro and ferri magnets.

Information on conduction electrons in semiconductors have been usually obtained by studying conductivity, Hall effects, etc. Surprisingly magnetic resonance has been used very little to understand the nature of conduction electrons in semiconductors. Professor Solomon showed, how, in some cases, magnetic resonance can yield valuable information on the nature of wave function of those electrons, which would often be very difficult to obtain otherwise. Professor Lösche analysed the shifts obtained in semiconductors and showed that their origin

could be either quadrupolar, chemical, or of hyperfine interaction.

The contributed papers, apart from knight shift studies, primarily dealt with the analysis of the molecular and crystal structures using the linewidth, lineshapes and shifts in nuclear magnetic resonance. Dr. Drain stressed the importance of purity in vanadium and showed that large changes in amplitude and shape could result from an impurity of one part in thousand. Professor Itoh (Japan) observed negative shifts for  $\text{Cu}^{63}$  resonance in Cu-Ni, Cu-Pd and Cu-Pt alloys. The possible origin for this shift could be a negative polarisation of copper s-band electrons at copper sites, induced by the moments of the nearest neighbour magnetic atoms.

The Sardinia Conference was mainly directed to attract chemists who have greatly profited from the discovery of N.M.R. phenomenon. The high resolution papers, naturally, dominated the discussion throughout, although one session was devoted to wide line papers. The Varian Associates (U.S.A.) described their superconducting magnets which give magnetic field of about 45 kilogauss. The spectra of protons and  $\text{B}^{11}$  at 200 and 60 mc. respectively showed the great usefulness of the cryomagnets in high resolution spectroscopy. Professor Dailey (U.S.A.) gave a new method to correlate the chemical shifts and the magnetic anisotropy in aromatic hydrocarbons. It can be shown theoretically that the chemical shifts due to the aromatic ring currents are directly proportional to the anisotropy in magnetic susceptibility. Dailey suggested that improved calculations based on "self-consistent field molecular orbital theory" should give better results and illustrated it with the examples of benzene and azulene.

Professor Buckingham (U.K.) mentioned that, in transition metal hydrides, the large chemical shifts of protons could be understood in terms of a theory in which the contributions of the metal d-electrons to the proton shielding are taken into account.  $\text{C}^{13}$  chemical shifts are very important in the determination of chemical structure but are difficult to observe owing to the poor abundance of  $\text{C}^{13}$  (1%), low gyro-magnetic ratio and unfavourable relaxation times. This difficulty can be overcome if one can indirectly monitor  $\text{C}^{13}$  transitions by observing proton signals which are coupled to carbon. Dr. W. Anderson (U.S.A.) described a novel method for observing the chemical shifts of  $\text{C}^{13}$ . A modulated radiofrequency field is applied near the  $\text{C}^{13}$  resonance frequency causing the



spins to nutate at the modulation frequency. A spin-spin coupling transmits this modulation to any proton in the molecule coupled to  $C^{13}$ . Effectively it represents a small magnetic field modulation at such proton sites, and shifts proton lines accordingly. This method has been used to identify  $C^{13}$  shifts in some organic liquids.

The Tata Institute of Fundamental Research (India) presented a paper which illustrated the effectiveness of using deuterium as a probe into the nature of molecular structure and chemical bonding. Replacing proton by a deuterium does not change a compound chemically. However, proton resonance is sensitive purely to magnetic

perturbations while deuterium resonance, apart from magnetic perturbation, is very susceptible to even slight changes in charge distribution. Other papers in this Conference mainly dealt with the technique of analysis of the high resolution N.M.R. spectra and its usefulness in the identification and complex structure of organic molecules.

In conclusion, the two Conferences brought out some selected topics by specialists in the field of nuclear magnetic resonance. They were extremely profitable to young scientists by offering them an incentive and opportunity to discuss a variety of recent problems with experts in this field.

## PHYSIOLOGIC SPECIALIZATION OF *PIRICULARIA ORYZAE* CAV. THE CAUSAL ORGANISM OF BLAST DISEASE OF RICE

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**B**LAST disease of rice, caused by *Piricularia oryzae* Cav. is the most serious disease of rice, wherever rice is cultivated. Prevention of loss caused by the disease through the cultivation of resistant varieties is the most hopeful and economic method. When rice varieties which had been selected as resistant to the disease at Cuttack<sup>1,2</sup> were sent to the State Research Centres under a co-ordinated programme for a trial of their performance under local conditions, many of them (except S. 67, BJ-1 and AC-2489 which were consistently resistant) behaved as resistant at some centres and susceptible at others.

This differential reaction exhibited by some varieties might be due to the interaction of environmental factors with the expression of disease resistance or due to the phenomenon of physiologic specialization in *Piricularia oryzae*<sup>3-6</sup> with the varieties being susceptible to some races of the pathogen, while behaving as resistant to others. This could only be found out by undertaking artificial infection tests under standard set of conditions with the isolates of the pathogen obtained from different regions of India.

Such a study has been undertaken at the Central Rice Research Institute, since 1961 (under a grant received from the United States Department of Agriculture from PL-480 funds). The principal object of the study was to deter-

mine whether *Piricularia oryzae* exists as specialised races of the pathogen in India and if so, to determine the number and distribution of such races in the country.

Samples of diseased leaf necks and nodes of infected rice were collected from the principal rice-growing regions of India, mostly through the courtesy of departmental officials in each State and also by personal collection during tours.

The varieties used for the tests included the differentials which had been selected for this purpose in U.S.A. and Japan and also some more varieties which had shown marked differential reaction in co-ordinated varietal susceptibility trials in India and in an International blast varietal programme, organised during 1957-59 by the writer.<sup>7</sup> The varieties used in the tests are listed in Table I.

Standard procedures were adopted for raising seedlings, infecting them, for scoring of infection and classifying the varieties. By the end of 1962 four distinct races could be distinguished, one each in the Eastern, Southern, Western and Northern rice zones. Several more races have been identified in India since then. The results are presented in detail elsewhere.

The reaction of four typical Indian races differentiated on U.S. differentials are presented in Table II. The first isolate corresponds to race 8 of the U.S.A. and the last to race 25.