since their indiscriminate use is likely to produce deleterious effects, firstly in developing in the target species a total or partial resistance to the chemical and secondly, in producing adverse effects on beneficial parasites. Use of selective insecticides such as Schradan and Aramite is advocated to overcome this risk. Dr. K. V. Joseph gave an account of the present position with regard to the control of rice pests in Kerala. The major pests are the stem-borers (particularly *Schœnobius incertulas*) against which no satisfactory control has so far been evolved, the swarming caterpillar (*Spodoptera mauritia*), the rice bug (*Leptoconisa acuta*), and the rice hispa (*Hispa armigera*). The latter three have more or less been successfully tackled by sprays and dusts of DDT and BHC. Dr. Sardar Singh spoke about "Effective Pest Control through Spray Programmes" and gave an account of the results of the spray programmes for various crops that have been initiated in the Punjab in 1956.

In the scientific meeting at the afternoon Session on the third day the following papers were presented : "The Yeast Nucleus" by Dr. M. K. Subramaniam ; "Studies on the Microbial Spoilage of Canned Food" by Dr. G. Rangaswami and Mr. R. Venkateshan ; "The characteristics and Questionable Taxonomic Position of the Oxalate Decomposing Bacterium, *Vibrio extorquens*" by Dr. J. V. Bhat ; "Conservative Systems in Physics" by Prof. G. N. Ramachandran, "Certain Fundamental Equations in the Study of Daylighting in Buildings" by Mr. T. N. Seshadri ; "Latent Heat of Vaporisation and Composition" by Dr. R. D. Desai.

There were two public lectures in the evenings of the 27th and the 28th. The first lecture was on "Supersonic Flight" by Dr. P. Nilakantan and the second was on "Radio Astronomy" by Dr. S. Bhagavantam.

Two excursions were arranged on the 29th one to the Neyveli Lignite Project and the other to the Estuarian Biological Laboratory at Porto Novo. A large number of Fellows and Delegates took part in these excursions.

At the business meeting held on 26-12-1959, the following were elected to the Academy :

Honorary Fellows : Prof. Albert Frey-Wyssling, Switzerland ; Prof. Nikolai Nikollaevich Semenov, USSR ; Prof. Arne Wilhelm Kaurin Tiselius, Sweden.

Fellows : Miss Anna Mani and Messrs. S. S. Dharmatti, G. S. Puri, G. Rangaswami, T. H. Rindani, K. S. Thind, M. K. Vainu Bappu.

CENTENARY OF SPECTRAL ANALYSIS*

ON the 20th October 1959 one hundred years ago, Robert Kirchhoff and Wilhelm Bunsen announced the result of their "Investigations on the Spectra of Coloured Flames", and in doing so laid the scientific basis for the development of spectral analysis. In their report, the important proof has been furnished for the first time that the Fraunhofer "D"-lines in the solar spectrum coincide with the two spectral lines which occur in the spectrum of a Bunsen-flame coloured with sodium chloride. From this result and from further investigations about the origin of the Fraunhofer lines, Kirchhoff and Bunsen deduced that the presence of the dark "D"-lines in the solar spectrum permit the conclusion that there must be a sodium content in the Sun's atmosphere. This practically provided—on the basis of an atomic absorption spectrum—the first qualitative spectral analysis by way of identifying an element by its spectrum. Even though it could not then be definitely stated that the clear correlation thus established between a spectrum and an element was the final clue leading to the atom, the discoverers of the spectral analysis, nevertheless, fully assessed the value of its great practical significance in that they declared :

> "Chemistry cannot show any reaction which could be compared even remotely with the spectro-analytical determination. The eye can, for example, even perceive 3×10^{-7} mg. Na..... The positions the spectral lines occupy in the spectrum presume a chemical property which is as immutable and as fundamental as the atomic weight of substances and can therefore be determined with an almost astronomical accuracy. Yet, what imparts a specific importance to the spectro-analytical method is the fact that it extends, almost to infinity, the limits up to which chemical characteristics about matter were restricted so far."

These statements are valid to this day as soon as it is intended to characterise the importance of spectro-analytical methods of investigation. Yet, promising as the new research method seemed to be, it took a long time, and

* In Commemoration of its Discovery by Robert Kirchhoff and Wilhelm Bunsen.

many obstacles placed in its way had to be removed, before industries envisaged to employ it in their laboratories. The result was that the method was resorted to only by some untiring research scientists on a purely scientific level, whilst the overwhelming majority of chemists practically disregarded so promising a method.

> "One can see, it is a wearisome and time-wasting process which in addition requires special instruments and training. It will therefore be applied on rare occasions only."

Thus wrote H. KAYSER in 1910 in his *Manual* of Spectroscopy. His verdict on the quantitative analysis is best expressed by the following sentence :

> "When summarising all the investigations discussed, I came to the conclusion that quantitative spectroscopic analysis has proved to be impracticable."

As late as in 1923, DE GRAMONT laments that French chemists have a latent fear of spectral analysis and that there still are instances of prominent physicists even refusing to inform themselves on any kind of spectral analysis, publicly declaring that spectral analysis since the times of KIRCHHOFF and BUNSEN had been a maldevelopment which had made no progress whatsoever from a practical point of view.

Yet, only one year later, F. LOWE drew the attention of his German professional colleagues to "A forgotten method of quantitative spectral analysis" with the result that the quantitative spectro-chemical emission analysis succeeded in finding general introduction in the metal-processing and metal-producing industry here as well as in a few other countries where in some isolated quarters it had proved its worth.

From that time on the development of the spectral analysis is characterised particularly by ever more perfected methods and procedures of investigation. Especially the use of new, highly sensitive radiation detectors (photoelectric cells, thermo couples) in conjunction with efficient amplifying equipment resulted in the design of "photoelectric spectrophotometers" which, for many purposes, provide a direct, and frequently automatically recorded, indication of the intensity of spectral lines or of the quantities of certain elements contained in the tested specimens.

Yet, even apart from the briefly indicated struggle for its practical applicability, the spectral analysis was the subject of eager activity on the part of investigators. As a result of the attempts at interpreting the emission spectrum of the atomic hydrogen the knowledge was arrived at that beyond furnishing the basis for the chemical identification of elements, the spectrum also represents the most striking means of disclosing information about the structure of the atom itself. Thus, after the pioneer work of KIRCHHOFF and BUNSEN, and with the assistance of many investigators not mentioned herein, a bridge has been built reaching from the spectral line to the atomic structure, and across which a road to modern atomic research leads even to this day.—OSWALD SCHIEK, *Veb Carl Zeiss, Jena.*

GROUND STATE OF THE C_2 MOLECULE

MOLECULAR spectroscopists who are familiar with the analysis of the well-known Swan bands ($^3\pi_g - {}^3\pi_u$) of the C_2 molecule have all along considered the $^3\pi_u$ state as the ground state of the molecule. Apart from the main reason for this assignment, *viz.*, that the Swan bands are the easiest to be observed in absorption, there are other reasons also as for example, (*i*) the observation of the Swan bands in emission from comets in which the emission is believed to be due to resonance fluorescence

state is the ground state for the C_2 molecule, in the gas phase at least. They base their assignment on the rotation vibration analysis of a new band system of the C_2 molecule in the near infra-red, in emission from a carbon furnace. An analysis of the perturbations of two levels involved in this emission band leads to the result that $^1\Sigma_g^+$ state lies below the $^3\pi_u$ state by about 610 cm.$^{-1}$ In this connection it is interesting to note that the Swan bands have never been observed in interstellar space. According to the present observation if C_2 is a constituent of the interstellar medium its presence should be sought by means of band systems involving $^1\Sigma_g^+$ state and not by means of the first lines of the Swan system.