Nevertheless, it may not be the case that only long-range translational symmetry will satisfy the basic requirements for describing biological sensitization by solid state concepts. As noted by W. Arnold (Oak Ridge National Laboratory), nature has been developing suitable mechanisms for 2 billion years. Further information on the structure of photoreceptors was presented by J. J. Wolken (University of Pittsburgh); his data were based on high-resolution electron microscopy. Simplified structural models for the chloroplast and retinal rods were proposed; these models permit maximum efficiency for energy capture and transfer by the pigments. The photoreceptors resemble a quasi-crystalline network, in which the pigment-lipid-protein complexes have the proper molecular shape for stabilization. Arnold proposed an electron-hole model to explain the primary step in photosynthesis, whereby a first exciton produced by light absorption in a photosynthetic unit dissociates to give a trapped electron and a free hole, and a second exciton dissociates to give a trapped hole and a free electron. The trapped carriers are available for the initial chemical oxidation and reduction processes, and the free carriers recombine eventually to give the delayed light which accompanies photosynthesis. The saturation of traps explains why the quantum yield decreases at high light intensities. Arnold emphasized that his model poses two questions, the first being whether two 1.8 ev excitons can dissociate as required, and the second concerning how electrons and holes move in a unit of 500 to 600 molecules. R. Livingston (University of Minnesota) presented a "prejudiced review of solid state mechanisms in photobiology" in which he noted that the recent great improvements in methods of detection of extremely small transient changes in the physical properties of biological systems require cautious interpretation. Referring to the model of Arnold, Livingston suggested that delayed light can be explained by induced chemiluminescence. The question was not resolved.

The proceedings were reviewed by a panel including R. C. Nelson, B. H. Carroll (Rochester Institute of Technology), R. K. Clayton (Charles F. Kettering Research Laboratory), J. F. Hornig (Dartmouth College), and J. R. Platt (University of Chicago). Discussion was given to a request from Platt that theoretical scientists emphasize concepts which can be tested with crucial experiments.

Papers given at the conference will be published in the *Journal of Physical Chemistry*. Support was provided by the Office of Naval Research, Air Force Cambridge Research Laboratories, and the National Institutes of Health. The conference will reconvene in 1967 at the University of Arizona, Tucson.

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Mass Spectrometry

Mass spectral studies and allied topics were reviewed at the 12th Annual Conference on Mass Spectrometry held at McGill University, Montreal, Canada, 7–12 June 1964. This conference, sponsored by ASTM Committee E-14, marked the first time this meeting was held on a university campus and the first time it was held outside the United States.

The use of mass spectrometers to study gaseous reaction systems was discussed. Various problems have been encountered in relating the quantities of species detected by the mass spectrometer to the composition of the reactive mixture in the low pressure flames, flash photolysis, and pyrolytic flow reactors being sampled. P. Le Goff (University of Nancy) discussed calculations of the role played by surfaces in low pressure reactors attached to the ion source. Based on Monte Carlo type calculations, he concluded that, for the typical pressures and reactor dimensions in his apparatus, the region preceding the actual reactor was the primary region of reaction. J. Cuthbert (UKAEA, Harwell) pointed out that, for pinhole sampling from sources at atmospheric pressure, supersonic flow results downstream from the pinhole. The resultant cooling from isentropic expansion can cause considerable condensation which explains the polymeric ions that have been observed in these systems. A. W. Tickner (National Research Council, Ottawa) discussed observation of two different ion generation mechanisms in the negative glow of a glow discharge. From the shift of the peak ion concentration and the nature of the species, it was established that ions are formed by electron impact and by Penning-type ionization from collision with metastable atoms generated by electron impact.

Considerable disagreement about the rate constants for the reaction of oxygen atoms with oxygen and ozone has arisen in the study of the role of these species in atmospheric aeronomy. This controversy now appears to be clarified by the results of several conclusive experiments reported by Schiff. Two reactive species (O and O_2^*) were detected in the laboratory system. It was found that the relative amounts of these species were dependent on the operating pressure; this explains the variety of results yielded by different experiments. From analysis of their results, Schiff determined the contributions due to the oxygen atoms alone.

J. Berkowitz (Argonne) reported on extension of the Stern-Gerlach experiments to several polyatomic molecules by use of mass spectrometric detection. In this way a particular species in the molecular beam may be studied. Initial emphasis is on choosing one of two possible ground states of a molecule after qualitative observation; the choice is based on whether it possesses a magnetic moment.

Considerable effort has been devoted in recent years to experimentally obtaining monoenergetic electron beams for the study of fine structure in the ionization efficiency curves. The retarding potential difference source, originated by R. E. Fox and co-workers (Westinghouse), and electrostatic electron selectors (E. M. Clark, St. Francis Xavier University, and P. Marmet and L. Kerwin, University of Laval) have been the principal experimental approaches to this problem. Both techniques have been plagued by lack of sufficient signal-to-noise for application to anything but the simplest compounds. There was therefore considerable interest in the paper by J. D. Morrison (CSIRO, Melbourne). He discussed his recently published procedure for mathematically removing the effects of the electron energy spread from data obtained with a source having the normal energy distribution. The effective reduction in signal-to-noise ratio by this procedure is considerably less than that observed experimentally for the same gain in energy resolution. P. Marmet also discussed the effects of radial energy distribution in space charge, limited electron guns on the ionization efficiency curves based on the equations recently published by Hartwig and Ulmer.

An extensive review was presented by Richard E. Honig (RCA) of the variety of ion sources employed in the analysis of solids. The use of laser radiation to flash-evaporate solids and ion and neutral beam sputtering sources were discussed. Honig described in detail a comparison of the operation and performance of the radio frequency spark, the pulsed d-c arc, and the vacuum vibrator. Considerable data on the comparison of the spectral features (for example, ratio of monopositive ions to polycharged ions), energy distribution of the various ion species, and relative ionization efficiencies for various elements by these three techniques were presented. J. Franzen (Max-Planck Institut, Mainz) discussed in more detail certain aspects of the problem of source conditions in the radio-frequency spark on elemental discrimination. This discrimination arises from the different kinetic energy distributions for elements of different volatility, and the importance of spark gap width and other source parameters on the surface temperature and energy distribution. The rapidly growing application of spark source mass spectrometry in the last few years is due to the availability of several commercial instruments, and there is much current need for a thorough understanding of the phenomena associated with this technique.

Basic studies of the fragmentation reactions of the molecule-ions formed in a mass spectrometer source, which lead to the patterns observed, have been hindered by lack of detailed information on the states of the ions formed and their internal energy distribution. Additional insight into this question may be gained from recent results of V. Čermák and Z. Herman (Czechoslovak Academy of Science, Prague) on the yield of various fragment ions resulting from a crossed beam study with metastable noble gas atoms. From interpretation of their data, Herman suggests that the internal energy distribution of the initial molecule-ion is similar to that formed by electron impact for the higher energies. However there is a considerably greater yield of ions with energies less than about 1 ev.

Another area of increasing interest in mass spectrometry is in the identification of the empirical formula of various ions in the spectra by precise mass measurement. This technique is especially valuable in the study of natural products where structure identification problems by other techniques are hindered by the small quantities of sample available and the complexity of the material. By providing a high resolution spectrometer with both direct sample introduction to the source and introduction from a gas chromatograph, the utility of this approach is greatly expanded. K. Biemann (MIT) and co-workers reported in detail on several aspects of this technique, including the use of digital data handling and computers to provide rapid, precise mass measurements of every ion in the spectra. H. E. Lumpkin (Humble Oil) discussed a similar application of this technique to analysis for nitrogen, oxygen, and sulfur compounds in trinuclear aromatic petroleum fractions.

W. G. Meinschein (Esso Research) discussed his observations of paraffins in meteorite samples; his investigations have caused considerable controversy. The inertness of paraffins causes their preferential survival, compared with other organic compounds. Mass spectrometry has established that the paraffins observed in sediments and meteorites are quite similar and distinctly different from those found in crude oil. The former are characterized by preference for the odd carbon numbers, while petroleum shows a steady decrease with carbon number.

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Plant Physiology

The functioning of plants from the subcellular structural level to the organism as a whole was discussed at the 6th annual meeting of the Canadian Society of Plant Physiologists (Société Canadienne de Physiologie Végétale), in Kingston, Ontario, 4–6 June 1964.

At a symposium on respiration, D. F. Parsons (University of Toronto) discussed the structure and junction of mitochondrial membranes. By a negative staining technique for electron microscopy, he found two types of projecting subunits. One is on the outer membrane and consists of 60-Å hollow cylinders; the other is on the cristae and consists of 90-Å, mushroom-shaped structures. The latter structures have been found in many plant and animal tissues. These subunits are protein, but they do not contain cytochromes. There is evidence for the presence of a flavoprotein and an adenosine triphosphatase. The subunits may be associated with oxidative phosphorylation.

In a paper on electron transport in plant mitochondria, W. D. Bonner, Jr. (Johnson Research Foundation, University of Pennsylvania), discussed the large number of cytochromes that have been described and the difficulties in characterizing them. Two *c*-type, three *b*-type, and three *a*-type cytochromes are present in the mitochondria of all plant species, regardless of the respiratory characteristics. At normal O_2 concentrations, when adenosine diphosphate (ADP) is limiting (state 4 conditions), oxidation by plant mitochondria is not inhibited by HCN or CO. However, when ADP is in excess (state 3 conditions), HCN + CO reduces the rate to that of state 4. State 4 rate corresponds to the "ground respiration" of plant physiological literature. This is completely inhibited at low concentrations of O_2 by HCN and CO; the same is true in mitochondria which show HCN and CO insensitive respiration (skunk cabbage). Kinetic analysis suggest that O_2 reacts with two separate oxidases. This is supported by optical demonstration of two $CO(O_2)$-binding pigments. The presence of a second CO-binding pigment provides an explanation for both "ground respiration" and "cyanide intensitive respiration."

The question of whether respiration is affected by light has in the past been answered by indirect means. However, the techniques issued by G. Krotkov (Queen's University) have made it possible to show that light and dark respiration are two different processes. "Photorespiration," or evolution of CO_2 in light, involves different pathways of metabolism and perhaps utilizes glycollic acid metabolism. Corn, a plant of exceptionally high productive ability, has no photorespiration and appears to lack cofactors for glycollic acid oxidation. Corn does not "waste" products of photosynthesis in respiration while it is illuminated, and it is thus more efficient than other plants.

A closely knit group of papers on translocation originated from the laboratories of the Division of Biosciences, National Research Council, Ottawa,