

National Academy of Sciences

Abstracts of Papers Presented at the Autumn
Meeting, 29 October, La Jolla, California,
30 October–1 November 1961, Los Angeles

Study of Rapidly Running Transitions at High Pressures

Diamond anvils have been used in a squeeze-type apparatus to follow high-pressure transitions with a recording x-ray diffractometer. The surface of the diamond presses against a lower Carbopol anvil with the sample, in the form of a thin disk, held between the two surfaces. Clear ray patterns are obtained with pellets less than 3 mm in diameter, and they yield information on equilibrium pressure and on transformation rates.

LEASON H. ADAMS, BRIANT L. DAVIS
University of California, Los Angeles

Terrestrial Age of Iron Meteorites

We have been engaged in a program of determining the amounts of a large number of radioactive and stable nuclides produced by cosmic rays in iron and stone meteorites. The main purpose of this work has been the study of possible time variations in the cosmic ray intensity over long periods in the past. However, as an interesting by-product, these measurements also provide a method for measuring the time since the fall of the meteorite. It has usually been assumed that iron meteorites disappear by weathering in a relatively short period, at least in most states. The meteorite Williamstown contains only about 25 percent of the amount of chlorine-36 (half-life, 3×10^5 years) found in recent falls which are similar in other respects. This indicates a terrestrial age of approximately 600,000 years. This meteorite was found in Kentucky. Recent data of Wanke and others indicates that terrestrial ages of this order of magnitude are not an unusual phenomenon.

The great resistance to corrosion shown by these meteorites is rather puzzling.

JAMES R. ARNOLD
University of California, San Diego

The Sun's Magnetic Cycle

Observations of the varying pattern of magnetic fields distributed over the surface of the sun have been under way since the solar magnetograph for 8 years. Significant results are as follows: (i)

the sun has a poloidal field that reverses its polarity near the peak of the sunspot cycle; and (ii) local magnetic areas, responsible for sunspots and other forms of solar activity, disappear by expanding.

A new theory of the solar cycle based on these findings calls on the differential rotation to draw out the submerged lines of force of the poloidal field into an amplified, shallow, spirally wound sheath, which grows to a critical intensity, necessary for the emergence of unstable bipolar loops, first at moderate latitudes and then progressively closer to the equator, according to the derived formula $\sin \phi_c = 1.5/(n + 3)$. This represents Spörer's law of sunspot latitudes and the Maunder "butterfly diagram." The amplification factor is about 50, and the total length of magnetic "flux rope" formed is ample to account for the few thousand sunspot groups formed in each cycle. The process is repeated every 11 years, with alternating magnetic polarity.

Expanding loops of the field lines above surface bipolar magnetic regions, together with enlargement of these regions, accounts for neutralization and reversal of the initial poloidal field and for the continuing release of detached flux loops of low intensity in the solar corona. The eventual dissipation of the magnetic energy of the flux loops, through Joule heating, is estimated to provide some 10^{30} ergs in each sunspot cycle; this may be a significant energy source for the corona.

HORACE W. BABCOCK
Mount Wilson and Palomar Observatories

Photoproduction of Hydrogen Gas Coupled with Photosynthetic Phosphorylation

Cells containing the enzyme hydrogenase are known to produce hydrogen gas from organic substrates. We have recently shown that the photosynthetic sulfur bacterium *Chromatium* (known to contain hydrogenase) can produce hydrogen gas from a reduced sulfur compound (thiosulfate), but only under the influence of light. We have interpreted the photoproduction of hydrogen from thiosulfate by *Chromatium* as another line of evidence for the electron-flow theory of photosynthesis, which ascribes the same primary

photochemical act to plants and photosynthetic bacteria: the photoproduction of transferable electrons by illuminated chlorophyll molecules [*Nature* 190, 601 (1961); 184, 10 (1959)]. Photoproduction of hydrogen gas thus occurs when thiosulfate donates electrons to chlorophyll (via cytochromes) and hydrogenase catalyzes the combination of these electrons ("expelled" from the light-activated chlorophyll) with protons from the medium. We have now obtained a light-dependent production of hydrogen gas by spinach chloroplasts supplemented with a partly purified hydrogenase from *Chromatium* (free from bacteriochlorophyll) and with cysteine as the electron donor. The photoproduction of hydrogen gas by isolated chloroplasts was accompanied by the formation of adenosine triphosphate. These findings provide further support for the identity of the primary photochemical act in plant and bacterial photosynthesis.

DANIEL I. ARNON,
A. MITSUI, A. PANEQUE
University of California, Berkeley

Studies of Integrative Processes in Cerebral Systems Based on Mathematical Analysis of Electroencephalographic Records

The ubiquitous nature of rhythmic wave processes in cortical and subcortical structures in the normal waking brain has long been recognized. These processes have been shown to occur independently of actual neuronal firing in the majority of the neurons in the participating population, and the relationship of neuronal firing to a particular phase of the wave process has remained unclear. Many investigators have regarded the wave process as a "noise" in the cerebral system, not clearly related to information handling mechanisms.

However, a careful reappraisal of this problem in the electroencephalographic records during training and subsequently during performance of a learned task in animals has disclosed close correlations of phase patterns between different brain regions with the level of learning. In the fully trained animal, further close relationships in phase patterns have been discerned to the correctness or incorrectness of a discriminative motor performance. In these studies, we have used auto-correlation and cross-correlation techniques, and have initiated the use of cross-spectral analyses which permit assessment of phase patterns across a spectrum of frequencies.

In attempting to model a cerebral system, the results suggest the possibility that individual neurons may function as phase comparators for graded, analog wave processes sweeping across their surfaces in spatiotemporal patterns. Electronic wave processes apparently arise mainly in dendritic mechanisms and in presynaptic terminals. Since altered impedance loading offered by adjacent cellular elements on the dendritic electrotonic generator may account for altered frequency patterns, we have developed a new technique for direct impedance measurement, to attempt assess-