recorded on several occasions. Since a third harmonic has never been reliably recorded, it is believed that the "fundamental" radiation frequency actually is a subharmonic and that parametric amplification or generation of radio waves takes place in the coronal plasma when the primary radiation is very intense. The exciting agent may be, for example, an ionized stream as in the plasma amplifier, an electromagnetic wave, or a mixture of both.

Nonlinear resonance and parametric amplification occurs for the most part in the top-side region of the ionosphere. "Top-side" ionospheric soundings by the Canadian Alouette Satellite have shown, for example, that it is possible to excite the fundamental electronic cyclotron resonance of the medium by harmonic pumping; actually harmonic (or parametric) pumping has been possible with frequency ratios as high as ten or more. If future "top-side" sounders are equipped also with harmonic receivers, it is most likely that other interesting non-linear phenomena will be observed.

Nonlinear wave and interaction phenomena are very important also in the fields of high-power sound, underwater sound, and in high-power laser physics and engineering, including future laser communication systems. The arranging committee for the conference believes that representatives from these fields of scientific and engineering endeavor should continue the practice of holding symposia similar to this type.

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Transplutonium

In order to mark the near completion of the new hot laboratory of the chemistry division at Argonne National Laboratory about 250 scientists from 12 countries attended a symposium on the transplutonium elements at Argonne, Illinois (15–17 May). Discussions reflected four characteristics of research with the very heavy elements: (i) the large installations required to produce, process, and study even modest amounts of material; (ii) the minute amounts of some of the elements now extant; (iii) the highly radioactive nature of the elements; and (iv) the rich insights into the fundamental nuclear and chemical properties of matter afforded by investigations in this region. The transplutonium elements are created by neutron buildup in reactors, by neutron buildup in the interior of a star or in a terrestial thermonuclear device, or by charged particles from an accelerator undergoing reaction with a suitable heavy-element target.

A. R. Van Dyken (U.S. Atomic Energy Commission) described the latest American transplutonium element production program, which has been initiated by the irradiation of 20 kilograms of plutonium-239 in production reactors in order to produce plutonium-242, americium-243, and curium-244. Relatively low fluxes are necessary for this first stage because of the problem of removing fission heat. After separation and purification, the Pu^{242}, Am^{243}, and Cm^{244} will be inserted into the high-flux isotope reactor at Oak Ridge when it is completed late in 1965. This reactor was described by J. R. McWherter and the accompanying process facility ("TRU") by D. E. Ferguson (both of Oak Ridge National Laboratory). The maximum flux in this reactor is expected to be 5×10^{15} n/cm^2 sec. One of the chief products of interest will be californium-252. Production of this nuclide will rise from a few milligrams in 1966 to a gram per year by 1969. The course of buildup of heavy elements in several reactors was calculated and compared by P. R. Fields (Argonne). Mendelevium-259 may be produced if the decay properties and cross sections of fermium-256, -257, -258, and -259 are consistent with reasonable estimates.

Another, and more intense source of neutrons is a small thermonuclear device. R. W. Hoff (Lawrence Radiation Laboratory, Livermore) described results from a small bomb of this type which was recently exploded deep underground. Isotopes up to americium-246 were found in the debris. The variation of yield with mass number below mass 246 compared favorably with that seen in "Mike," the 1952 thermonuclear device in which elements 99 and 100 were first observed and masses up to 255 were produced. When development of a successful thermonuclear device is completed, it will be detonated in a salt dome so that large-scale recovery of the products will be simplified.

The very large number of neutrons required to account for the solar system abundances of the heavy elements would imply the rapid collapse of a helium-rich shell into a 10^9-degree stellar interior, according to A. G. W. Cameron (National Aeronautics and Space Administration). Small peaks observed at mass numbers 170 and 104 in the abundances of elements created on a fast time scale were attributed by him to peaks at mass numbers 138 and 56 (arising from earlier processes) being swept upwards by subsequent neutron capture in part of the material.

J. A. Wheeler (Princeton) discussed the theoretical considerations limiting the addition of neutrons to a nucleus in order to increase the mass number. He concluded that the highest nuclide likely to persist for 10^{-4} seconds or longer would be at either mass 650 or 274, depending on the spontaneous half-life systematics applied. However, in very high density stars, a possible state might exist with all of the electrons squeezed out. The entire stellar mass would in effect be one continuous nucleus.

Prediction of the spontaneous fission half-life of unknown isotopes is one of the key unsolved problems in planning the production of even heavier nuclides. G. N. Flerov (U.S.S.R.), in a paper read by S. M. Polikanov (U.S.S.R.), told of a new isotope of element 102 made by E. D. Donets, V. A. Schegolev, and V. A. Ermakov, utilizing the reaction, $U^{238}(Ne^{22},4n)No^{256}$. This nuclide decays by alpha emission with an 8-second half-life. Its spontaneous fission half-life exceeds 50 minutes—far in excess of current predictions. A trend toward larger spontaneous fission half-lives in the heavier elements would be advantageous in producing transfermium elements.

Flerov also considered the cross sections for producing Fm^{250} (plus four neutrons) by three different reactions: $C^{13} + Pu^{241}$, $O^{16} + U^{235}$, and $Ne^{22} + Th^{232}$. The decline in cross section with increasing atomic number of the projectile is greater than would be expected from consideration of coulomb barrier heights. Flerov speculated that this might be due to an increased probability for fission of the compound nucleus as its angular momentum increased, or to the possibility that the greater vibrations brought into the compound nucleus by the impact with heavier ions might induce fission more readily.

R. Vandenbosch (Argonne) in reviewing fission, noted that an increase in distortion energy in a fissioning nucleus would be accompanied by a comparable and opposite decrease in coulombic energy as the centers of charge separate further. Shell structure within a fragment would stiffen it against distortion at the time of scission, with the deformation energy then going to the less constrained complementary fragment. These considerations were related to experimental observations on the variation of ν (neutrons emitted per fragment) with mass number, the variation of total kinetic energy with mass number, and the large ν and low kinetic energy seen in the symmetric fission of U^{235}. Vandenbosch pointed out that much valuable experimental work has been made possible in this area by the availability of the spontaneously-fissioning nuclide Cf^{252}.

The oxidation of $Am(OH)_3$ in $NaHCO_3$ produces a soluble complex of Am(VI), but if $KHCO_3$ is used, an insoluble Am(V) compound results. These reactions were discussed by T. K. Keenan (Los Alamos Scientific Laboratory). The plus four states of Am and Cm, although difficult to obtain, have now been stabilized in aqueous solution by dissolving previously prepared $Am(OH)_4$ or CmF_4 in saturated ammonium or cesium fluoride. The current unsolved problems in americium chemistry include the synthesis of AmF_6, preparation of divalent Am compounds, and the study of the structures of the complex fluorides and carbonates.

W. T. Carnall (Argonne) emphasized the utility of working in a molten $LiNO_3$-KNO_3 eutectic rather than in an aqueous medium for some purposes. Absorption spectra in the fused salt system may be obtained to 2.6 microns. The system is particularly useful with the very heavy elements, since radiation damage to the solvent is reduced.

B. B. Cunningham (Lawrence Radiation Laboratory, Berkeley) noted that the size of the unit cell for actinide dioxides (fluorite structure) decreases with atomic number with the expected actinide contraction; the exception is CmO_2. This lead him to question the literature value given for that compound. He also suggested that the "metallic valences" of the actinides should be related to curium metal with a +3 valence assignment rather than to thorium metal with a +4 as suggested by Zachariasen. Cunningham cited magnetic susceptibility measurements to support his frame of reference.

Talks by D. F. Peppard (Argonne), J. Kooi (Euratom), V. N. Kosyakov (IAEA), and J. Maly (U.S.S.R.) considered various aspects of the solvent extraction of the transplutonium elements. The trialkylamines are most valuable for giving actinide-lanthanide separations, while the alkylphosphoric acids give the best resolution of the actinides from each other. The paper by Maly described an interesting experiment using only 15 atoms of mendelevium to obtain the distribution coefficient of that element between tributyl phosphate and 13.1*M* HNO_3 by a reverse phase chromatographic approach.

D. C. Stewart acted as general chairman of the meeting, while C. H. Youngquist described the new chemistry research hot laboratory and organized the subsequent tour of the facility.

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Plant Tissue Culture

Thirty years after the initial isolation of tomato roots in vitro by Philip R. White, a group of about 150 tissue culture experts from all over the world met, at White's invitation, under the auspices of the Pennsylvania State University and the NATO Advanced Study Institute at University Park, Pennsylvania (28 May–1 June), to discuss the present problems and future developments of plant tissue culture. Subcultures of the roots originally isolated by White and kept in continuous culture for 30 years were mute testimony to the possibilities of tissue and organ culture.

Although defined synthetic media have been used in plant tissue culture for over a quarter of a century, the nature and the extent of the interactions between the tissue and the medium on which it is grown is still the subject of intensive investigation. The older ideas of the medium playing the role of mechanical support and source of needed growth factors and nutrients has been replaced by the realization that not only does the medium act upon the tissue, but also that the tissue has complex effects upon the medium. Street reported that isolated roots release into the medium as many as 18 amino acids as well as some indolic compounds. Other investigations revealed "exsorption" of iron-chelating agents by callus cultures (Heller); the release of arginase by ginkgo tissues (Tulecke); and the release of peroxidase by sunflower tissues (Lipetz).

The release of some of these substances by roots was reported by Street to be light sensitive. Burstrom reported that the action of light upon the growth of roots of monocotyledons could be divided into two parts, red-light action which stimulates cell division and blue-light action which stimulates cell elongation.

The various enzymes released into the medium not only affect its composition, as shown by Tulecke, but also are released in response to calcium concentrations in the medium (Lipetz). These complex medium-tissue interactions were reported to influence the suitability of certain nitrogen sources (such as ammonium) for growth (Street), the differentiation of tissues (Lipetz), and overall growth (Heller).

Wood also reported on the effects of the medium on tissue growth. High concentrations of certain ions could substitute for growth-factor requirements formerly believed to be specific for the tissues. One of the ions reported necessary in high concentrations was K, which previously could not be entirely replaced by Na.

The observations that single cells and small clumps of cells usually require a medium previously "conditioned" by growing cultures (Muir, Reinert, Jones, and others) can possibly be explained in terms of the above reports. More specifically, Earle has demonstrated that single cells require exogenous kinetin for growth, whereas larger clumps of cells do not. It was also noted that as embryos mature, their requirements for exogenous supplies of certain specific growth substances decrease (Raghaven).

Sussex's report on the growth of various members of cell populations in shake culture also seems to bear out the point that all the cells in a given culture are not identical in size, shape, or growth ability. It is thus possible that the medium may act as a selecting agent.

Tissue culture has become an important tool in the study of morphogenesis. The development of flowers and floral organs on isolated stem fragments, separated from correlative and other influences of the intact organism, were reported by Tepfer, Jacobs, and Vasil. Vasil also described attempts to