centers of electrical energy—one positive, one negative. These charges rotate around each other and give the photon rotational energy ($E=hv$). Movement of the whole photon gives the photon translational energy. A combination of these two energies can allow one to imagine a particle that will have properties which are wavelike but are still not waves. It is hoped that this model picture will stimulate new research into the nature of light.

M. K. Healy (Jarrell-Ash Co.) reported on the laser microprobe which has given to emission spectrochemical analysis facilities that previously have been unavailable. These include the analysis of preselected portions of any solid sample without the need to remove them from the matrix and the independence of electrical conductivity. The laser microprobe provides the excitation of a 50-micron spot in a one-shot process so that inclusions and heterogeneities may be directly analyzed.

A simple and effective attenuated total reflection unit for the ultraviolet-visible-near infrared region designed for use in a standard spectrophotometer was described by W. N. Hansen (North American Aviation Science Center). Detailed studies have been made to compare attenuated total reflection and transmission spectra. For an aqueous solution of eosin-B, which obeys Beer's law by transmission, the behavior of the visible attenuated total reflection spectrum as a function of concentration was described. Results are comparable with theoretical predictions.

The annual regional meeting was presented by the Chicago, Cleveland, Detroit, Indianapolis, Milwaukee, Niagara Frontier, and St. Louis sections of the Society for Applied Spectroscopy. In addition, a one-day meeting on gas chromatography was held by the Chicago Gas Chromatography discussion group.

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Antigens

In order to study problems on mycobacterial and fungal antigens, a conference was held at Airlie House, Warrenton, Virginia (1–3 April). Over 150 scientists from Asia, Canada, Europe, South America, and the United States attended.

Pulmonary lesions caused by *Mycobacterium tuberculosis*, unclassified mycobacteria, and fungi are indistinguishable roentgenographically. There is a great need for specific antigens for case-finding, diagnostic, and immunologic use.

Almost 40 years ago Florence B. Seibert and Esmond R. Long had identified protein as the active principle of tuberculin. Subsequently, Seibert developed purified protein derivative for use in skin testing for tuberculosis infection. For all practical purposes the standard derivative (PPD–S) has been considered specific for tuberculosis infection until the past few years. Now some of the so-called "unclassified" mycobacteria have been found to have cross-reactions to the standard derivative. The specificity has been questioned.

As papers were presented at the conference, it was evident that the relatively simple precipitation methods used to fractionate bacterial cells and culture filtrates when the derivative was first developed have been superseded to a large extent by more precise methods which have been made possible by advances in instrumentation. Electrophoresis and chromatography and new variations on these principles are being employed today as efforts continue to refine antigenic material down to the basic particle that elicits a specific immune reaction.

A combination of several methods was reported by Japanese investigators in obtaining two extracellular protein antigens of tubercle bacilli in "highly purified form." The work was done at Osaka University by Masahiko Yoneda and Yoshio Fukui. The antigens, designated as α and β, were fractionated by ammonium sulfate precipitation and purified by electrophoretic and column chromatographic techniques. Subsequent immunochemical analysis, by gel diffusion techniques, of 22 strains of mycobacteria suggested that a relationship may exist between the biological type and the distribution pattern of the two antigens in mycobacteria.

W. T. Kniker (Scripps Institute) reported using ion-exchange chromatography to separate the antigens from culture filtrates of different species of mycobacteria. After "semipure" chromatographic fractions are obtained, they can be further refined by rechromatography, and so on until the single desired antigen is obtained.

The cell wall was suggested as the proper hunting ground for antigens, in a paper presented by C. S. Cummins (London Hospital Medical College, University of London) who discussed studies showing that strains of mycobacteria, corynebacteria, and nocardia have the same sugar and amino acids in their basic cell-wall structure. Cummins has found that strains with this type of cell wall appear to contain at least one antigenic component in common. Located in the wall, the component can be detected in an agglutination by using a suspension of cell-wall fragments as antigen. Cummins suggested that bacterial anatomy would be the basis for a fruitful search for mycobacterial and related antigens.

A two-stage process was described by Richard S. Farr (Scripps Clinic and Research Foundation). Farr's process, briefly, was to label cell-free extracts with radioactive iodine and to use the labeled antigen precipitate to measure the binding capacity of serums for the bacterial extract. In a series of serums from 88 tuberculosis patients, he reported that 37 had a higher binding capacity than was found in any of 63 nontuberculosis patients.

A paper by a veterinarian called attention to the importance of antigens specific for each species of mycobacteria. W. LeRoy Mallman (Michigan State University) reported isolating unclassified mycobacteria from a herd of swine raised at the university. The possibility that these organisms cause a reaction to the tuberculin test cannot be ignored and could mean that many cattle slaughtered on the assumption that they are tuberculous are actually not capable of transmitting the disease to man.

Development of two vaccines effective against experimentally produced coccidioidomycosis in mice and monkeys was reported by John L. Converse (U.S. Army Biological Laboratories, Fort Detrick, Md.). One of the vaccines is made from dead spores of *Coccidioides immitis* and the other from live spores. The vaccine killed by formalin did not appear to give as great a protection as the live vaccine.

One paper was based on studies in leprosy. R. J. W. Rees (National Institute for Medical Research, London) reported serological studies on 75 patients with different types of leprosy. By means of agar-diffusion techniques, precipitating antibodies to a variety of mycobacterial antigens have been detected in patients' serums. The results indicate that different types of leprosy can be identified by the pattern of antibodies.

The importance of the work of the scientists to the ultimate control of tuberculosis was emphasized in greetings extended by James E. Perkins (managing director of the National Tuberculosis Association). "Diagnostic specificity," he said, "depends to a major extent upon the availability and use of pure, specific antigens. With further progress in research in the sphere of antigens we will be in a position to determine more nearly precisely the interrelationships of genera and species of mycobacteria, be more certain in our diagnostic procedures, more nearly accurate in our prognoses, determine better the extent of the tuberculosis problem at a given time in a given area, measure more accurately subsequent progress in the reduction of tuberculous infection, and improve our efficiency in our control procedures, particularly with regard to determining more accurately candidates for secondary chemoprophylaxis."

This conference was held under the joint sponsorship of the George Washington University School of Medicine, the American Thoracic Society of the National Tuberculosis Association, and Pfizer Laboratories Division of Chas. Pfizer and Co., Inc.

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Protactinium Chemistry

Although protactinium was discovered 50 years ago, it remains one of the least studied elements in the periodic system. Now, under the joint stimulus of thorium reactor programs and the British isolation of more than a hundred grams of the element, protactinium chemistry is being actively investigated in a dozen laboratories throughout the world. These recent activities were the subject of a two-day symposium on the chemistry of protactinium held at Gatlinburg, Tennessee, (25–26 April) under the sponsorship of the Oak Ridge National Laboratory. The papers presented covered a wide range of activities, including solution and solid state chemistry, adsorption behavior (Kirby, Mound Laboratory), and applications to the dating of ocean bottom sediments (Rona, Oak Ridge Institute of Nuclear Studies).

In the processing of thorium reactor fuels, the isolation and recovery of protactinium have been an unsolved problem. This becomes particularly important in homogeneous thorium breeder reactors where continuous removal of protactinium from fuel or blanket solution is desirable in order to minimize parasitic neutron captures by Pa^{233}. A promising new scheme for protactinium isolation, that involves the adsorption of protactinium from acid nitrate solutions on columns of silica gel or unfired, pulverized Vycor glass, was reported (Moore and Rainey, Oak Ridge National Laboratory); it features simplicity of application and good decontamination factors from the major fission products. The required low concentration of protactinium in breeder-blanket solutions can also be maintained by a coprecipitation of protactinium as a peroxide that also includes a small fraction of the thorium content (McDuffie and co-workers, Oak Ridge National Laboratory). Of course, all these methods require that protactinium be sufficiently stable against precipitation or adsorption in the acid thorium nitrate solution for a long enough time to allow side-stream removal. That this condition can be met in a reactor environment has not been demonstrated, but laboratory-scale experiments by Barton and co-workers (Oak Ridge National Laboratory) in pressurized systems indicate a sufficient stability up to at least 160°C, provided that the acid concentration is high enough.

Similar problems in the molten-salt reactors received attention in a paper by Shaffer and co-workers (Oak Ridge National Laboratory), who reported the successful precipitation of protactinium from a molten $LiF\text{-}BeF_2\text{-}ThF_4$ system by the addition of a few weight percent of solid beryllium or thorium oxide.

Investigations of the fundamental chemistry of protactinium were reported from laboratories in the United States, England, France, and Germany. The study of ionic species by two-phase equilibrium techniques continues to be a popular though difficult approach. The complexities introduced by the well-known tendency to protactinium species to hydrolyze and polymerize were discussed by Hardy (Harwell) in the nitric acid-tributyl phosphate system. Paper chromatographic evidence for the existence of at least two species in the organic phase was presented together with evidence for equilibria between monomers and inextractable polymers of various degrees of aggregation in the aqueous phase. The polymerization of protactinium in sulfuric acid solution was discussed by Campbell (Oak Ridge National Laboratory) who reported on solvent extraction by amines. The hydrochloric acid system was examined by Scherff and Herrmann (Mainz) by diisobutylcarbinol extraction with careful attention to the distribution of all components and the activity coefficients involved. Their study included some analytical work on the organic phase. Hydrolytic and solvent extraction behavior in dilute perchloric acid systems was also examined by extraction with the chelating agent, thenoyl-trifluoroacetone, as reported by Muxart (Paris).

Another approach to the problems of ionic species in solution based on spectroscopic studies is gaining favor. Preliminary Raman spectra of K_2PaF_7 (whose preparation seems not to be so simple as once thought) were obtained in an extension of techniques successfully applied to the niobium and tantalum complex fluorides (Keller, Oak Ridge National Laboratory) and work on the ultraviolet absorption spectra is continuing. It still seems fair to state, however, that no ionic species of protactinium in aqueous solution has been positively characterized.

Considerable progress in the preparation of solid compounds of protactinium has been made recently, though not without some surprises. The dry preparation of the tetra- and pentavalent fluorides has been further investigated (Stein, Argonne). The pentafluoride seems not to be as volatile as previously reported, and the oxyfluoride prepared either from oxidation of PaF_4 or hydrolysis of PaF_5 has the composition Pa_2OF_8.

The peroxides precipitated from various mineral acids have been studied (Bouissieres and co-workers, Paris) and informal discussions revealed other studies in progress on the protactinium oxides (at Harwell), sulfates (at Harwell and Mound), and complex fluorides (at Cambridge and Oak Ridge National Laboratory).

While it is too soon to say that any real understanding of the chemistry of protactinium has been achieved, the stimulation of this conference should do much toward increasing the interest in this little understood element.

The proceedings of the symposium will be published by the Technical Information Division (USAEC).

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