Meetings and Societies

Size and Shape of the Earth

Quite frequently I have been asked, "You used to be a geodesist—what are you doing in fact?" When I have answered that the most important practical purpose of a geodesist is to carry out all the measurements and computations needed to establish a reliable control-point system, without which no adequate mapping would be possible, I have been answered, "Now I know—you are a 'tape man.' "

About a century ago it was still nearly correct to say that the men who were making or leading the measurements for the mapping work were "tape men," because then the classic method of measurement by rods and tapes was generally used. However, now it is as far from the truth as east is from west to claim that geodesists who are working with the size and shape of the earth are tape men; geodesists—for instance, the American, Hayford, who derived the constants of the international earth ellipsoid, the Dutchman, Vening Meinesz, who has made gravity observations from submarines at sea, and Walter D. Lambert, the grand old man of American geodesy—hardly have seen surveyors' tape. I used it for the last time two decades ago.

Now the geodesists need quite different methods, because problems are different. Even in local surveying, tape has been replaced by optical measuring equipments. In triangulation we do not need the usual tapes at all but, instead, Invar wires and a light-interference comparator to measure the base lines. The old methods for measuring details have been replaced essentially by aerial photogrammetry. As far as geodesy in general is concerned, the tape can be put in the museum.

To start with, we must know the size and shape of the earth. Both have been determined by the aid of arc measurements. In arc measurement, we measure, along the earth's surface, arcs that are as long as possible, and make astronomical observations of latitude, longitude, and azimuth at the end-points of the arcs. These observations yield the central angle corresponding to the measured arc. The arc itself is measured by triangulation. This means that we measure only the angles of consecutive triangles and only a few base lines to get a scale for the triangulation. The longest of the measured arcs is the arc from the Arctic Ocean to Cape Town in South Africa along the meridian 24° east. This method has given dimensions of the earth ellipsoid that are sufficiently accurate for most practical purposes.

During this century we have faced new problems, and therefore new methods have had to be discovered. Earlier all countries had their own geodetic control-point systems. In general, these systems, even those of neighboring countries, were quite different. Nobody knew how big the differences were. For the purposes of one country, even poor dimensions of the earth and classic triangulation were sufficient. Now we have to convert not only the geodetic systems of different countries but also those of different continents into a world geodetic system. In addition, it is becoming more and more desirable to be able to compute superlong distances, even across the oceans. In order to do all this, we have to know very accurately the dimensions of the earth. If, for instance, our measurement of the radius of the equator has an error of only 200 meters, then the computed distance from Washington, D.C., to Melbourne, Australia, would have an error of about 500 meters. In addition, we need the detailed shape of the sea level and its continuation under the continents. We call this surface the geoid. In other words, we must know both the earth ellipsoid along which we make the computation of the control points of different parts of the world and the deviations of the geoid from the ellipsoid and its inclination as referred to the ellipsoid. The deviations of the geoid, or undulations as we call them, and the inclination of the geoid cannot be obtained from a general formula but must be computed from point to point.

When all this has been done, we can convert the existing geodetic systems into the same world geodetic system. It is immaterial where the initial point of the world system is—in Washington, in Paris, in London, or somewhere else. What is most important is that the control points of every continent are computed in the same system.

Now we have, in addition to the classic arc-measuring method, at least four celestial methods, which use the moon or an artificial satellite as one triangulation point, and also the very flexible and very important gravimetric method.

To compare these different methods and to discuss in what way they can be combined to get the most benefit for geodesy and to get the main problems of geodesy solved as soon as possible, preparations were begun a year ago, at the initiation of the late Father Macelwane, professor of geophysics in St. Louis University, for holding a large-scale symposium, "Size and shape of the earth," at St. Louis University in November 1956. I had the honor to be the chairman of the steering committee for this symposium. Since it was impossible to get sufficient support for such an international symposium, the meeting was canceled. However, because interest in this subject is at the present time very keen all over the world, and because a great deal of preparatory work had already been done by the steering committee of 12 scientists, I thought that it might be good to try to arrange a "substitute" symposium.

When the National Science Foundation (U.S.) and the Graduate School of Ohio State University generously promised their support, we were able to carry out these plans. The symposium, which met 13–15 Nov. 1956, was sponsored by the Institute of Geodesy, Photogrammetry and Cartography and by the Mapping and Charting Research Laboratory of Ohio State University. The supporter of the World-Wide Gravity Project at Ohio State University, the U.S. Air Force Cambridge Research Center, also gave its wholehearted support.

The symposium had four sessions dealing with the "Classic and modern arc-measuring method," "Celestial methods," the "World gravimetric system," and the "World geodetic system."

In the arc-measuring method, we need the measurements of angles and base lines as well as astronomical observations of latitude, longitude, and azimuth. Since not very much essentially new has been discovered in astronomical observation during this century, this aspect was left out of the program. Instead, there were several addresses concerning triangulation, the measurement of standard base lines, and electronic methods, particularly shoran. Albert J. Hoskinson (retired chief, Geodesy Division, U.S. Coast and Geodetic Survey) gave a paper on the geodetic works of the Coast and Geodetic Survey and the accuracy required. As we know, the Inter-American Geodetic Survey takes care of the geodetic measurements of different types in Latin America in close cooperation with scientists of different countries. Concerning these measurements James Case (Institute of

Geodesy, Photogrammetry and Cartography, Ohio State University) gave a picture story about the measurements there. He had been conducting for 3 years measurements of some groups.

T. J. Kukkamäki (Finnish Geodetic Institute) sent a paper, "Standard base lines unify triangulations and trilaterations." In this paper, he explained the light-interference method devised by the Finnish professor, Y. Väisälä and used by the Finnish Geodetic Institute. Standard base lines which are yielding an accuracy of 1/10,000,000 (1 inch per 160 miles) have been measured so far in Finland and in Argentina and will be measured next summer in the Netherlands and in Germany. It is hoped that one such type of standard base line will be measured in the United States, perhaps in Columbus. Since modern triangulations give an accuracy of 1/1,000,000, as the triangulations of the Baltic Geodetic Commission show, it is highly desirable that the Invar wires that are used in the measurements of field base lines be calibrated in very accurate standard base lines.

The electronic methods developed during the last two decades have opened a new phase in geodetic measurements. Best known of these methods is shoran, which has been designed, developed, and applied in the United States and Canada on a large scale. The principle of this method is as follows. We measure the propagation time of the electromagnetic impulses or light waves from the observation points to the target and back. The impulses are sent from an airborne station and are reflected from the ground stations *A* and *B*. By the aid of this method, we can measure directly the distance *AB* up to 900 kilometers. The accuracy of these methods is dependent, of course, on how well the effect of many disturbing elements of the atmosphere can be eliminated or measured. An accuracy of 1/100,000 has already been obtained.

J. E. R. Ross (Dominion geodesist, Ottawa, Ontario) gave a very interesting paper, "Accomplishment of geodetic shoran survey in Canada." The new method has made it possible to measure the vast wilderness areas of the northern part of Canada, where other methods would take too much time. In general, Canada begins to be one of the geodetically best surveyed countries.

W. P. Scales (Fort Belvoir, Va.) told about continuous wave-distance measuring equipment. C. E. Westerman (Fort Belvoir) discussed the latest developments in geodimeters. Three different types of geodimeters, originally devised by the Swedish geodesist Bergstrand, were checked by the scientists at Fort Belvoir. These checks revealed that rather high accuracy, 1/1,000,000, can be obtained with good conditions. It will be seen on how big a scale this method will replace the use of the usual field base lines. Whatever method we might use in triangulation, either the classic or the electronic method, the equipment must be calibrated, and calibration can be accomplished only from standard base lines.

Armando Manzini (Aeronautical Chart and Information Center, St. Louis, Mo.) gave the last paper of the first session, "Computation of distances and azimuths of superlong geodesic lines." Until recent times, it has been necessary to compute only distances up to some 100 kilometers; now, when we join the continents to the same system, we must compute distances even to 10,000 kilometers. For this purpose, quite a few more or less new methods have been developed. Manzini gave a short analysis of the speed of these methods and the accuracy obtained.

Most fascinating, without a doubt, are the celestial methods: the solar eclipse method, star occultation, moon camera, and the artificial satellite method. In the solar eclipse method, developed by I. Bonsdorff, late director of the Finnish Geodetic Institute, B. Lindblad, director of the Stockholm Observatory, Gaviola in Argentina, and Francis Heyden, director of the Georgetown College Observatory, Washington, D.C., the moon is used as one triangulation point. We measure the exact moment when the totality of the eclipse begins and ends at three stations *A, B,* and *C,* of which *A* and *B* are on the same continent and *C* is on another continent. When we know, by aid of triangulation, the distance *AB,* we can compute the accurate distance of the moon and use this distance for computing an accurate distance *BC* across the ocean. This method was used in 1945, 1947, and 1954 to measure the distances between South America and Africa and North America and Europe. Heyden's expeditions have, in addition, used several solar eclipses to measure distances between Africa and the Far East. Altogether, at least 40 expeditions have been sent so far to observe total solar eclipses for geodetic purposes. The results have not been promising. Most of the time it has been cloudy or raining at the time of the eclipses, so that no observations have been possible. Accuracy is not as high as we anticipated beforehand. The moon's irregular limb is one of the main sources of error. Only one paper, a publication by Kukkamäki, gives the distance across the ocean—namely, the distance between the observing sites of the two Finnish expeditions, one in Brazil and one in the Gold Coast. The accuracy, however, is only about 120 meters.

Heyden has continued using a less accurate, but also more convenient, method, the light-intensity method, during several solar eclipses. He gave a paper, "Comments on the solar eclipse observations by photographic and photoelectric methods," in which he evaluated different methods. Unfortunately, he did not discuss the obtainable accuracy.

R. A. Hirvonen (Finland Institute of Technology) was, in 1947, the leader of a Finnish expedition to Brazil and, in 1954, the leader of an expedition to Oland, Sweden. His paper was, "Accuracy of the photographic method." Discouraged by the bad luck of most of the solar eclipse expeditions, he was quite pessimistic about the possibilities of this method.

David K. Scott (U.S. Naval Observatory) told about "Measuring of the profile of the moon's visible limb." Scott has participated in the studies of Watts in which attempts have been made for a decade to measure the profile of the moon's limb. This big work will be of basic significance to whatever purposes the observations of the moon's limb may be used.

The Mapping and Charting Research Laboratory of Ohio State University had the pleasure to establish, under the auspices of the Air Force Cambridge Research Center, four expeditions to observe the total solar eclipse in 1954, which was seen in America, Europe, and Asia. (The next equally good opportunity will come 197 years later). These expeditions used only the accurate Bonsdorff and Lindblad methods. The leaders of the expeditions were Frederick J. Doyle (Institute of Geodesy, Photogrammetry and Cartography, Ohio State University) at Knob Lake, in Quebec; A. E. Halbach (Astronomical Observatory of Milwaukee) at Okak Island, in Labrador; T. J. Kukkamäki in Greenland; and J. Allen Hynek in Iran. Unfortunately, none of these expeditions had success because of "heavenly sabotage." Doyle told a picture story about the experiences of the Knob Lake expedition.

Arne Slettebak (Perkins Observatory) told of the possibility of the occultation method. He has made theoretical studies of this method, which is quite similar to the solar eclipse method. The only difference is that, in the occultation method, the moments when a star disappears behind the moon's limb and again emerges from behind the limb are observed. Rather little has been published about the achievements of this method.

Very important and practical seems to be the moon camera method devised by W. Markowitz (U.S. Naval Observatory). The moon camera permits photographing of the moon and the neighboring stars so that the stars and the moon's limb will be stationary during the exposure, and consequently the images will be distinct. By measuring the small angular distances of the different points of the moon limb from the neighboring stars, the direction to the moon can be computed. In his paper, Markowitz told about the Moon Position Program and how the general shape of the geoid can be obtained by this method. During the International Geophysical Year, about 20 observatories around the world will participate in the Moon Position Program.

J. Allen Hynek (Satellite Tracking Commission and Harvard University) told about the "Accuracy of the satellite tracking position." In addition, he gave a popular lecture, "Artificial satellites," at the dinner meeting on 14 Nov. If the artificial satellite can be observed sufficiently accurately, then this method will give new possibilities for measuring the size and general form of the earth. Of course, it is too early to say anything concerning the accuracy, because the satellite is not yet in the sky. It is the hope of the scientists working with this program that important results can be obtained.

Paul Herget (Cincinnati Astronomical Observatory), told about "Computations for Vanguard satellites."

The third session brought us to the gravimetric method. The prerequisite of all geodetic methods is having as good observations as possible, because geodesy is, perhaps more than any other science, struggling against observation errors of different types. To get good results, we must have excellent measuring instruments, and these we have at least in gravimetry.

The new gravimeters are like a miracle if we compare their achievements with the results obtained by the old pendulum method. The gravimeters—spring balance principle—permits the measurement of gravity in 3 to 5 minutes with 20 to 50 times higher accuracy than pendulum apparatuses are able to accomplish in 2 days. The pendulum equipment weighs 2000 pounds; the modern Worden gravimeter weighs only 10 pounds.

We had the pleasure of having in the symposium the two best known inventors in this field, Lucien LaCoste (LaCoste and Romberg, Austin, Tex.), who has invented different types of gravimeters, one even for gravity observations from the submarine and one for the measurement of the earth tide, and Sam Worden (Houston Technical Laboratories), inventor of the geodetic Worden gravimeter, which in my opinion is the best of this type—it can measure big gravity differences accurately without any readjustment. This gravimeter has been used in most of the world-wide gravity measuring trips.

LaCoste gave a paper, "Gravimeters for accurate measurement of earth tides." The accuracy he gave was, in fact, very high. Earlier we used the milligal as a unit (1 mgal $= 0.001$ cm/sec^2); he used the microgal (1 μgal $= 0.001$ mgal). His tables showed that an accuracy of about 2 microgals can be obtained; this means that we can measure the periodic variations of gravity with a relative accuracy of 1/500,000,000. This type of instrument will be used, particularly during the International Geophysical Year, simultaneously in different parts of the world.

Worden brought his "toy cabinet," an enormously instructive and important collection of models of different gravimeters. This collection gave good ideas of the principles of gravimeters. One picture tells more than 1000 words; one model tells as much as 100 pictures.

To be able to use the anomalies of gravity for geodetic purposes, we must have gravity observations from different parts of the world. The oceans, which cover about 70 percent of the earth's surface, have been in this respect the "Achilles heel." Fortunately, F. A. Vening Meinesz (the Netherlands) invented in 1923 a special pendulum apparatus to be used for gravity observations at sea from submarines. He himself measured gravity at about 850 points in different oceans. These observations have been continued by the Columbia University group under the leadership of Maurice Ewing and Lamar Worzel. These observations include more than 3500 points. Worzel gave a paper, "Gravity measurements at sea," in which he told about the latest observations. Without the efforts of Vening Meinesz and Worzel, the geodetic applications of the anomalies of gravity would hardly be possible!

Seven percent of the ocean area is shallow shelf area with depths less than 200 meters. The submarine cannot be used in shallow waters. Therefore, it is very significant that the Gulf Oil Company invented about two decades ago a special underwater gravimeter which is sunk to the bottom of the sea; readings are made from the surface boat. Later on, about 30 underwater gravimeters were made by different inventors and companies. The Gulf Oil Company generously loaned its underwater gravimeter to the Finnish Geodetic Institute to be used for the gravity survey of the waters of the Baltic Sea. T. B. Honkasalo (Finnish Geodetic Institute) made this gravity survey at 170 points last summer. His paper concerning these observations was referred to in the symposium.

G. D. Garland (University of Alberta, Canada) gave an interesting summary about the enormous number of gravity observations that have been carried out in Canada.

All gravity observations of the world must be made in the same system. Fortunately, during the last decade there has been particular interest in different countries in connecting the national base stations to the same system, the Potsdam system. Some scientists of France, Great Britain, and Italy have done a good job in this respect; however, G. P. Woollard's group at the University of Wisconsin has alone done more in this respect than all the others combined. Using the Worden gravimeter, Woollard and his students have flown several times around the world in different directions and have occupied more than 3000 gravity base stations on the continents and on most ocean islands too. As a result of this global work, the world gravity data are now in the same system, approximately with the accuracy of 1 milligal. Woollard's paper concerning the last world-wide observations was delivered at the meeting.

We understand well that no one country alone can accomplish the necessary geoid studies on a world-wide scale. We need international cooperation. The central international organization is the International Association of Geodesy, which has its offices in Paris. This organization sponsored an International Gravimetric Conference in Paris last September. In this conference about 20 nations were represented. Donald A. Rice (chief of the Department of Gravity and Astronomy of the U.S. Coast and Geodetic Survey), who was the main representative of the United States (others were Walter D. Lambert and I) told about this conference.

The main purpose of this conference was to arrange the gravimetric calibration lines to all continents. Essentially they have already been measured in Europe and North America, but other continents still do not have such measurements. The purpose of these calibration lines is to permit the calibration of the gravimeters to be used. In addition, there was in Paris a discussion about cooperation between the West and East. The center of the Potsdam system is in the Eastern Zone of Germany. Since World War II no Western scientist has been able to make gravity observations in Potsdam. As a result of private discussions during the meeting, T. B. Honkasalo was allowed to go to Potsdam to join gravimetrically the base stations at Helsinki, Copenhagen, and Potsdam. It is to be hoped that other scientists can also make similar measurements later on.

The amount of gravity material that has been collected is already so enormous that one must have some gravimetric "clearinghouses" to analyze the material and to bring the data in to the same world system. Quite a bit of such work has been done in some geodetic institutions, such as the Coast and Geodetic Survey of the United States, the Geodetic Commission in the Netherlands, and the Geodetic Survey of India. It was also realized that we need additional analyzing centers. In 1936 the International Union of Geodesy and Geophysics established the International Isostatic Institute in Helsinki, Finland, under my direction. The main purpose of the institute has been to prepare isostatic reduction maps and tables and to make isostatic reductions at the individual gravity stations. This work has been done for a large part of the Eastern Hemisphere and for large areas of the oceans. The work will continue in close cooperation with the Columbus center. In 1948, there was established in Paris the International Gravity Center under the direction of Pierre Lejay. The main purpose of this center has been to make gravity observations in France and French territories. The center has also been interested in establishing calibration lines and tying the base stations into the same system.

In 1950 I had the privilege and opportunity to establish, and later on to conduct, the World-Wide Gravity Project of the Mapping and Charting Research Laboratory of Ohio State University. This project was sponsored by the Cambridge Air Force Research Center. The purpose of the project is to apply the gravity anomalies to all possible geodetic purposes. This work has been made possible only by close cooperation with other groups in various countries. At present, the geodetic institutions and private geodesists of 35 countries and several oil companies are in close cooperation with the Columbus center. They will even send in unpublished gravity anomaly maps and gravity data. I gave a short paper concerning the gravimetric part of international geodetic cooperation.

Walter D. Lambert (retired chief of the department of gravity and astronomy, U.S. Coast and Geodetic Survey) lifted our eyes from the earth to the higher sphere. He gave a paper on "Normal gravity field in high elevations," a problem which he, as consultant of the Columbus gravity project, has studied for quite a long time. It was revealed that, if we know the gravity anomaly field on the earth's surface, we can compute the gravity field at any elevation. This will be very important later on when the computations of the artificial satellite observations will be actual.

The last session dealt with the world geodetic system. Since the representative of the Army Map Service was unable to attend the symposium, I gave a short report, "Dimensions of the earth according to the Army Map Service." This report called attention to the enormously important studies made by the Army Map Service concerning the dimensions of the earth under the leadership of Floyd W. Hough. These studies, published recently in the *Transactions of the American Geophysical Union,* showed that the Army Map Service now has much longer measured arcs available than ever before. Consequently, the results are obviously of higher accuracy than the earlier ones. This study indicated also that it is very important to combine the arc-measuring method with the gravimetric method. The classic method cannot give at any point the absolute undulations of the geoid or the absolute deflections of the vertical, so, depending on what value for these quantities will be given at the initial point of the different arcs, we will get different values for the dimensions of the earth. In addition, it was clear that the observed deflections of the vertical cannot be used to compute the dimensions of the earth. The deflections must be isostatically reduced. The equatorial radius a obtained by the Army Map Service is 6,378,260 meters, or 128 meters less than the radius value of the international ellipsoid. It remains to be seen how much this value will change when the gravimetric method is also applied.

Fortunately, the earth topography is in broad lines in isostatic equilibrium. This means that the mountains are supported by the root formations in a way similar to the way icebergs are supported by sea water. The roots of a mountain are about 4 to 5 times as high as the elevation. So the earth's crust under the mountains is thicker than it is under the level lands. Similarly, the earth's crust is thinner under the oceans. The root formations of the mountains and the antiroots of the dense material of the oceans compensate the mass plus of the mountains and mass deficiency of the oceans, so that the undulations of the geoid are only of the order of 100 meters. If isostatic equilibrium did not prevail, the undulations of the geoid would be of the order of 1 mile. In that case, the material existing now would not be sufficient to compute the shape of the geoid. Lassi Kivioja (Mapping and Charting Research Laboratory) gave a paper, "Significance of the isostatic equilibrium," and explained the problems involved.

Urho Uotila (Mapping and Charting Research Laboratory) gave a paper, "Determination of the shape of the geoid," which, in fact, was a summary of work done in Columbus under the World-Wide Gravity Project. There were shown the different kinds of computations one has to carry out to get the reliable gravity anomaly maps that are needed to compute the undulations of the geoid and the deflections of the vertical. These studies showed also that the International Gravity Formula that has been used, practically speaking, in all gravimetric studies, needs only very small corrections, if any. It was also made clear that we cannot extrapolate the gravity anomalies very far from the computation point. The studies, particularly those made by R. A. Hirvonen, made it clear that this can be done only in the neighborhood of the station to the distance of 300 kilometers. Beyond this boundary, it is best to use the isostatic gravity anomaly zero. This is not very far from the truth, because nearly complete isostatic equilibrium prevails. It is also clear that we still do not have sufficient material to develop successfully the gravity anomalies in spherical harmonics.

William Kaula (Fort Belvoir) told about the "Accuracy of the gravimetric determination of the deflections of the vertical." Starting from the studies of Hirvonen, he showed how big will be the error in the deflections of the vertical in the gravity anomaly field when only very few gravity observations, if any, have been carried out far from the computation point.

My paper, "Combination of different methods: a look at the future," tried to show what can be done now and with what accuracy. The main achievements are as follows. (i) We can check the equatorial radius and the flattening of the meridian with relatively high accuracy. (ii) The undulations of the geoid N and the deflection of the vertical components ξ and η can be computed in all such areas where detailed gravity anomalies exist. (iii) At the initial points of the different geodetic data, the quantities N, ξ, and η must be computed with very high accuracy; an extremely good local gravity station net must exist in the neighborhood of these points. (iv) When we know N, ξ, and η at the initial points of the geodetic data of different continents, we can easily convert all these systems to the same world system. (v) We can also compute the distances across the oceans with the accuracy of 100 to 200 meters. The largest part of the error is brought about by the error in the equatorial radius of the earth. (vi) When we correct the astronomical latitude and longitude, using the gravimetric deflection of the vertical, we can use any such astronomical point as control point of the small-scale maps beginning from scale 1/100,000. The accuracy of all these computations will be the higher, the better gravity anomaly maps we have. The values we get now can be corrected, say after 5 years, easily considering only the effect of the additional material obtained later on.

Bela Szabo (Aeronautical Chart and Information Center) gave a paper showing how important it is from the point of view of long-range navigation to establish a uniform world geodetic system.

The symposium was opened with a word of welcome by J. Osborn Fuller, associate dean of the College of Arts and Sciences at Ohio State, and by my opening address. Paul M. Pepper (Mapping and Charting Research Laboratory), Walter D. Lambert, Paul Herget, and Albert J. Hoskinson served as chairmen of the sessions. There were visits to the new headquarters of the Institute of Geodesy, Photogrammetry and Cartography and to the Mapping and Charting Research Laboratory.

It was interesting to realize how big an interest in this subject exists in the United States. No less than 28 different governmental and private organizations and universities were represented; altogether, about 100 scientists attended. It was important too that quite a few scientists of international recognition, such as Garland, Herget, Heyden, Hirvonen, Hoskinson, Hynek, Kukkamäki, LaCoste, Lambert, Markowitz, Rice, Ross, Woollard, Worden, and Worzel, participated in the symposium or sent their papers to be delivered.

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Aviation Writers

The first Congress of the International Society of Aviation Writers will be held in Washington, D.C., 2–6 Apr. A special feature of the congress will be a complete briefing on the International Geophysical Year. The writers will also hear addresses on developments in various fields of aviation. Seminars will be held on topics of importance to international aviation writers. Part of the Washington congress will be devoted to organizational matters, since this will be the first formal meeting of the society.

Participants have been invited to the sessions of the American Rocket Society, which is meeting at the same time. Of special interest will be that society's sessions on the Vanguard project.

It is the ISAW's plan to alternate its meetings from hemisphere to hemisphere to enable as many aviation writers as possible in different parts of the world to attend. For information about the Washington congress, communicate with the program chairman, Erik Bergaust, 1001 Vermont Ave., NW, Washington, D.C., U.S.A., who will forward a detailed program and arrange accommodations.

ACS Miami Meeting

Some 6000 chemists and chemical engineers from all parts of the United States and several foreign countries will convene in Miami, Fla., for the 131st national meeting of the American Chemical Society, 7–12 Apr. John S. McAnally, assistant professor of biochemistry in the University of Miami School of Medicine, Coral Gables, has been named general chairman of the semiannual conference, which will be the largest spring meeting of the society in its 81-year history.

Chemical research on the problems of aging, development of flame-resistant cotton and rayon, and the increasingly important role of nuclear technology in the petroleum and chemical industries are among the subjects to be discussed in 1358 reports during the week. One hundred fifty local sections of the society, serving all 48 states, the District of Columbia, Puerto Rico, and Hawaii, will be represented.

A new class of pain-relieving drugs, chemical contributions to the citrus fruit industry, and improvements in paints, plastics, and other chemical products will be described at technical sessions sponsored by 20 scientific and technical divisions of the society. Nutrition, air pollution, cancer, and the status of chemical education are among the many subjects to be considered.

The Priestley medal, highest honor in American chemistry, will be presented to Farrington Daniels of the University of Wisconsin, world authority on both atomic and solar energy, at a general assembly of the society to be held in the Band Shell, Bayfront Park, on 8 Apr. Daniels will speak on "Chemistry and the world's energy needs." Peter J. W. Debye of Cornell University, Nobel prize winner in chemistry in 1936, is among the 15 other outstanding scientists who will receive awards at the general session.

Willard F. Libby, member of the U.S. Atomic Energy Commission, is one of the speakers who will be heard at luncheons and dinners sponsored by several ACS divisions. He will address a joint luncheon of the Division of Industrial and Engineering Chemistry and the Division of Petroleum Chemistry on "The chemist and peaceful uses of the atom."

Information Retrieval

Western Reserve University will sponsor a Symposium on Systems for Information Retrieval, 15–17 Apr., at Masonic Auditorium in Cleveland, Ohio. The symposium for the first time will include demonstrations of working equipment as well as systems presentations.

Closed-circuit television between the exhibit areas and the auditorium will be used to coordinate the demonstrations of equipment with the systems presentations. The equipment is being furnished by Commercial Controls Corporation, Dage Television Division, Thompson Products, Inc., International Business Machines Corporation, the Ohio Bell Telephone Company, and the Remington Rand Corporation. Western Reserve's searching selector, now completed, will also be used in the program. The university's School of Library Science and its Center for Documentation and Communication Research will be hosts at the conference.

Banquet speakers will be Robert C. Watson, U.S. Commissioner of Patents, and Verner W. Clapp, president of the Council on Library Resources. One of the highlights of the program will be "The intercontinental guided missives demonstration." This will be a practical demonstration of the use of world-wide telecommunications in the process of information retrieval. James D. Mack, librarian of Lehigh University, will conduct the demonstration with the cooperation of the Ohio Bell Telephone Company and the Radio Corporation of America. Complete information on the conference is available from the Dean, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

High-Energy Physics

Some 300 nuclear physicists, 100 more than last year, will assemble at the University of Rochester 15–19 Apr. for the seventh annual Rochester Conference on High Energy Physics. The participants will include four Nobel prize winners and many research directors from the leading laboratories in this country and 25 foreign nations.

Approximately 85 visitors from abroad are expected to attend the conference, which is sponsored by the National Science Foundation, the U.S. Atomic Energy Commission, the Office of Naval Research, the Air Research Development Command, International Union of Pure and Applied Physics, and the University of Rochester. Industrial sponsors contributing financial support are General Motors, General Dynamics, the Rand Corporation, Hughes Aircraft, Ramo-Wooldridge Corporation, and four Rochester firms. Robert E. Marshak, head of the Rochester physics department, is conference chairman.

Scientists in the following countries have received invitations: Australia, Belgium, Bolivia, Brazil, Canada, Czechoslovakia, Denmark, England, France, Germany, India, Ireland, Israel, Italy, Japan, Mexico, the Netherlands, Norway, Pakistan, Poland, Scotland, Sweden, Switzerland, the Soviet Union, and Yugoslavia. A 2-week tour of high-energy installations in the United States has been arranged for the foreign delegates at the close of the Rochester conference. The group from abroad also will attend the American Physical Society meeting in Washington, D.C., 25–27 Apr.

Three Russian scientists attended the Rochester conference last year for the first time and talked freely about the work in nuclear physics in the U.S.S.R.

This is the first year that invitations have been sent to physicists from Belgium, Bolivia, Czechoslovakia, Norway, Poland, and Yugoslavia.

Fourteen American scientists, including Marshak, were invited by the U.S.S.R Academy of Sciences to a high-energy physics conference in Moscow last May following the Rochester conference. They reported that they were given full opportunity to inspect Soviet scientific installations and received a great deal of valuable information on Soviet scientific and technologic activities and achievements, both during the Stalin era and since.

The purpose of the Rochester conference is to promote the interests of fundamental research in the field of high-energy nuclear physics by open, informal discussion and exchange of information among members of the world community of science. All of the information discussed at the meetings deals with non-secret research and will be summarized and published later for public distribution in a volume of proceedings.

Venereal Diseases

The eighth annual symposium on Recent Advances in the Study of Venereal Diseases will be held in the auditorium of the Department of Health, Education, and Welfare, Washington, D.C., 24–25 Apr. The sessions are open to all interested physicians and workers in allied professions. Hundreds of participants from all parts of the country, including many experts on venereal disease, attend annually to exchange the latest available information. Topics to be discussed include basic and clinical research, serology, epidemiology, treatment, program operation, and professional education.

Society Elections

■ Tau Beta Pi: pres., Harold M. King; v. pres., Walter C. Voss; sec.-treas., Robert H. Nagel, University of Tennessee, Knoxville; sec.-treas. emeritus, R. C. Matthews.

■ National Association for Research in Science Teaching: pres., Nathan Washton, Queens College; v. pres., Thomas Fraser, Morgan State College; sec.-treas., Clarence M. Pruitt, University of Tampa.

■ Optical Society of America: pres., Ralph A. Sawyer, University of Michigan; exec. v. pres., Irvine C. Gardner; v. pres., Stanley S. Ballard, Scripps Institution of Oceanography; sec., Kasson S. Gibson, National Bureau of Standards; treas., E. D. McAlister, Eastman Kodak Company; past pres., Deane B. Judd, National Bureau of Standards.

■ National Society for Medical Research: pres., Jules Cass; 1st v. pres., Bennett J. Cohen; 2nd v. pres., Victor Schwentker; sec.-treas., Robert J. Flynn.

■ Oklahoma Academy of Science: pres., D. E. Howell, Oklahoma Agricultural and Mechanical College; v. pres., George J. Goodman, Oklahoma University; sec.-treas., Philip E. Smith, Oklahoma University Medical Center; asst. sec.-treas., Donald E. Mitchell, Continental Oil Company; permanent sec. and representative to the AAAS Council is Orville Schultz.

Forthcoming Events

April

19–21. American Psychiatric Assoc. Research Conf., Oklahoma City, Okla. (L. J. West, Univ. of Oklahoma Medical Center, 800 Northeast 13 St., Oklahoma City 4.)

20–26. Industrial Health Conf., 12th natl., St. Louis, Mo. (E. C. Holmblad, Industrial Medical Assoc., 28 E. Jackson Blvd., Chicago 4, Ill.)

22–24. National Acad. of Sciences, annual, Washington, D.C. (H. L. Dryden, NAS, 2101 Constitution Ave., NW, Washington 25.)

23–25. Chemistry and Biology of Mucopolysaccharides, Ciba Foundation Symp. (by invitation only), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

23–25. Solid State Devices in Electric Circuits, symp., New York, N.Y. (J. Griesmann, Microwave Research Inst., 55 Johnson St., Brooklyn 1, N.Y.)

23–26. American Industrial Hygiene Assoc., annual, St. Louis, Mo. (G. D. Clayton, AIHA, 14125 Prevost, Detroit 27, Mich.)

23–27. Separation of Isotopes, colloquium of IUPAP, Amsterdam, Netherlands. (J. Kistemaker, Laboratorium voor Massaspectrografie, Hoogfe Kadijk 202, Amsterdam C.)

24–25. Industrial Research Conf., Chicago, Ill. (C. E. Barthel, Armour Research Foundation, Illinois Inst. of Technology, 10 W. 35 St., Chicago 16.)

24–25. Recent Advances in the Study of Venereal Disease, 8th annual symp., Washington, D.C. (W. J. Brown, Program Committee Chairman, Communicable Disease Center, Atlanta, Ga.)

24–26. Purity Control by Thermal Analysis, IUPAC, Amsterdam, Netherlands. (W. M. Smit, Central Inst. for Physico-Chemical Constants, Biltstraat 172, Utrecht, Netherlands.)

24–26. Sanitary Engineering Conf. on Solids Handling and Anaerobic Digestion, New York, N.Y. (W. W. Eckenfelder, Jr., Civil Engineering Dept., Manhattan College, New York 71.)

24–27. Plant Quality, 2nd internatl. colloquium, Paris, France. (L. Genevois, Faculté des Sciences, Université de Bordeaux, 20, Cours Pasteur, Bordeaux, France.)

25–26. Institute of Environmental Engineers, 1st annual tech. conf., Chicago, Ill. (G. D. Wilkinson, IEE, 9 Spring St., Princeton, N.J.)

25–26. Midwest Benthological Soc., annual, Urbana, Ill. (A. Lopinot, 205 W. Osie, Gillespie, Ill.)

25–27. American Physical Soc., Washington, D.C. (K. K. Darrow, APS, Columbia Univ., New York 27.)

25–27. West Virginia Acad. of Science, annual, Keyser. (M. Ward, Glenville State College, Glenville, W. Va.)

25–29. Pan American Cancer Cytology Cong., Miami, Fla. (J. E. Ayre, New York Univ., New York, N.Y.)

26–27. Alabama Acad. of Science, annual, Jacksonville. (H. A. McCullough, Dept. of Biology, Howard College, Birmingham, Ala.)

26–27. American Assoc. of University Professors, annual, New York, N.Y. (R. F. Fuchs, AAUP, 1785 Massachusetts Ave., NW, Washington 6.)

26–27. Iowa Acad. of Science, annual, Cedar Falls. (J. L. Laffoon, Dept. of Zoology and Entomology, Iowa State College, Ames.)

26–27. Kentucky Acad. of Science, Mammoth Cave. (G. Levey, Berea College, Berea, Ky.)

26–27. Mississippi Acad. of Sciences, annual, Columbus. (C. Q. Sheely, State College, Miss.)

26–27. Montana Academy of Sciences, 17th annual, Billings. (L. H. Harvey, Montana State Univ., Missoula.)

26–27. South Dakota Acad. of Science, annual, Sioux Falls, S.D. (J. M. Winter, Botany Dept., Univ. of South Dakota, Vermillion.)

26–28. Cooper Ornithological Soc., annual, Los Angeles, Calif. (J. Davis, Hastings Reservation, Jamesburg Route, Carmel Valley, Calif.)

27–2. Scientific Apparatus Makers Assoc., 39th annual, White Sulphur Springs, W. Va. (SAMA, 20 N. Wacker Dr., Chicago 6, Ill.)

28. American Soc. of Hospital Pharmacists, New York, N.Y. (Mrs. G. N. Francke, 1812 Norway Rd., Ann Arbor, Mich.)

28–30. American Assoc. of Colleges of Pharmacy, annual, New York, N.Y. (G. L. Webster, Univ. of Illinois College of Pharmacy, 808 S. Wood St., Chicago 12.)

28–2. Southwestern and Rocky Mountain Division–AAAS, annual, Tucson, Ariz. (F. E. E. Germann, 1800 Sunset Blvd., Boulder, Colo.)

28–3. American Pharmaceutical Assoc., annual, New York, N.Y. (R. P. Fischelis, APA, 2215 Constitution Ave., NW, Washington 7.)

28–3. Soc. of American Bacteriologists, annual, Detroit, Mich. (J. H. Bailey, Sterling-Winthrop Research Inst., Rensselaer, N.Y.)

29–30. National Assoc. of Boards of Pharmacy, annual, New York, N.Y. (P. H. Costello, NABP, 77 W. Washington St., Chicago 2, Ill.)

29–1. American Assoc. of Spectrographers, 8th annual, Chicago, Ill. (T. H. Zink, H. Cohn & Sons, 4528 W. Division St., Chicago 51.)

(See issue of 15 March for comprehensive list)