orological work under way at present and envisioned for the future will be carried out by teams of researchers consisting of physiologists, agronomists, meteorologists, and representatives of other disciplines needed in a specific research endeavor. J. Young (University of Nebraska) suggested that agricultural meteorological work has not helped as much as it could in agricultural problems, not because information is not available but because it has not been applied. J. McQuigg (U.S. Weather Bureau, Columbia, Missouri) challenged the members to forget they are meteorologists and approach specific problems from the standpoint of the person who must decide how to solve them. An analysis of the decision-making processes will show whether or not weather information would be helpful, and if so, how and when and what information is required.

At the final session L. Pierce (U.S. Weather Bureau, Columbus, Ohio) showed from measurements of soil moisture made simultaneously under fallow and under corn that soil moisture is first used directly beneath the row of corn and exceeds evaporation from a fallow surface when the corn is about 18 inches (46 cm) high. Only when the reservoir had been depleted was the moisture between the rows extracted. Surprising persistent differences in measured precipitation due to differences in elevation of less than 20 feet were presented by A. Eichmeier (U.S. Weather Bureau, East Lansing, Michigan).

A study of departures from normal precipitation reported by S. Changon (Illinois State Water Survey) indicates that droughts in Illinois tend to have a SW–NE orientation and are more severe in the southern part of the state. W. Palmer (U.S. Weather Bureau, Washington, D.C.) applied his method of measuring the severity of meteorological drought to the study of drought patterns and frequencies in the eastern and central United States. The conference closed with a study of drought in relation to corn near Ames, Iowa. R. Dale (U.S. Weather Bureau, Iowa State University) speculated that the combined frequencies of soil moisture supply and atmospheric evaporative demands result in moisture stress conditions which reduce corn yields in about half of the years.

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Orbits in the Solar and Stellar Systems

In recent years much new work has been stimulated in dynamical astronomy by new observational techniques, by applications of powerful computing facilities, and by a renewed interest in the mathematical analysis of dynamical systems. Results of some of this work were reported at the International Astronomical Union Symposium 25 on the Theory of Orbits in the Solar System and in Stellar Systems, held 17–22 August 1964 in Thessaloniki, Greece, in conjunction with the 12th General Assembly of the IAU. Sixty-five astronomers representing 13 countries participated in the symposium.

Owing to results announced years ago by Kolmogorov, the problem of small divisors has at least been partially solved by topological methods. These investigations are important toward achieving a better understanding of the nature of integrals of dynamical systems and therefore of orbits in the solar system as well as in stellar systems. In view of the significance of their contributions to this area of research, it was particularly regrettable that no Soviet scientists participated in the symposium; the organizing committee had invited a strong representation from the Soviet Union, but had been informed that organizational difficulties would prevent their participation.

The keynote address of the symposium was given by G. Contopoulos (Greece) on the subject "Recent developments in stellar dynamics." This address foreshadowed the considerable interest during the symposium in the subject which is generally, but not entirely accurately, called the "third integral." A dynamical system of n degrees of freedom is represented by a system of differential equations of the $2n^{th}$ order. Integrals of such a system of differential equations are helpful in obtaining the solution of the dynamical system; their role in promoting the understanding of the general behavior of the system is essential. The existence of integrals expressing energy and momentum conservation in galactic problems permits reduction of the order of the differential equations. An additional integral (the third one in this special case), if available in analytical form, renders problems of two degrees of freedom completely solvable since the last integral can always be found.

Depending on the force field (that is, potential field), additional integrals can be found analytically or numerically, exactly or approximately. An n-body gravitational problem, for instance, has ten known integrals, the restricted problem of three bodies using rotating coordinates has only one, the generally used galactic potential problem has two, and so forth.

Significant progress indicating the existence of a second integral of the restricted problem by numerical experiments was shown by M. Henon (France) for a large variety of initial conditions. For collision orbits and for the elliptic restricted problem, similar results were offered by V. G. Szebehely (Yale). A. Ollongren (Netherlands), L. Perek (Czechoslovakia), and B. Barbanis (Greece) made contributions to the third integral of galactic problems.

The pure concept of an integral of a system of differential equations is stretched somewhat and is intermingled with the ergodicity of the system; nevertheless, at a time when experimental evidence is accumulating, a rigid sorting out of results of special and general significance seems to be difficult.

The two generally accepted dynamical models available for studying the behavior of stellar systems are (i) the averaged potential and (ii) the n-body field. The first of these was discussed in some detail in connection with the concept of the "third integral." The second was a subject of considerable interest at the meeting, since the availability of large-scale, high-speed digital computers makes it possible to find simultaneously the motion of an impressive number of particles. These bodies all attract each other according to the Newtonian gravitational force. Results of numerical integrations were described for order of 10 and order of 100 bodies. The contributors' understanding of the difficulties of such undertakings assured a most profitable exchange of information. Improvement of analysis and numerical techniques seems to be necessary if meaningful results are to be obtained in the future. S. M. Ulam (Los Alamos), R. H. Miller (University of Chicago), and S. Aarseth (England) discussed results of considerable interest.

The outstanding contribution presented during a session called "New method in celestial mechanics" was by W. J. Eckert (I.B.M.), who gave an account of his numerical verifica-

tion of the late E. W. Brown's solution of the main problem of the lunar theory. The procedure adopted required the substitution of Brown's solution into the parts of the differential equations that represent the perturbative accelerations. A system of linear equations is then obtained, the unknowns of which are corrections to the coefficients of periodic terms and to the motions of the perigee and node. The novel difficulties of the problem arise from the large number of unknowns (over 6000) and the presence of small divisors which cause near-indeterminateness for some of the unknowns. It was found that grouping of unknowns into families overcame both obstacles. It permitted replacing the total system of equations by a number of subsystems. A process of iteration then converged to a definite solution. Eckert stressed that, although the work was begun before the era of high-speed calculators, it could not have been completed with the perfection achieved without powerful computing facilities.

Results reported in sessions on planetary theories and the three-body problem depended heavily on the availability of powerful high-speed calculating equipment. I. Izsak (Smithsonian Astrophysical Observatory) reported on his work on an analytical development of the planetary disturbing function on a digital computer. The principle is not essentially different from the development by Newcomb late in the 19th century, but these developments have not been extensively used because of the excessive amount of labor required. Yet they are almost indispensible if planetary theories are to be constructed which will be valid for an indefinite length of time.

D. Brouwer (Yale) reported on a recent result obtained by C. J. Cohen and E. C. Hubbard (Naval Weapons Laboratory) on the orbit of Pluto. By extending the numerical integration of the five outer planets with the Naval Ordnance Research Calculator (NORC) over 120,000 years, they found that a resonance relation between the elements of the orbits of Neptune and Pluto exists which prevents Pluto from coming closer than 18 astronomical units to Neptune at any time during the period covered by the numerical integration. The conclusion is probably valid for a much longer period, but this will require further exploration of the resonance relationship.

J. Schubart (Germany) presented an impressive compilation of numerical results, obtained while he was guest investigator at the Smithsonian Astrophysical Observatory, pertaining to orbits in resonance regions in the plane restricted problem.

The British Astronomer Royal, Sir Richard Woolley, gave an account of astrometric investigations of star clusters which have already yielded significant observational information on the structure of the Galaxy. Other contributions closely related to observational evidence were made by M. Schmidt (California Institute of Technology) on a revised potential of the Galaxy and by I. King (University of California, Berkeley) on the stability of star clusters.

The symposium was organized in cooperation with the Committee on Space Research of the International Council of Scientific Unions and received support from UNESCO, the government of Greece, the U.S. Air Force Office of Scientific Research, and the U.S. Office of Naval Research, as well as from the IAU.

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Virus Infections in Cold-Blooded Vertebrates

A conference on viral diseases of poikilothermic vertebrates was held in New York City 23–26 September 1964. R. Weissenberg, who in 1914 reported on lymphocystis disease in fish, the first viral infection of a cold-blooded vertebrate to be described, gave the keynote address, in which he reviewed 50 years of research on this disease.

The conference made possible new and expanded contacts between those interested primarily in viral infections of amphibia and those whose primary interest is diseases of fish. Such contacts in recent years have been mutually beneficial—for example, Granoff used the fathead minnow cell line, which was newly described by Gravell and Malsberger at this conference, to propagate the frog virus which he has recently isolated.

The first group of papers to be presented dealt with amphibia. The frog renal adenocarcinoma (Lucké tumor) was the topic of all but two of the 16 papers in this group, and collectively these papers represent a major advance in the study of this disease.

The etiology of frog renal adenocarcinoma has yet to be established, but the presence of virus in some tumor-bearing frogs was established by isolation and by electron microscopy. Rafferty (Johns Hopkins) isolated viral agents from tumors which bore Type A nuclear inclusions, but he was unable to isolate virus from frogs having no inclusion tumors. Granoff (University of Tennessee) also isolated viral agents from frog kidneys; these viruses proved lethal to frog embryos. Evidence for the presence of virus or virus-like particles was obtained by a number of electron microscopists—Barch (Michigan State University), Lunger (Rockefeller Institute), and Zambernard (Tulane). The new findings confirmed earlier ones made by means of electron microscopy and showed morphological similarities between viruses from Vermont and Wisconsin frogs.

Mizell (Tulane) suggested that a lysogenic-like state exists in frogs infected with renal adenocarcinoma, an hypothesis which integrates seemingly conflicting data from a number of sources. Although lysogenicity is best known in bacteria, latent herpes is another animal virus infection which resembles the lysogenic state.

The role of some fish viruses, unlike that of amphibian viruses, has been well established, and new findings were reported for several of the agents. In addition, the first "orphan virus" from fish cell cultivations was described by Clem (University of Miami). Electron microscopy and multiplication of infectious pancreatic necrosis (IPN) virus were described by Malsberger and Cerini (Lehigh University). They found that IPN virus measured 18 $m\mu$ and thus is the smallest known pathogen of fish.

Viral hemorrhagic septicemia of European rainbow trout, a serious infection with which the audience was, for the most part, unfamiliar, was the subject of a series of papers presented at the conference. The pathological behavior of the fish and the symptoms of the disease were clearly illustrated by means of color film and slides. Jensen (Denmark), who first isolated the causal agent, Egtved virus. described additional biological attributes of the virus. French workers (Besse and Bellet), while not disputing the viral etiology, firmly maintained that nutritional factors strongly influenced