at least once in every set of N successive integers of the sequence.

In any domain of transitivity the two extreme types of motion are the recurrent motions on the one hand and the motions which pass arbitrarily near every state of motion in the domain on the other. Both types necessarily exist, as well as other intermediate types.

The precise nature of such recurrent motions has yet to be determined, but Dr. H. C. M. Morse in his 1918 dissertation at Harvard has shown that there exists non-periodic recurrent motions of entirely new type in simple dynamical problems.

Such are a few of the steps in advance that theoretical dynamics has taken in recent years. I wish in conclusion to illustrate by a very simple example the type of powerful and general geometric method of attack first used by Poincaré.

Consider a particle P of given mass in rectilinear motion through a medium and in a field of force such that the force acting upon P is a function of its displacement and velocity. In order to achieve simplicity I will assume further that the law of force is of such a nature that, whatever be the initial conditions, the particle P will pass through a fixed point O infinitely often.

If P passes O with velocity v it passes O at a first later time with a velocity v_1 of opposite sign. We have then a continuous one-to-one functional relation $v_1 = f(v)$. If v is taken as a one-dimensional coordinate in a line, then the effect of the transformation $v_1 = f(v)$ is a species of qualitative "reflection" of the line about the point O.

If this "reflection" is repeated the resultant operation gives the velocity of P at the second passage of O, and so on. But the most elementary considerations show that either (1) the reflection thus repeated brings each point to its initial position, or (2) the line is broken up into an infinite set of pairs of intervals, one on each side of O, which are reflected into themselves, or (3) there is a finite set of such pairs of intervals, or (4) every point tends toward O (or away from it) under the double reflection.

Hence there are four corresponding types of systems that may arise. Either (1) every motion is periodic and O is a position of equilibrium, or (2) there is an infinite discrete set of periodic motions of increasing velocity and amplitude (counting the equilibrium position at O as the first) such that, in any other motion, P tends toward one of these periodic motions as time increases and toward an adjacent periodic motion in past time, or (3) there is a finite set of periodic motions of similar type such that, in any other motion, P behaves as just stated, if there be added a last periodic motion with "infinite velocity and amplitude" as a matter of convention, or (4) in every motion P oscillates with diminishing velocity and amplitude about O as time changes in one sense and with ever increasing velocity and amplitude as time changes in the opposite sense.

Here we have used the obvious fact that there is a one-to-one correspondence between velocity at O and maximum amplitude in the immediately following quarter swing.

This example illustrates the central rôle of periodic motions in dynamical problems. It is also easy to see in this particular example that the totality of motions has been completely characterized by these qualitative properties in a certain sense which we shall not attempt to elaborate.

What is the place of the developments reviewed above in theoretical dynamics?

The recent advances supplement in an important way the more physical, formal, and computational aspects of the science by providing a rigorous and qualitative background.

To deny a position of great importance to these results, because of a lack of emphasis upon the older aspects of the science would be as illogical as to deny the importance of the concept of the continuous number system merely because of the fact that in computation attention is confined to rational numbers.

GEORGE D. BIRKHOFF

SIR WILLIAM OSLER (1849–1919)

AFTER a tedious and painful illness, Sir William Osler, Regius professor of medicine at Oxford, died at his home in Norham Gardens on December 9, 1919. In spite of in-

termediate convalescence, a severe attack of bronchitis, due to exposure through attending a professional consultation, developed into a pneumonia with pleurisy and empyema, necessitating surgical drainage; and although he had been cheerful three days before his death, the end was gravely apprehended by those around him. He is survived by his widow, Lady Osler, and two brothers, his only son having been killed in the war.

Sir William Osler, the son of Rev. F. L. Osler of Falmouth, England, was born at Bond Head, Province of Ontario, Canada, on July 12, 1849. A medical graduate of McGill University (1872) with the customary post graduate study in the London clinics and German universities, he became lecturer and professor of the institutes of medicine at McGill in 1874 and easily rose, without stress or undue effort, to the top of his profession. In succession, he was professor of medicine at the University of Pennsylvania (1884–9) and the Johns Hopkins University (1889–1904), was appointed Regius professor of medicine at the University of Oxford in 1904 and received his baronetcy in 1911. On July 11, 1919, his seventieth birthday was honored by the presentation of two anniversary volumes made up of contributions by English and American colleagues.[1] Due to delays in printing, the completed volumes reached him only a few days before his death.

Of Osler's scientific work, it may be said that no great physician has been more firmly grounded in the fundamental disciplines of his calling. Of the arduous years of post-mortem work at Montreal the Pathological Reports of the Montreal General Hospital (1876–80) are a permanent record, as also the eight editions of the great text-book on Practice of Medicine (1892), which has been translated into French, German, Spanish and Chinese. The disciple of Morgagni and Virchow is equally apparent in the hundreds of clinical papers, the larger monographs in Osler's "Modern Medicine" (1907–10), the Gullstonian lectures on malignant endocarditis (1885), and the separate treatises on the cerebral palsies of children (1889), chorea (1894), abdominal tumors (1895), angina pectoris (1897), and cancer of the stomach (1900). From the start he did much original investigation of high quality. At the age of twenty-five (1874), he described the blood platelets associated with the name of Bizzozero, and defined their status as the third corpuscle of the blood and their relation to the formation of thrombi. Such early papers as those on the blood in pernicious anemia (1877), overstrain of the heart (1878), fusion of the semi-lunar valves (1880) reveal the born clinical and pathological observer. Osler was a profound student of all modes of aneurism, of tuberculosis, of typhoid fever, of disorders of the circulation. He was the first to emphasize the relation between mycotic aneurism and mycotic endocarditis, first described the ball-valve thrombus at the mitral orifice, the visceral complication of erythema multiforme (1895), chronic cyanosis with polycythemia, known as Vaquez' disease (1895), multiple telangiectasis (1901), the erythematous spots in malignant endocarditis (1908), and he discovered the parasite of verminous bronchitis in dogs (*filaria Osleri,* 1877). But to sense the magnitude of Osler's clinical work, it must be taken by and large in the 730 titles of the recently published Osler Bibliography (1919).

At the farewell banquet given him in New York in 1904, Osler said that he desired to be remembered in a single line: "He taught clinical medicine in the wards." He found his great opportunity when he became physician to the Johns Hopkins Hospital. During the six years intervening between the opening of the hospital (1889) and the beginning of undergraduate instruction in medicine (1893), Osler blocked out the arrangements for a graded whole-time upper resident staff of men of exceptional promise, a lower resident staff of one year internes, careful instruction in case-taking and clinical laboratory work for third year students and the appointment of fourth year students as "clinical clerks," in actual charge of patients in hospital, for three months each. The feeling of confidence and of personal responsibility acquired by these advantages was further strengthened by assigning advanced pupils to

[1] Science, September 12, 1919, p. 244.

teach extempore, to read and report on foreign literature, to cultivate the history of their profession. In his Saturday night meetings at his home in West Franklin Street, his aim with young students was to make good physicians of them, to make good men out of them, to teach them to think for themselves and to be themselves. As Dr. H. M. Thomas has said, Osler "put the students in the wards, but he did not leave them there; he stayed with them"; and he adds: "What good there is in me as a teacher and a physician I owe to him." This is the common sentiment, that he took his students with him into the upper reaches of their profession and the broad sunshine of actual life. Only Astley Cooper or Carl Ludwig could have produced such a train of loyal disciples; only Pasteur could have inspired such universal regard and affection.

Space permits but a passing reference to Osler's work on the history of medicine, to which, through his personal interest and his many unique contributions, he gave a greater impetus than any other; to his civic activities, his labors in behalf of medical libraries, his splendid service to his country in wartime. His great collection of original texts and documents relating to discoveries and advances in the science and art of medicine, the hobby of his later years, was all but completed as to items, but the big human touch which would have made its catalogue one of the unique things in medical bibliography could only have been given by Osler himself.

Essentially English in character, Osler had, through his forebears, Cornish and Spanish elements in his composition, easily sensed in the "hauntings of Celtism" in his ringing eloquent voice, the suggestion of the hidalgo in his slender, aristocratic figure, the clean-cut features and the tropical brown eyes. His was the longish head of the man of action, the active practitioner against disease and pain. Osler's warm glance and utter friendliness of manner told how naturally fond he was of people. He had the gift of making almost any one feel for the moment as if he were set apart as a valued particular friend, and so became, in effect, a kind of universal friend to patients, pupils and colleagues alike. But there was nothing of the politician in him. He rather paid with his person through the demands made by importunate patients and visitors upon his time. Such an effective concentration of the "fluid, attaching character" has seldom been found in a single personality, possessed, as it were, by the impartial, non-exclusive spirit of all pervading Nature, "which never was the friend of one,"

> But lit for all its generous sun,
> And lived itself, and made us live.

Many are the tales of the clever hoaxing and practical joking put over by Osler on his boon companions and professional fellows in his salad days, but the chaffing was carried on in such a jolly spirit that it left no sting behind. In his address on the male climacteric, delivered on the occasion of his retirement from the Johns Hopkins faculty, he found to his dismay that he had chaffed a whole nation. The hazards incurred by his chance reference to Trollope's fable about "chloroforming at sixty" have been set forth at undue length in the public press and even on the stage. But Osler's reasoning about the comparative uselessness of men at sixty, in the face of the imposing array of exceptions in Longfellow's "Morituri Salutamus," was obviously an expression of his essential preference for and innate sympathy with the oncoming race of younger people, whose worth he had sensed many times over in his beloved pupils.

The last two years of Sir William Osler's life were clouded by the death of his only son, Lieutenant Revere Osler, an artillery officer and a youth of great promise, who was killed in the action about Ypres in 1917. This he bore bravely, concealing his grief from his friends and busying himself with his own duties to the sick and wounded, but, the war at an end, his loneliness increased in spite of the companionship of his wife and his ever-generous hospitality to American officers and physicians. Toward the end, his intimates began to realize that he had "trod the upward and the downward slope" and was done with life. Up to that time he had remained cheer-

ful, buoyant, resilient, as if, like the beloved of the gods, he was predestined to die young. Yet the supreme test was nobly borne, and to many of his pupils and colleagues, who see in the death of this great, benignant physician, the loss of their best friend, the expressions of ancient belief will not seem unavailing: *Requiem æternam dona ei, Domine, et lux perpetua luceat ei.*

F. H. Garrison

Army Medical Museum

SCIENTIFIC EVENTS

A BOTANIC SCHOOL IN REGENT'S PARK

The report of the committee appointed last April by Lord Ernle, the former president of the British Board of Agriculture, to consider what steps should be taken to improve the usefulness of the Royal Botanic Society in London, is now published and an abstract is given in the London *Times*. The members of the committee, all of whom sign the report, were: Lieutenant-Colonel Sir David Prain, F.R.S., director of the Royal Botanic Gardens, Kew (chairman); Sir W. H. Dunn; Surgeon-General Sir A. Keogh, Imperial College of Science and Technology; Sir Malcolm Morris; Major R. C. Carr; Mr. Morton Evans, joint secretary of the Office of Woods; Mr. H. J. Greenwood, L.C.C.; and Professor F. W. Keeble, F.R.S., Board of Agriculture and Fisheries and Royal Horticultural Society; with Mr. G. C. Gough, B.Sc., secretary.

The society was incorporated in 1839, and was granted a lease of 18 acres in Regent's Park until 1870. This lease was renewed by the Commissioners of Woods and Forests in 1870, and in 1901 at an increased rental. The present lease terminates in 1932.

The committee have formed the opinion that the Royal Botanic Society could be made more useful both from the scientific and educational point of view by the establishment of: (1) A school of economic botany, at which a knowledge of the economic plants and their products including those of tropical regions, might be obtained; (2) an institute which might be made a center for research, more especially in plant physiology where the living plant is essential; (3) a center for teaching in horticulture, the students of which could receive their necessary training in pure science at existing London colleges; (4) courses in school gardening, at times suitable for teachers in elementary, continuation, and other schools. In addition, the committee consider that the gardens might extend their present utility as a center from which colleges and botany schools could be supplied with material for teaching and research, and in which students could make use of the existing facilities for the study of systematic botany.

In an appendix the committee deal with the financial side of the scheme. They consider that the suggestions need not entail, in their initial stages, any very great expenditure. Buildings should be of a temporary nature and of not more than two stories, and might be erected near the present greenhouses. After giving details of the laboratories and rooms required, the committee suggest that the staff should consist of the following:

A director at a salary of £800 to £1,000, able to cooperate with the teachers of botany in London, and with a knowledge of economic problems or of vegetable physiology. An assistant director, salary £500 to £700, to be appointed after the director. His knowledge should supplement that of the director—*e. g.*, if the former be an economic botanist the latter should be a physiological botanist. An assistant, salary £250 to £400, to act as curator of the museum and librarian, with a general knowledge of plant diseases. At least one of the officers should have a practical knowledge of the tropics, tropical plants, and their products.

The committee estimate the total cost of the staff, with attendants, etc., at £3,000 to £3,500 per annum; the cost of the buildings, £4,000; and the cost of equipment, including books, plants, etc., £500.

THE ATTITUDE OF GERMAN PHYSICIANS TOWARDS INHUMAN ACTION

It will be remembered that a protest signed by M. Calmette and four other members of scientific organizations who had remained at Lille during the occupation by the Germans,