diametrically opposite conclusions. A third faction in this particular dispute would claim that Newton's own explicit statement of what led him to his method, not known when the controversy was at its hottest, has abolished the topic of debate. Gregory now (p. 13) enters the lists as a competitor for the honor of having invented the differential calculus: "These notes are the silent but unerring witness giving Gregory the right to take his place with Barrow, Newton and Leibnitz as a principal discoverer of the differential calculus." This may be so; it is only for historians to decide. In the important detail of Gregory's claim to Taylor's theorem, it would seem that until positive evidence is discovered, and there appears to be but a slim chance of this after Professor Turnbull's painstaking search, the field for inconclusive speculation is wide open for all who care to cultivate it.

Passing to the second item, we note that Gregory's quality as a mathematician appears unmistakably in his conjectures (in modern terminology) that the numbers π and e are transcendental, and in his suspicion that not all equations are solvable by radicals.[2] Although he had been anticipated by Omar Khayyam and Fibonacci in conjectures of the second of these species, there appears to be no question that Gregory was original in his doubts. This is mathematics of a far higher order than mere algoristic ingenuity. Gregory's own attempts to implement his doubts were abortive, not being aimed in the right direction.

The third and last item of Gregory's mathematics to be noted here is his work in diophantine analysis. The evidence in this instance is fairly complete that Gregory was acquainted with the conclusions and at least some of the methods, including Fermat's of infinite descent, of his immediate predecessors and contemporaries. As to the quality of Gregory's work in this field, naturally it is in the pre-Lagrangian tradition, which prevailed from Diophantus to Euler, of ingenious devices, incomplete solutions, and disregard of existence theorems. It was not until nearly a century after Gregory's death that Lagrange inaugurated (1766–69) the civilized era in diophantine analysis with his complete discussion of the so-called Pellian equation (Fermat's equation). For the continued sane development of diophantine analysis, it can not be too strongly emphasized that the tradition of Diophantus, Gregory and Euler belongs to a memorable but buried past, and that Lagrange was the first to elevate the subject above haphazard ingenuity to a mathematical discipline. Still hopelessly in the Dark Ages of diophantine analysis, Gregory nowhere gives any indication that he had grasped the nature of the real problem in the subject, that of devising a non-tentative method for exhibiting all numbers, and only those, satisfying a given equation. Before Lagrange, Legendre and Gauss confined their efforts to single equations of degree not higher than the second, little bearing any resemblance to reputable mathematics was accomplished in diophantine analysis. The absurdly difficult problems attacked by Lagrange's contemporaries and predecessors, including Gregory, are a testimonial to lack of insight rather than to daring originality. Gregory's last (1675) and in some respects most individual venture, his problem of cubes, is in this venerable tradition of ingenuity without insight.[3]

This meagre sample of Gregory's impressive work in mathematics must suffice here. For a vivid picture of the man himself, and of his equally notable achievements in other departments of mathematics and in the science of his times, we must refer to Professor Turnbull's full and documented account. We have tried only to suggest that this extremely interesting volume may supply historians of mathematics with much new fuel for their interminable controversies. Whether such disputes as are likely to be engendered by critical evaluations of Gregory's claims add anything worth having to human knowledge, is a matter of opinion. Whatever the final verdict is to be, it seems likely that James Gregory will remain as he is portrayed in this book, a mathematician whose reputation might have overshadowed that of many others who have long since passed into the traditional history of mathematics, had fortune been only a little kinder to him.

E. T. BELL

CALIFORNIA INSTITUTE OF TECHNOLOGY

REPORTS

SUMMER CONFERENCES AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A SUMMER program of technical conferences and courses on research and practice on the frontiers of science and engineering has been announced by Professor Raymond D. Douglass, chairman of the summer session of the Massachusetts Institute of Technology. This program, which supplements the regu-

[2] There seems to be a slight confusion on p. 383, where it is stated that Tschirnhausen solved (1683) the quintic and sextic algebraically "when the second and third highest terms were absent," although the following sentence states (correctly) that "Abel demonstrated the impossibility of such a solution, in general, for the quintic and higher equations."

[3] Contrary to the statement in p. 435, it has not been proved that the problem is impossible. In addition to the cited note by Fauquembergue, the remarks by Tannery on the page following the note should be consulted. Fauquembergue's attempted proof of impossibility is unsound.

lar summer courses for undergraduate and graduate students, will include four important conferences and thirteen special advanced courses.

In announcing the program, Professor Douglass said that the conferences and special courses are planned primarily to meet the requirements of graduate engineers who wish to be brought up-to-date in the scientific and technical background of their professions. "This is particularly important," he added, "in the constantly broadening fields of physics, chemistry, metallurgy, mechanical engineering and food technology in which the engineer now feels the need of post-industrial courses in which significant technical information, carefully selected from the rapidly accumulating mass of scientific knowledge, is evaluated by the standards of sound engineering practice."

A conference on "Friction and Surface Finish" will be held from June 5 to 7 under the direction of Dr. Jerome C. Hunsaker, head of the department of mechanical engineering. This conference will bring together physicists, chemists, metallurgists, oil technologists and designing and producing engineers in a study of problems concerning boundary lubrication, the critical and illusive phenomenon of friction which occurs just before failure. Associated with Dr. Hunsaker in conducting the conference will be Dr. Robert B. Williams, head of the department of metallurgy, and Dr. John Wulff, of the same department, and Professor John H. Lessells, of the department of mechanical engineering.

The eighth International Conference on Spectroscopy will be held from July 15 to 17. The program includes discussion of the spectroscopic analysis of materials and other applications of spectroscopy to biology, medicine, chemistry, metallurgy, mineralogy and industrial and engineering problems. The conferences will be directed by Dr. George R. Harrison of the department of physics.

The solution of complex scientific and engineering mathematical problems with the aid of the differential analyzer of the institute will be the subject of a conference on the "Center of Analysis," which is to be held under the direction of Dr. Samuel H. Caldwell from July 8 to 12. The differential analyzer, now recognized as the outstanding means of solving ordinary differential equations, offers scientific workers the opportunity to familiarize themselves with the design and operating characteristics of the machine.

Powder metallurgy will be discussed in a late summer conference from August 29 to 31. This conference will bring to the institute a group interested in the fundamental scientific and engineering problems of powder metallurgy, as well as the present state of industrial application and possible future developments and research which are necessary to advance this significant process. The conference will be under the leadership of Dr. John Wulff, who is a recognized authority in this field.

Special summer courses will include spectroscopy and its applications, which will be given from June 1 to August 1, under the direction of Dr. Harrison. Courses in general bacteriology and public health bacteriology, directed by Dr. Cecil G. Dunn and Dr. John W. Williams, of the department of biology and public health, will be offered to public health workers, as well as to students, teachers and technicians in the various fields of public health. The course on general bacteriology will be given from June 10 to 28 and that on public health bacteriology from July 1 to 19.

Dr. Ernst A. Hauser will continue his summer course on theoretical and applied physics and physics of matter in the colloidal state from June 17 to June 20.

A summer program in public health, school health, and health education leading to the certificate in public health, will begin this summer under the auspices of the department of biology and public health under the direction of Dr. Clair E. Turner. The program will cover four years in summer courses. The staff will include Dr. John W. Williams and Dr. Murray P. Herwood, and the course will be given from July 1 to August 21.

There will also be a summer program in food technology from July 1 to July 19, under the direction of Dr. Bernard E. Proctor. The course will meet the demand for advanced knowledge on the basic sciences pertaining to food and technical processes of production, manufacture, storage and distribution.

Professor Frederick H. Norton, of the department of metallurgy, will lead a summer conference on ceramics, dealing with ceramic molding processes. This conference, which will be held from July 8 to 13, will consider problems in methods of forming clay wares, a field in which there have been a number of recent developments of special interest.

Professor John T. Rule, chairman of the section of engineering drawing and descriptive geometry, will be in charge of a course on graphics for teachers of mechanical drawing, which is to be given from July 8 to August 16.

The division of city planning will offer a course on the principles and techniques, legislation and administration in city planning from July 8 to 26, under the direction of Professor Frederick J. Adams.

The well-established summer course on principles of textile analysis will again be given this summer by Professor Edward R. Schwarz from July 22 to August 30. Photoelasticity, a new summer course, will be given from July 22 to August 2, under the direction of Dr. William M. Murray, of the depart-

ment of mechanical engineering. The course is designed to meet the need for instruction in this method of stress analysis and is expected to be of value to industrial research workers interested in the development of photoelasticity laboratories.

Professor Ralph E. Freeman, head of the department of economics and social sciences, and Professor George F. Wadsworth, of the department of mathematics, will give a joint course on statistical methods from September 4 to September 14.

Graduate courses in chemistry will be offered from June 10 to August 2. This program is in charge of Professor Leicester F. Hamilton, of the department of chemistry.

THE NATIONAL ACADEMY OF SCIENCES

ABSTRACTS OF PAPERS

(*Continued from p. 423*)

Upward movement of salt in the plant, with special reference to metabolic activities of roots: D. R. HOAGLAND, T. C. BROYER and P. R. STOUT. Previous investigation has proved that accumulation of salt by the plant from the nutrient medium depends on aerobic metabolism of root cells. The relation of root activities in salt accumulation to movement of salt to the shoot has now been studied from several points of view. For certain purposes it has been necessary to conduct experiments over short periods of time with tracer elements, not initially present in the plant. Bromide ions and salts of the radioactive isotopes of Br, Na, P and K have been utilized. One of the authors (P. R. Stout) has developed technique for showing in graphic manner the general distribution of radioactivity in the plant by effects produced on x-ray films. Several general cases of salt movement are recognized: (a) under influence of root pressure, (b) as affected by transpiration, (c) movement under conditions conducive to root injury produced by high salt (*e.g.*, NaCl) concentrations. Xylem exudates may very rapidly build up concentrations of salt much higher than those of the external solution. This may occur even before the roots have attained their maximum capacity for salt accumulation. The phenomenon is related to oxygen supply to roots, concentrations and kind of salt supplied, and indirectly to photosynthesis. Soluble organic nitrogen compounds and organic acid can also move in the exudate dependent on metabolic activities of the root and nature of salt supplied. The effects of $KHCO_3$ are particularly interesting in connection with organic acid metabolism. Young active barley plants may absorb and translocate nutrient ions almost as readily in the dark as in the light, over brief experimental periods. Such plants may grow normally for some time with nutrients supplied only during the diurnal dark periods. With large plants, or those less capable of developing root pressure, rapid upward movement of salt depends on transpiration which may thus indirectly influence absorption of salt by the root. Further evidence was obtained on the path and rate of upward and downward movement of PO_4 by the use of radioactive phosphorus.

Mutations and reversions in reproductivity of Aspergilli with nitrite, colchicine and d-lysine: CHARLES THOM and ROBERT A. STEINBERG. Injury mutants showing loss in reproductive capacity have been obtained thus far with eight species of Aspergilli through the use of nitrite. The interpretation of amino group destruction in proteins of the genetic mechanism is rendered more probable by similar positive results obtained with ninhydrin, chloramin-T, hydriodic acid and hexamethylenamine (formin). Somewhat similar mutants were obtained with colchicine with *Aspergillus nidulans, A. fischeri, A. flavus, A. alliaceus,* and *A. fumigatus. A. variecolor, A. amstelodami* and *A. niger* presumably required higher concentrations of colchicine. Use of excess calcium carbonate to prevent hydrolysis of colchicine to colchicein was found necessary for positive results, though the metabolic effect of neutrality may also be a contributary factor. Partially successful attempts based on theoretical chemical considerations have been made to reintroduce amino groups assumed to have been destroyed by the action of nitrite through the use of high concentrations of d-lysine, and of reducing agents (sodium thiosulfate) in neutral solution. Mutations showing partial to full reversion in reproductivity were obtained with *A. amstelodami* and *A. niger.*

The soil as a source of microorganisms antagonistic to disease-producing bacteria: SELMAN A. WAKSMAN and H. BOYD WOODRUFF (introduced by Charles Thom). Fresh field and garden soils contain a large number of microorganisms which are antagonistic to disease-producing bacteria. When these bacteria are introduced into the soil, as in the excreta of patients suffering from various diseases, as well as in the dead bodies of men and animals, they are rapidly destroyed by the corresponding antagonists. As a result of this, the soil can hardly be considered as a source of epidemics and as a carrier of the more common infectious diseases. A special method was developed for demonstrating the presence and abundance of antagonistic microbes, based upon the use of living bacteria as the sole nutrient. It was established by means of this method that the introduction of large numbers of disease-producing bacteria into the soil leads to their rapid disappearance and is accompanied by a rapid multiplication of antagonists. Particular attention was paid to certain gram-negative bacteria, especially members of the coli-aerogenes group and *Brucella abortus.* Two specific bacteria and several actinomycetes were isolated from the soil and shown to possess the property of antagonizing these gram-negative bacteria, as well as various gram-positive forms. By the use of three bacteria of varying degrees of sensitivity (*Sarcina lutea, Bacillus mycoides* and *Escherichia coli*) as standards of measurement of inhibition, it was found that the active substance