SCIENCE NEWS

Science Service, Washington, D. C.

EXTENSION OF EINSTEIN'S THEORY OF RELATIVITY

By Watson Davis

Director, Science Service

More precise in defining the fundamental law of the universe than even Einstein's general theory of relativity, Professor Tullio Levi-Civita, professor of mathematical physics at the University of Rome, on September 4 announced at the Harvard Tercentenary Celebration new relativistic formulae that apply to two bodies instead of just one as in the case with those of Einstein.

Hailed as an important contribution to the understanding of the motion of heavenly bodies, the new work may herald an advance of somewhat the same character as occurred as the result of the Einstein era of astronomy and physics that began shortly after the World War.

Previous verifications of the general theory of relativity dealt only with gravitational fields due to a single body. In the classic case of the advance of the perihelion of the planet Mercury, Einstein considered the field as due to the sun alone, an approximation which is legitimate owing to the smallness of the ratio of the mass of the planet to that of the sun. But Professor Levi-Civita now considers the corresponding problem for two bodies of comparable mass as for instance two suns or stars whirling around each other.

His equations show that it is possible to visualize the force exerted as consisting of two parts, one an attraction that acts the way Newton assumed and the other an Einsteinian perturbation. These two together produce an advance of perihelion. This is not so surprising, but it is strange that the center of gravity of the motion wobbles slightly instead of being at rest or moving uniformly in a straight line.

Einstein's sensational prediction of the advance of Mercury's perihelion which brought his general theory of relativity into prominence was tested by direct observation. The revision of the Einstein theory that Professor Levi-Civita suggested can not be tested upon the planet Mercury with quite so much ease, but he does expect that astronomers will test it by observations upon double stars which are gigantic systems of twin suns seen as one spot of light in telescopes, but capable of being disentangled by their spectra or "rainbows" of light.

Professor Levi-Civita's solution of the relativistic problem of several bodies will probably be the focus of mathematical and astronomical work for several years to come. The expounder of this new relativistic view is no novice in mathematical physics. He has been a leader in hydrodynamics, theoretical dynamics and pure geometry. His contribution to the theory of absolute differential calculus is credited with helping to lay the foundation for the general theory of gravitational relativity of Einstein.

THE COSMICAL CONSTANT AND THE RECESSION OF THE NEBULAE

In his own characteristic way Sir Arthur Eddington, noted British astronomer of the University of Cambridge, mildly chided both the relativity theory and the quantum theory for artificiality in his address at the Tercentenary Celebration of Harvard University.

Speaking on "The Cosmical Constant and the Recession of the Nebulae," Sir Arthur set up a simple ideal problem in cosmology and attempted to solve it by mathematical attack on the large, or macroscopic scale through relativity and also on the small or microscopic scale through quantum theory.

His intent in doing this, he indicated, was to find some link in meaning between the important constants "K" of gravitation and the cosmical constant "lambda" in the relativity theory, and the equally important constants of quantum theory—Planck's constant "h" and the other microscopic constants.

The two answers to his hypothetical problem linking relativity and quantum theory, he said, must agree and should disclose hitherto unrecognized relations between the mutual constants. Both quantum theory and relativity theory have inherent artificialities which make the problem difficult. For example, Sir Arthur said, "We had to catechize the quantum physicist, who writes down a wave equation for two or three particles, as to what he had done with the rest of the universe. Similarly when the cosmologist treats the curvature of a vacuum (in relativity theory) we have to ask what he has done with the particles removed."

The ideal problem he proposed for solution is to find the state of equilibrium of a radiationless, self-contained system of a very large number of particles, both positive and negative. The first step is to obtain the projection of the spherical Einstein universe into a flat space. A spherical space of uniform density throughout, he disclosed, becomes, after projection, a flat sheet with a density distribution concentrated toward the center and fading off to zero at infinity. This distribution resembles the distribution of electron density in the atom of the physicist.

Without following the details of Sir Arthur's mathematics it can be explained that he arrives at a value for the number of particles in his idealized universe problem which he calls a "deputy cosmical constant." To distinguish it from the important cosmical constant lambda, he calls it the "cosmical number." "I feel satisfied," he said, "that the cosmical number is precisely $2.136.2^{256}$." The number of particles in this Eddington universe would be 2 multiplied by itself 255 times and then multiplied by 272.

From his mathematics Sir Arthur was also able to calculate the limiting maximum speed of recession of the

distant nebulae which checks fairly well with observed measurements on the expansion of the universe. The limiting speed, he said, is 432 kilometers per second per megaparsec. The first part, 432 kilometers per second is, of course, a velocity amounting to 268 miles a second, or 964,800 miles an hour. A parsec is an astronomical unit of distance equal to 3.26 light years or about 20,000,000,-000,000 miles. And a megaparsec is a million parsecs. Therefore, for every 20,000,000,000,000,000,000 miles one goes out into space the velocity of recession of the nebulae increases by 964,800 miles an hour.

ADDITIVE NUMBER THEORY
By Watson Davis
Director of Science Service

Hailed as one of the greatest recent advances in the science of numbers, Professor Leonard Eugene Dickson, of the University of Chicago, presented to the Harvard Tercentenary Celebration the first rigorous proof of an extension of one of the problems that has wrinkled the brows of mathematicians since the middle ages.

Ranking with the famous and impossible trisection of the angle as a brain puzzler, the task Professor Dickson set himself and solved is what is called "additive number theory" or "Waring problem."

In its simplest form, the one that was discussed during the middle ages, the problem concerns the fact that every whole number is either an exact square or the sum of two, three or four squares. By a coincidence, the famous mathematician Fermat in 1636—the year of the founding of Harvard University which is now being celebrated—first discovered the general theorem.

Many of the best brains in the world have set themselves the task of working out the rules, formulae and proofs, and as early as 1772, a mathematician named Euler—son of a more celebrated mathematician—worked out the formulae for any power.

Amateur mathematicians may wish to ponder over it. Here it is. To express any number as the sum of two other numbers raised to any selected power, for convenience designated mathematically by the small number n, the maximum number needed of numbers so raised to the selected power is found by raising two to the selected power, subtracting two and then adding the fraction three over two raised to the selected power, discarding the decimal fraction.

For squares the answer is four, for cubes it is nine, and for fourth powers it is 19, for fifth powers it is 37, and so on. Mathematicians know and have confidence in this rule, but it had never been rigorously proved for any but squares and cubes. Professor Dickson's achievement is to prove it rigorously for all powers from the seventh power to infinity powers. How did he do it? He did not even try to tell in the one lecture he gave. He explained that it would take 120 lectures to mathematically-trained listeners to give full proof.

There are still three powers in additive number theory that have not yet been conquered, the fourth, fifth and sixth powers. Professor Dickson expects to work out the proof of these also.

Professor Dickson glories somewhat in the impracticality of this particular branch of mathematics. It has been useful in the mathematics of the new quantum theory of physics, wave mechanics, and so on. But it hardly is useful as yet to practical chemists, physicists and engineers who apply science to every-day life. That does not mean that it will not be useful in the future.

Going back to the formula for a minute, Professor Dickson on the back of an envelope worked out the maximum number of terms in a series of seventh powers that will add up to any number. It was 143.

EFFECT OF PITUITARY GLANDS ON MAN'S BEHAVIOR

Dr. James Bertram Collip, professor of biochemistry at McGill University, reported at the Harvard Tercentenary Celebration, on September 7, that the small pituitary gland in the head has more to do with man's behavior than any of the other glands.

All the glands have an important influence on behavior, but the pituitary, because of the way it affects each of the other glands and various other organs of the body, has the greatest effect. Dr. Collip explained how the glands and nervous system work together in man and higher animals. The glands themselves are influenced by the nervous system, but the chemicals they produce, known as hormones, may in turn affect the nervous system.

Scientific knowledge of the glands shows how widespread their influence on behavior is, but it does not justify some of the "fantastic" claims that have been made. Dr. Collip warned his hearers against overlooking basic principles in interpreting behavior on glandular grounds.

As an example of the way in which the pituitary gland affects behavior, Dr. Collip cited the case of a wolf-hound puppy studied in his laboratory. Soon after removal of this animal's pituitary gland, it was noted that the puppy, although belonging to a naturally aggressive stock, became extremely timid and stupid in his behavior, which was entirely different from that of a normal wolf-hound puppy. A few days after treatment with anterior pituitary extract, the animal's behavior changed markedly again, so that he became much more like the normal puppy of his breed. The change was so apparent that a worker in the laboratory, unaware that treatment had been started, commented on the unusual activity of the puppy and asked if anything had been done which might account for it.

Even more dramatic was the case Dr. Collip cited to show how more than one set of glands may similarly affect body mechanisms and behavior. This was the case of a man who had diabetes and was having insulin treatment. In this condition it sometimes happens that too much insulin has been given, or not enough carbohydrate food is eaten. The patient then suffers from too little sugar in his blood, has convulsions and will become unconscious unless given some sugar or other carbohydrate at once.

The patient Dr. Collip described was walking down the street one day when he felt such an attack coming on and realized that he had forgotten to provide himself with a chocolate bar for the emergency. He went at once to a

drug store and tried to explain to the druggist what he wanted. But by that time his gait was unsteady and his speech incoherent. The druggist thought he was a drunken man and threw him into the street. The patient became enraged at this treatment, promptly recovered, and was able to proceed to another drug store where he made known his wants, obtained what he needed and continued on his way.

In this case, Dr. Collip explained, another set of glands, the adrenals, became activated by anger and released enough of their hormone, adrenalin, to cause an increase of the patient's blood sugar sufficient to restore his equilibrium and powers of speech. The insulin-producing islets of Langerhans in the pancreas are the glands primarily concerned with control of the body's use of sugar, but the case of this patient shows how the adrenalin glands also may affect sugar utilization and also behavior.

THE BRAIN AND HUMAN BEHAVIOR

IF man's life is ever to be lived along entirely rational lines, free from such disturbances as war, crime and economic booms and depressions, he will have to find a way of increasing the size of his brain.

This is the conclusion to be drawn from what Professor Edgar Douglas Adrian, of the University of Cambridge, Nobel laureate and one of the pioneers in "brain wave" investigations, reported at the Harvard Tercentenary Celebration concerning the relation between the nervous system and human behavior.

Scientific investigations into the mechanism of the mind and body, by "brain waves" and other techniques, show that the only certain method by which human behavior can be improved is the apparently impossible feat of breeding men with larger brains.

"It is tantalizing," Professor Adrian said, "to think of the new relations we should see, of the new world of thought we should live in, if our brains were but twice their present size. Our behavior would then be superhuman!" Not even the most fanciful mind, given to picturing a race of supermen in a world to come, could conceive of the result, which Professor Adrian described as "beyond the power of human thought."

It is unlikely, he said, that neurology, the study of the brain and nervous system, will give new methods of control over human behavior, though it will certainly improve some of the methods that already exist, such as the control of behavior by drugs. The new narcotics which "give peace of mind before a surgical operation" show what may be expected in the future from this method of regulating our brains and controlling our behavior.

Studies of the electrical activity that accompanies brain activity, the so-called brain waves, may show what takes place in the brain during the learning process, when new associations are formed in the brain, and why an incentive of an emotional sort is necessary to this process. There are definite changes in the electrical activity of different regions, Professor Adrian pointed out, when we direct our attention from the visual field to the auditory, and vice versa. These are not beyond analysis and ten or even twenty years from now he believes that much more about the nerve changes that take place during certain mental processes will be known. The nerve mechanism of consciousness itself, however, will perhaps never be discovered.

ITEMS

FROM excavations in the Aleutian Islands this summer, Dr. Hrdlička is convinced that these islands that swing out from Alaska toward Asia were once thickly inhabited. They contain hundreds of sites, many of them pre-Russian. And in the days when America was being populated by its original "natives," these Aleutian Islands were probably a secondary highway which carried wanderers into this continent. Bering Strait, farther north, has long been recognized as the primary highway of the ancient migration, but the Aleutian Islands have heretofore been considered a mere side-track into which some groups drifted from the Alaskan side.

MORE than thirty settlements of human beings dating from the Stone Age, or about the year 3000 B. C., have been unearthed in Swedish Lapland by Kurt Tinnberg, of Stockholm. In a few months he has gathered some 3,000 flint tools, weapons and utensils, said to be the most northerly ever found in Sweden. According to Mr. Tinnberg, researches show that the climate of Scandinavia in those distant days was warmer than now. To support his theory he points to recent finds indicating that grapes grew wild in Sweden more than 4,000 years ago.

CHILDREN brought to the General Hospital in Cincinnati when suffering from painful burns and scalds soon are made to laugh and temporarily forget their injuries in the new burn-treatment room recently opened. Swifter and easier emergency treatment in the crucial initial stages of burns is the result. Animal cut-outs of fairyland characters dot the walls. Tubs for bathing the children with soothing liquids are in brilliant colors as are the tile floors. A huge electric kaleidoscope flashes hundreds of colored designs on the walls. Dr. H. Jerry Lavender, of the hospital staff, designed the so-called "fun room," which is working out successfully.

FOREIGN-BORN persons in New York State are no more subject to mental disease than are native Americans, if allowance is made for difference in age and environment. Dr. Benjamin Malzberg, of the New York State Department of Mental Hygiene, in the *American Journal of Psychiatry*, reports that although the average annual rates of first admissions to mental hospitals seem to indicate that the cases of mental disease among foreign-born are twice as numerous as among native Americans, these figures are misleading. The foreign-born are older, on the average, than the natives and consequently have had more chance to develop mental disease. They are also more concentrated in cities, where mental disease, or at least hospitalization for it, is more common.

A SCIENCE NEWS note in SCIENCE for August 14 called attention to the broadcast of musical pitch which has been sent out by the Bureau of Standards for the past two weeks. There was, however, an error in that it is not a 400 cycle note that is being broadcast but a 440 cycle note.