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SELECTED ESSAYS FOR 1965

Ellsworth, Harold D. and Suppers, Donald L. ON THE NATURE OF PARTICLES AND FIELDS WITH SPECIAL REFERENCE TO GRAVITY AND ANTIGRAVITY.

The purpose of this paper is to present one simple hypothesis from which a coherent concept of "space", matter, and energy may be derived, and to demonstrate its validity by some derivations which are in accord with observation and logic.

This hypothesis has been arrived at by a rigorous application of Ockham's Razor to the extensive complex of physical theories. That which survives appears sufficient to provide an explanation, in spatio-temporal terms, of many aspects of the physical world, including the nature and behavior of gravity and inertia, the necessity for and identity of antimass, and the process of creation and destruction of matter, etc.

Only a limited number of topics are considered herein, and only in a summarized form. The brief treatment may serve, however, to indicate the usefulness of this approach to a more satisfactory view of the physical world.

Forward, Robert L., Bell, Curtis C. and Morris, Roger
ROTATING GRAVITATIONAL SENSORS.

We have been investigating a novel class of gravitation sensor which utilizes the rotational properties of tensors in order to separate the effects of forces from the effects of the gradients of the forces. These sensors are theoretically capable of distinguishing the gravitational effects of a nearby mass from the inertial effects of acceleration and rotation. The basic concept is that tensors of the nth rank, when examined in the rotating reference frame of a sensor, will be found to produce time-varying signals that are at n times the rotational frequency of the sensor. Work has been started on a research model of a gravitational mass sensor. The program objective is a sensor that will detect the presence of a small, nearby moving mass through gravitational interactions. The ultimate objective of our effort on gravitational mass sensors is the development of a small, lightweight, rugged sensor to be used on lunar orbiters to measure the mass distribution of the moon and on deep space probes to measure the mass of the asteroids.

Gilpin, Michael GRAVITATIONAL RADIATION FROM STAR CLUSTERS.

Using linearized gravity theory the gravitational radiation for a "Collision" or hyperbolic interaction between two stars is calculated in terms of certain collision parameters. It is then shown that collisions of this type are responsible for gravitational radiation generated by a globular cluster. Then a method for determining the number and intensity of such collisions in a globular cluster is found. This allows us to find an average power for the gravitational waves generated by a globular cluster.

Greenberger, Daniel M. EQUIVALENCE AND THE UNCERTAINTY PRINCIPLE.

It is shown that if scale (the standard of length or time) is taken seriously as a dynamical feature of a physical coordinate system, then scale and mass satisfy an uncertainty principle. The special role of the equivalence principle is to make the classical concepts of gravitational fields and electromagnetic fields complimentary, in the sense that one can determine masses exactly in an electromagnetic field, but can say nothing about scale, while a gravitational field determines a scale exactly, but cannot be used to measure masses.

Hawking, S. W. THE GRAVITATIONAL COLLAPSE OF THE UNIVERSE.

It is shown that if gravity is always attractive and if the Universe obeys the Copernican Principle, that it is spacially homogenious, there must be a singularity where the density is infinite either in the future or in the past. If, as seems to be the case, the singularity is in the past, this implies that the Universe had a beginning.

Hsu, Lee ON THE FUNDAMENTAL STRUCTURE OF GRAVITATION THEORY.

We examined the basic theoretical structures for gravitation and electromagnetism. In doing that we raised the question whether the disparate treatment of the two, in terms of second order tensor and vector respectively, is in accord with the physical situation.

In giving the example of the difficulties that substantiates our doubt we did the 3-fold thing: (1) Introduced a new way for deriving quantum mechanical equations starting from unitarity. (2) Introduced a reasonable quantum gravity from a particle point of view. (3) Arrived at the example.

We believe in practicality one must be broad-minded besides applying an uncritical extension of general relativity.

Just, Kurt MULTI-BARYONS AND VERY MASSIVE STARS.

The Oppenheimer limit on the mass of a cold star can be exceeded by models in which a small core of steeply decreasing density is surrounded by a large envelope of "ordinary" matter. Such models agree with Einstein's theory of gravity if matter under high pressure consists of heavy particles, formed from baryons by many-body forces and here called multi-baryons. A gravitational collapse, forcing us to abandon the law of baryon conservation, is thus avoided.

Kiehn, R. M. GRAVITATION AND CORRELATIONS.

A statistical concept of the gravitational field is postulated by the statement: "The universe behaves like a real gas near the critical point." Such a concept advances arguments for why the night sky is granular, and why the gravitational force is inverse or squared. A geometrical approach to the idea of statistical correlations of the gravitational and electromagnetic fields may lead to a more fruitful experimental approach, and a better understanding of gravity.

Lipkin, Daniel M. ESSAY ON THE PRODUCTION AND PERVASIVENESS OF NONPERMANENT GRAVITATIONAL FIELDS.

On the basis of existing principles of physics, any mechanical action that imparts an observable net momentum to an observer can be regarded by him as the source of a transient gravitational field of large magnitude whose region of influence expands radially away from him at a speed not exceeding that of light. The creation of large nonpermanent gravitational fields may therefore be argued to be such a commonplace thing that it has heretofore escaped attention, due largely to the tacit standardization of the ground or earth as a frame of reference in ordinary speech.

Martin, R. Chris GRAVITY PREFERENCE.

The studies reported here are part of a program of investigation of the effects of gravity upon behavior. Based upon the assumption that prolonged periods of weightlessness, which might be encountered on space flights, are harmful both physically and mentally and that man will prefer to have some level of artificial gravity, the questions under investigation are: (a) what level of gravity do organisms prefer? (b) can this preference be modified? and (c) how well can organisms discriminate between gravity levels? Results of some of these studies and plans for orbital flights for gathering data are outlined.

Pirani, Felix CONFORMAL TRANSFORMATION A POWERFUL TECHNIQUE FOR THE EXPLORATION OF GRAVITATIONAL FIELDS.

The power and versatility of conformal transformation techniques in gravitation theory is pointed out, and reasons for their significance are suggested. This significance arises, physically, from the conformal invariance of zero mass free fields and appears, mathematically, in the invariance of null cones and null geodesics. Some examples, including optical experiments and the diffusion problems are discussed briefly, and prospects for the future are suggested.

Prakash, Anand GRAVITY, ELEMENTARY PARTICLES, AND THE UNIVERSE.

Gravity has played a leading role in the development of physics. In this essay we show how an understanding of what gravity is provides a possible simultaneous solution of the two most baffling problems of modern physics-- the discovery of the existence of $K^0_2 \to 2\pi$ decay and the discovery of the quasi-stellar radio sources. (Quasars).

Roman, P. and Aghassi, J. J. FIELD THEORY OF GRAVITATION IN A DE SITTER WORLD.

A non-geometrical field theory of gravitation, defined with respect to a rigid de Sitter background, is proposed. Gravitation is introduced by a Yang-Mills type non-Abelian gauge principle, where the gauge group is that of de Sitter transformations with coordinate dependent parameters. The compensating field turns out to be a de Sitter tensor of rank four with two pairs of antisymmetric indices. The local limit and the overall features of the theory are outlined.

Roxburgh, Ian W. THE EFFECT OF ROTATION ON THE GRAVITATIONAL INSTABILITY OF VERY MASSIVE STELLAR OBJECTS.

The theoretical investigations of Hoyle and Fowler on the structure of very massive star-like objects gave a possible means of explaining the large energy sources in the so-called quasi-stellar radio sources. It was then shown that such an object would become gravitationally unstable long before the object has contracted sufficiently to form a massive star, so that Hoyle and Fowler's analysis was not revelant. This instability arises from the fact that general relativistic effects become important at an early stage, due to the canceling of classical effects. In this essay we show that the conclusion that the star becomes unstable is a result of the assumption that the star is spherical, when one includes the effects of non-sphericity, caused by the object's rotation about itself, then a massive star can exist for a sufficiently long time before becoming gravitationally unstable to explain the emission from the quasars.

Sciama, D. W. A RIGOROUS FORMULATION OF MACH'S PRINCIPLE IN GENERAL RELATIVITY.

According to Einstein's interpretation of Mach's principle the g_{ij} (metric) field of general relativity should be entirely determined by the distribution of energy and momentum (T_{ij}) in the universe. This requires the introduction of suitable boundary conditions, since Einstein's field equations are differential equations. In this essay, we introduce such boundary conditions by expressing the g_{ij} field in terms of the T_{ij} field by means of a Green's function despite the non-linearity of Einstein's equations. The non-linearity is here expressed by the fact that Green's function itself depends on g_{ij}. This means that we have an integral equation for g_{ij}.. Since the Green's function does not in general vanish within the light cone, our integral equation will be difficult to solve. Nevertheless solutions of Einstein's field equations, such as Minkowski space, are not consistent with the integral equation.

Silk, Joseph LOCAL IRREGULARITIES IN A GÖDEL UNIVERSE, AND MACH'S PRINCIPLE.

The effects of local irregularities on the equations of motion for a test particle in a Godel universe are considered by use of Einstein's field equations of gravitation. This investigation leads to a verification of the relationship, often referred to as Mach's principle, between the kinematical and gravitational properties of matter.

Surdin, Maurice ELECTROMAGNETISM, GRAVITATION AND MACH'S PRINCIPLE.

A model, satisfying Mach's Principle, is advanced, in which gravitational forces are accounted for by random electromagnetic fields.

Using this model a numerical value for the gravitational constant is calculated, which is in good agreement with the value generally adopted.

An expression giving the magnetic field created by rotating massive bodies is obtained, which agrees with Blackett's empirical formula.

Wang, Chi-yuen ORIGIN OF THE UNDULATIONS ON THE EARTH'S SATELLITE GRAVITATIONAL POTENTIAL.

The negative correlation coefficient, -0.82 between Izsak's (1963b) satellite geoid and Lee and MacDonald's 1964 heat-flow distribution suggests a correlation between the geoidal undulations and the highs and lows of heat flow, in the sense that depressions on the geoid correlate with regions of high heat flow while rises on the geoid correlate with regions of low heat flow.