$$\gamma + Z \to (f, A_2, f') + Z \qquad (3)$$

The spin structure of the amplitudes of reactions (2) reduces to five invariants in the general case and to 20 invariants for a nucleon target, but in the small production-angle region, only one invariant is left, by virtue of helicity conservation. In the system where the meson is at rest, the amplitude of reaction (3) is proportional to $\phi_{ab}\, \ell_a k_b$, where ϕ_{ab} is the wave function of the tensor meson, and ℓ_a and k_b are the photon polarization and momentum vectors. The reaction (3) proceeds via exchange of states with ω-meson quantum numbers. In the region of small Θ_0, we have $d\sigma/d\Omega \sim$ const and $d\sigma/dt \sim E^{(2\alpha_\omega - 1)}$ for small t and for $E \to \infty$, in accord with the Regge-pole model. The angular distribution of the pions from the $f \to 2\pi$ decay is given by $dW \sim \cos^2\Theta \sin^2\Theta\, d\Omega$, where Θ is the angle between the momenta of the photon and one of the pions. A similar distribution is obtained for the decays $A_2 \to \bar{K}K$ and $\eta\pi$ and $f \to \bar{K}K$. In the main decay $A_2 \to \rho\pi$ we get $dW \sim \cos^2\Theta\, (1 + \cos^2\Theta) d\Omega$. We see thus that in coherent photoproduction of boson resonances on nuclei, the picture of the angular distribution is much simpler than in photoproduction on nucleons. This gives grounds for hoping that such processes can be separated experimentally, and by the same token that the energy dependence of the amplitudes of reactions with f and ω-meson quantum numbers can be investigated at high energies. We regard the latter as rather important for checking and determining the limits of applicability of the Regge many-pole model [4].

The authors are grateful to K. A. Ter-Martirosyan for fruitful discussions.

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THE STRUCTURE OF THE GRAVITATIONAL LAGRANGIAN

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Submitted 13 May 1967
ZhETF Pis'ma 6, No. 2, 531-533 (15 July 1967)

It can be asserted at present that the motion of Mercury contradicts Einstein's equations. This is the result of the quadrupole increment

$$\delta\phi = \frac{1}{2}\, Gmq\, (3\cos^2\theta - 1)\, r^{-3}$$

of the sun's gravitational field; here m and q are the mass and quadrupole moment of the sun ([q] is in cm^2, $q > 0$, θ is the angle between the plane of the orbit and the sun's axis of rotation, and G is Newton's constant. Allowance for δφ leads to the following value for the relativistic shift of the perihelion (per revolution): $\delta\alpha = \delta\alpha_0 - \delta\alpha_q$, where $\delta\alpha_q = 6\pi q/p^2$, and $\delta\alpha_0$ is the difference between the observed shift angle and its theoretical nonrelativistic value, calculated without allowance for δφ. For Mercury $p = 5.4 \times 10^7$ km and $\delta\alpha_0 = (42.9 \pm 0.2)''$

per century [1]; According to Einstein's equations $\delta\alpha = \delta\alpha_E = 6\pi r_0/p = 43.03''$ per century ($r_0 = Gm/c^2 = 1.5$ km). Therefore for Mercury $\delta\alpha = \delta\alpha_E(1 - \delta)$, where $\delta = 6\times10^3\gamma + (3\pm5)\times10^3$, $\gamma = q/a^2$, and a is the sun's radius. At the present time the exact value of γ is unknown, and it cannot be obtained from the observed oblateness coefficient $\gamma_1 = \delta a/a$ without using special model theories. One can use as a reasonable approximation the value $\gamma \approx \frac{2}{3}\gamma_1 - \frac{1}{3}\omega^2 a^3 (Gm)^{-1}$, which is obtained by neglecting the latitude dependence of the angular velocity of the ω layers of the sun. For an average period of 25/4 days [2] and for the empirical value $\gamma_1 \approx 5\times10^{-5}$ (Dicke, Goldenberg, Hill [3]) we get $\gamma \approx 2.5\times10^{-5}$ and $\delta \approx +10\%$ regardless of the sign of the quantity 3 ± 5. A discrepancy of this magnitude can apparently not be compensated by nonrelativistic factors [3], and if this is so, it must be assumed that Einstein's equations are in contradiction with reality.

An explanation of the δ-effect does not require rejection of the physical principles of general relativity. The absence of mass-anisotropy and exact satisfaction of the equivalence principle (with a possible error $<10^{-11}$ [4]) allow as to state that matter bends 4-space directly, without generating additional nonmetric fields (of the type of the Dicke scalar field [5]). We therefore suppose that the δ-effect merely signifies that while the basic principles of Einstein's general relativity theory remain unchanged, only the concrete form of the Lagrangian Λ of the gravitational field need be modified ([6,7]). Consequently [7], $\Lambda = (R + X)/2x_1$, where $x_1 > 0$, R is the scalar curvature of 4-space, and X is an invariant that depends only on the metric tensor and its derivatives, and vanishes more rapidly than R when $R^{ik}_{\ell m} \to 0$ ($R^{ik}_{\ell m}$ is a Riemann tensor which is antisymmetric in the upper and lower indices). Let us establish several properties of X, which are deduced from empirical weak-field data.

The most general expression for X is

$$X = X[\ell^2 R,\ \ell_1^2 P^i_k,\ \ell_2^2 S^{ik}_{\ell m}], \tag{1}$$

where ℓ, ℓ_1, and ℓ_2 are universal constants with the dimensions of length,

$$P^i_k = R^i_k - \frac{1}{4} R\delta^i_k,\quad R^i_k = R^{im}_{km},\quad S^{im}_{km} = 0,\quad S^{ik}_{\ell m} = R^{ik}_{\ell m} - \delta^i_\ell Q^k_m -$$

$$- \delta^k_m Q^i_\ell + \delta^k_\ell Q^i_m + \delta^i_m Q^k_\ell,\quad 2Q^i_k = R^i_k - \frac{1}{6} R\delta^i_k .$$

The quantities R, P^i_k, and $S^{ik}_{\ell m}$ are algebraically-independent parts of $R^{ik}_{\ell m}$ and therefore serve as independent arguments of X. The square brackets in (1) denote a dependence not only on the arguments indicated, but, in general, on their covariant derivatives; the dependence is nonlinear, in a degree >1. For any choice of X (except Einstein's X = 0, which contradicts the δ-effect), the gravitation equations contain covariant derivatives of R, P^i_k, and $S^{ik}_{\ell m}$ of order not lower than the second, and consequently the connection between the curvature and matter is nonlocal (unlike the local equations of Einstein)

$$R^i_k - \frac{1}{2} R\delta^i_k = \kappa T^i_k\ ;$$

where T^i_k is the matter tensor and $\kappa = 8\pi G/c^4$); the nonlocality radii are determined by the constants ℓ, ℓ_1, and ℓ_2.

It is known [8] that the nonrelativistic relation $-G_{00} = 1 + 2\phi/c^2$, where ϕ is the gravitational potential, follows directly from the equivalence principle, independently of the concrete form of the gravitation equation. The gravitation equations should therefore lead in the nonrelativistic limit to

$$R_0^0 \cong \frac{1}{2}\Delta G_{00} = -\frac{1}{2}\kappa\rho c^2$$

(ρ is the mass density), at least for objects in which the Poisson equation $\Delta\phi = 4\pi G\rho$ holds. The latter is known to hold for bodies with ordinary density and with dimensions up to $b \sim 10^2$ cm (the smallest bodies that can be sensed by gravitational prospecting with gravimeters having an accuracy of 10^{-7} [2]). Thus, in weak fields the connection between the R_0^0 and the matter tensor should be local. It can be shown that under very simple assumptions concerning X this requires smallness of the constants: $\ell_1 \leq b$ and $\ell_2 \leq b$. It is significant that the nonrelativistic locality of R_0^0 takes place [7] not only at small values of the constant ℓ, but for ℓ much larger than the dimensions of the nonrelativistic bodies, and in the latter case we have $\kappa_1 \simeq \frac{3}{4}\kappa$. If all three constants ℓ, ℓ_1, and ℓ_2 were to be equally small, then the curvature would attenuate exponentially in outer space and we would get $\delta \sim e^{-r/b}$ (r - radius of Mercury's orbit), contradicting the estimate $\delta \sim 10\%$. Consequently $\ell \gg \ell_{1,2} \leq b$, and when $\delta \sim e^{-r/b}$ we get $\ell \sim 10^6$ km, which leads unambiguously to $\kappa_1 = \frac{3}{4}\kappa$.

We see that data on the weak field (the δ-effect and the nonrelativistic locality of R_0^0) determine the coupling constant $\kappa_1 = \frac{3}{4}\kappa$ and show that the dependence on P_k^i and $S_{\ell m}^{ik}$ is much less significant than its dependence on the scalar curvature. We can therefore assume either that X = X[R], or that X[R] is a good approximation to the exact structure. The concrete form of X[R] must be established empirically. We note that pseudo-Einstein [7] structures of X[R] lead to $\delta = 0$ and are therefore excluded from among the possibilities.

A detailed exposition and a more complete analysis will be published in JETP.

I am grateful to Ya. B. Zel'dovich, S. G. Matinyan, and E. L. Feinberg for advice and information.

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