Widths. An axial meson cannot decay into a pair of particles having identical spin and parity. Its decay follows the scheme

$$(1^+) \rightarrow (0^-) + (1^-), \tag{8}$$

with the symmetry of the 405-plet requiring that the coupling be of pure F type. This leads to the following relations between the widths

$$\Gamma(A_1) = \Gamma(B) = 2\Gamma(C) \tag{9}$$

(the experimental values are 125, 122, and 60 MeV respectively [2]). In the decays of tensor mesons, pure D-coupling is realized, and if we assume that SU(6) symmetry is exactly satisfied, we obtain the ratio

$$\Gamma(A_2) = \tfrac{3}{5}\,\Gamma(B) \tag{10}$$

(experiment yields a ratio 0.65 ± 0.10 [2]).

We can thus assume that the greater part of the 405-plet has already been observed.

This raises the following problems: a - searches for scalar mesons, b - searches for 27-plets. The second problem is easier to solve by investigating the states $K_+K_+^*$, $K_+\rho_+$, and $\pi_+\rho_+$. Discovery of a resonance in any of them would be evidence in favor of the existence of $\underline{27}(1^+)$.

We note that the multiplets $\underline{27}(1^+)$ and $\underline{27}(2^+)$ are nonexistent if the particles considered are part of the 189-plet (and not the 405-plet). This supermultiplet, however, does not interact with the baryon current, and has different mixing angles and different types of decay interactions. All this influences us in favor of the 405-plet.

[1] S. Glashow and R. Socolow, Phys. Rev. Lett. 15, 329 (1965).

[2] A. Rosenfeld et al., Revs. Modern Phys. 36, 977 (1964).

NON-EINSTEINIAN GRAVITATION

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According to Einstein's hypothesis, the invariant Lagrangian density of the free gravitational field in $\Lambda = R/\kappa$, where R is the scalar space-time curvature and $\kappa = 2 \times 10^{-48}$ g/cm-sec^2. The only experimental argument in favor of this hypothesis is that it leads automatically to Newtonian gravitation and to correct relativistic corrections in the case of a weak field. The argument is not unique. An analysis shows that none of the presently known facts proves the incompatibility with experiment of an infinite set of non-Einsteinian expressions for Λ. Therefore, without patently contradicting experiment, we assume that the expression $\Lambda = R/\kappa$ is actually only an approximation, which is valid only for a sufficiently weak field (a criterion will be given later). Speaking somewhat more precisely - we assume that Einstein's equations do not present a fully equivalent description of non-quantum gravitation.

The theory is constructed on the basis of the Lagrangian formalism. The expression for Λ is obtained from considerations of dimensionality and invariance, and also from the experimentally-required limiting condition that Λ is proportional to R when the curvature is vanishingly small:

$$\Lambda = \frac{1}{\kappa_1} R \, \Phi \, (I_1, I_2, \ldots), \tag{1}$$

where I are dimensionless invariants, Φ a dimensionless function (with $\Phi(0, 0, \ldots) = 1$), and κ_1 a universal constant proportional to κ (we omit a discussion of the reasons why κ_1/κ can depend on the structure of the function Φ; the latter should be determined from experimental data).

The independent invariants of the gravitational field are the contractions (of suitable degrees) of the components of the fourth-rank curvature tensor and its covariant derivatives. The dimensionalities of these quantities are cM^{-n} (with integer $n \geq 2$), and to make them dimensionless we must multiply them by factors ℓ^n with numerical coefficients (ℓ is a universal constant with dimension of length). If $\ell = 0$, then all the $I \equiv 0$, and (1) coincides with Einstein's expression. Consequently if the proposed non-Einsteinian (anomalous) gravitation is a real fact, then there exists in nature a new universal macroscopic constant ℓ, the numerical value of which can be established experimentally. A criterion for the applicability of the Einstein approximation $\Lambda = \text{const}\cdot R$ is obviously the smallness of ℓ compared with all linear parameters of the gravitational field (including the square root of the reciprocal curvature).

Application of the standard variational technique to (1) leads to the gravitational equations

$$X_{ik} = T_{ik}, \tag{2}$$

where T_{ik} is the material tensor and X_{ik} a symmetrical tensor containing (for any structure of Φ except Φ = const) derivatives of order not lower than second of the components of the curvature tensor. Equations (2) are inhomogeneous equations of the wave type, relating the curvature of space-time with the material tensor; this relation (the solution of the equations) is always nonlocal, but satisfies the causality conditions (the details of nonlocality and wave properties of the curvature of the anomalous field are determined by the concrete structure of the function Φ). An exception is the one and only (Einsteinian) case $\Phi \equiv \text{const} = 1$, when the wave equation degenerates into an algebraic one and the indicated relation becomes rigorously local. Thus, the physical difference between all possible anomalous gravitational fields and the Einsteinian field is that the former propagate in the form of special gravitational waves, which can be called invariant because the wave character of Eqs. (2) cannot be eliminated by any choice of the coordinate system or reference frame. We note that in an Einsteinian field the wave equations for the metric are obtained somewhat artificially (with the aid of a special choice of additional coordinate conditions) and are not unique consequences of the gravitation equations. We can therefore assume that the problem of gravitational radiation is physically defined only for an anomalous field.

In addition to the invariant gravitational waves, anomalous effects can arise in collapsing systems. It is perfectly obvious that when a certain gravitating medium contracts, the Riemannian curvature of the gravitational field increases (at least during the Einsteinian stage of contraction) together with the density of matter, and under certain conditions can reach and exceed the critical value $l^2R \sim 1$. In such a case an anomalous collapse arises, the qualitative character of which is determined by the parameters of the medium and by the structure of the function Φ in Eq. (1). A tentative investigation of the simplest relations of the type $\Phi = \Phi(l^2R)$ shows that in the case of anomalous collapse of a homogeneous and isotropic medium the state with infinite density can apparently be entirely nonexistent (it is well known to be unavoidable in the case of ordinary collapse). Under certain conditions, the anomalous collapse of such a medium degenerates into stable undamped pulsations of density between two finite limits. It is not at all excluded that the universe as a whole is just in such a state, whereas individual parts of it collapse in the usual fashion (contracting until nuclear reactions occur). The anomalous gravitation thus leads to the physical possibility of an entirely different cosmology of the universe as a whole and of its individual parts. In Einstein's cosmology (within the limits of the homogeneous and isotropic model) such an alternative is completely excluded.

Detailed results will be published in coming numbers of JETP. I am grateful to Ya. A. Smorodinskii and E. L. Feinberg for interest and stimulating discussions.

PREDICTION OF MASSES IN MESONIC MULTIPLETS IN THE SIMPLE QUARK MODEL

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Reference [1] discussed, within the framework of SU(6) symmetry, a model of higher meson resonances, consisting of a quark and antiquark in a state with orbital angular momentum L = 1. The spin-orbit interaction $\alpha(\vec{L}\cdot\vec{S})$, where S is the total spin of the quarks, has split the multiplets with respect to the angular momentum J. The splitting of the mesons inside the multiplets was described qualitatively by an increase of the third quark mass [2]. The recently published experimental data on several meson resonances fit the foregoing model well 1). The experimental data presented below are taken from the proceedings of the Oxford conference (September 1965) and from the reviews [3,4]. The resonances discovered were $K^{**}(1320) \to K^*\pi$ (denoted in [1] as K 1360) and $f'(1510) \to \bar{K}^*K, \bar{K}K$ (denoted in [1] as φ 1600). A study of the quantum numbers of the resonances B 1220 and E 1420 favors $J^P = 1^+$, in agreement with [1], and analysis of the energy distributions in the decay $A_1 \to \rho\pi$ indicates that this resonance can have $J^P = 1^+$ or 2^-. In neither case can the resoance A_1 decay into $\pi\eta$. However, the $\pi\eta$ spectrum contains an appreciable maximum at energies of the order of 1040 MeV [5]. The maximum in the $\pi\eta$ spectrum is apparently connected with the resonance T, $J^{PG} = 1, 0^{+-}$, which according