ratio of the cross section at the 1.66 eV minimum to the section at the principal maximum should be $\sim 5 \times 10^{-3}$ at $T = 1°K$, and the ratio at the 2.48 eV minimum should be $\sim 2 \times 10^{-3}$. These ratios are much larger on the experimental curve.

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THE SUN'S GRAVITATIONAL FIELD

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The discrepancies between the consequences of Einstein's equations and the measurement results of Dicke and Goldenberg [1] lead to a discussion of gravitational bending of light waves. Let $\delta_\gamma = 1 - \beta\beta_E^{-1}$, where β is the empirical angle of deflection of the ray at the edge of the sun, and β_E is the Einstein value (1.75"). The empirical data [2] allow us to assume that $\delta_\gamma \sim -0.1$. If we admit the existence of a non-metric gravitational field (independent of the curvature tensor) then, according to [3], $\delta_\gamma = (2\omega + 4)^{-1}$, where ω is a universal constant. An estimate based on the perihelion rotation leads to $\omega > 6$ and to $0 < \delta_\gamma < 6\%$, which certainly disagrees with experiment if $\delta_\gamma < 0$.

Let us consider the metric theory [4]. In the simplest case, the non-Einstein gravitation equations have the following form:

$$R_k^i - \frac{1}{2} R\delta_k^i + \zeta_n^2 \delta_k^i - \zeta_k^i + Y_k^i = \kappa_1 T_k^i, \quad (Y_k^i = \zeta R_k^i - \frac{1}{2} X \delta_k^i), \tag{1}$$

where T_k^i is the matter tensor, R_k^i is the Ricci tensor, $R = R_n^n$, $X = RF(\ell^2, R)$, $\xi = dX/dR$, ξ_k^i are the covariant derivatives of the function ξ, and ℓ and κ_1 are universal constants ($[\ell] = m$, $[\kappa_1] = cm/erg$). According to the conditions for the conversions of the integral 4-momentum we have

$$R = \text{const}\, l^{-2} \zeta^n, \quad (\zeta \to 0), \tag{2}$$

with either $1 \leq n < 3$ or $n > 3$. In a static field, the condition (2) leads to the asymptotic form $\varphi = -Gmr^{-1}$, $\xi = r_1 r^{-1}$, $(r \to \infty)$, where r is the distance from the matter, φ the gravitational potential, G Newton's universal constant, and m the gravitational mass. The asymptotic parameters m and r_1 define in general form the component $P^0 = m_0 c^2$ of the total static 4-momentum, i.e., the inertial rest mass of the matter:

$$\frac{m_0}{m} = \frac{\kappa}{\kappa_1}\left(1 - \frac{r_1}{r_0}\right), \quad (r_0 = 2Gmc^2, \ \kappa = 8\pi G c^{-4}). \tag{3}$$

If $1 \leq n < 3$, then $m_0 r_1 \equiv 0$. On the other hand, if $n > 3$, then $r_1 \neq 0$ and in this case r_1 is determined by the parameters of the matter. Consequently, the theory admits of the non-universality of the ratio $m_0 m^{-1}$. The result need not at all contradict reality, since the equality $m_0 = m$ has been accurately verified only for laboratory masses, and there is still no known procedure for precision measurements of m_0 and m for astronomical masses.

The possibility $r_1 = 0$ contradicts experiment. The result follows from the non-relativistic limit of (1) for a static field:

$$\Delta\phi + \frac{1}{2}c^2\,\Delta\zeta = 4\pi\frac{\kappa_1}{\kappa}G\rho, \quad \Delta\zeta - \frac{1}{3}R = -\frac{1}{3}\kappa_1 c^2\rho, \tag{4}$$

where Δ is the Laplacian and ρ the mass density. To obtain agreement with the laboratory data, taking (3) into account, we must assume $\kappa_1 = \kappa$ when $r_1 = 0$. In this case, according to (4) and (2), we have in an internal field $\Delta\varphi = 4\pi G(1 + \epsilon)\rho$, where $\epsilon \sim (\kappa c^2\rho)^{1/n-1} a^{-2} \ell^{2/n}$, $(1 \leq n < 3)$, a is the dimension of the body, and the correction ε should be small under ordinary conditions. To estimate this correction let us find the constant ℓ from the parameter δ of the anomalous rotation of the perihelion of Mercury. Form (1) and from formula (1) of [5] it follows that

$$R(p) \approx -9\frac{r_0^2}{p^4}\left(\delta - \frac{4}{3}\frac{r_1}{r_0}\right), \tag{5}$$

where R is the scalar curvature, the parameter r_1 pertains to the sun's field, $r_0 \approx 3$ km is the gravitational radius of the sun, and $p \approx 5.5 \times 10^7$ km is the radius of Mercury's orbit; according to the measurements of [1], $\delta \approx +0.08$. According to (2) and (4) we have in outer space

$$R(r) \approx \ell^{-2}(\ell/r)^{2n/n-1}, \ (1 < n < 3); \quad R(r) \approx \ell^{-2}(r_1/r)^n, \ (n > 3); \tag{6}$$

at n = 1 we have $R(r) = \text{const.}\, r^{-1}\exp(-r/\ell)$. From (5) and from the first formula of (6) we get an estimate of ℓ for $r_1 = 0$, according to which $\epsilon \sim (a_0/a)^2\, 10^{9/n-7}$ at a density $\rho \approx 5$ g/cm^3, where $1 \leq n < 3$ and $a_0 \approx 6 \times 10^3$ km is the earth's radius; for a gravimetric object with dimensions a ~ 10 km we get ε ~ 40, which cannot be taken into consideration. The result excludes completely the possibility of $r_1 = 0$ and consequently, according to (3), the equality $m_0 = m$ is not an exact law of nature.

Violation of the law $m_0 = m$ leads to observable effects. From (1) of the present paper and formula (3) of [5] it follows that when $r_1 \neq 0$ we have $\delta_\gamma = (r_1/r_0)_\odot$ accurate to $\sim r_0 r_\odot^{-1} \approx 5 \times 10^{-6}$ ($r_\odot = 7 \times 10^5$ km, the symbol ⊙ pertains to the sun). Consequently

$$\frac{m_0}{m}(\odot) = \frac{\kappa}{\kappa_1}(1 - \delta_\gamma), \tag{7}$$

which makes it possible to obtain the solar mass ratio from the observed parameter δ_γ. The numerical value of the universal constant $\kappa\kappa_1^{-1}$ follows from (4) and from the estimate $\ell = \lambda^{n/2} \times 10^{20-4n}$ cm, $\lambda = |o|\delta_\gamma|$, n > 3, which corresponds to (5) and to the second formula of (6). According to (4), the Poisson equation is satisfied not only when

$\Delta\xi \ll R$ $(\kappa_1 = \kappa)$, but also when $\Delta\xi \gg R$ $(\kappa_1 = \frac{3}{4}\kappa)$; in the latter case $\Delta\varphi = 4\pi G(1 + \epsilon_1)\rho$, and if $\epsilon_1 \lesssim 1$, then $\epsilon_1 \sim R(\Delta\xi)^{-1} \sim \ell^{-2}(\varphi/c^2)^n$, where φ is the Newton potential. At the given order of magnitude of ℓ, the possibility $\kappa_1 = \kappa$ is excluded (in analogy with the case $r_1 = 0$), and ϵ_1 turns out to be $\sim(a/a_0)^{2n}(\rho/5)^{n-1}\lambda^{-n}10^{-14}$ (ρ is in g/cm^3) and leads to imperceptible (under ordinary conditions) violations of Poisson's equation. Therefore, in a real field

$$\kappa_1 = \frac{3}{4}\kappa \qquad (8)$$

and according to (7) the quantity $\delta_m = m_0 m^{-1} - 1$ for the sun has a nonrelativistic order of magnitude (provided only $\delta_\gamma \neq +0.25$, i.e., $\beta \neq 1.31''$, which is apparently excluded with certainty). When $\delta_\gamma = -0.1$ we have $m_0(\odot) = 1.47m(\odot)$ and for all the probable values of δ_γ we have $m_0(\odot) > m(\odot)$.

We see that according to the metric theory δ_γ is due to the inequality of the solar masses. The nonrelativistic nature of δ_m is due to the non-Einstein character of the internal field, which (according to the estimate of ϵ_1) can deviate appreciably from Poisson's equation, remaining at the same time nonrelativistic ($|\varphi| \ll c^2$). Therefore the internal state of the nonrelativistic stars (as well as of the sun) should differ noticeably from the Poisson state. For planets of the solar system $\delta_m \sim \epsilon_1 \ll 1$ (for Jupiter and Saturn $\delta_m \sim 10^{-8}$ and 10^{-9} if $n = 4$ and $\delta_m \sim 10^{-7}$ and 10^{-8} if $n = 5$).

The detailed theory will be published in JETP.

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NONLINEAR NEGATIVE ABSORPTION OF LIGHT IN AN INHOMOGENEOUSLY INVERTED SEMICONDUCTOR

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Certain experimental singularities of the dynamics of the emission of semiconductor lasers [1-5] give grounds for assuming that a semiconductor structure consisting of alternating sections with different positions of the Fermi quasilevels μ (for example, a laser with isolated injection regions [6,7]) constitutes a nonlinear stable medium with negative absorption, similar to the well-known two-component media [8-10], and has the following nonlinearity mechanism.

Light acting on a semiconductor structure which is stable in the initial state causes raising of μ_m in the absorbing section and lowering of μ_n in the amplifying section; this is accompanied by change in the corresponding negative-absorption coefficients g_m and g_n. By virtue of the asymmetry of the frequency dependence of the absorption coefficient, these changes occur, for a specified light frequency ω, at different rates: