CONCLUSIONS

The increase in the discharge current of a He–Ne laser with the cavity mirror shielded by a shutter has been investigated for different operating conditions in the laser power supply unit and cavity tunings, and also with different numbers of emitting quantum transitions. Conclusions were drawn as to the effect of the electron excitation intensity and the presence of radiation from λ = 3.39 μm on the nature of the change in the contribution to neon ionization as the electron density increases. It has been suggested that the reaction of the gas-discharge current to a change in the laser output power be used as the feedback circuit in systems for servostabilization of laser power — primarily lasers with a high radiation level or a range of wavelengths that makes it difficult to employ optical parts. A schematic diagram for servostabilization of the laser power of such lasers is shown, and possible variations are discussed.

LITERATURE CITED


HOMOGENEOUS ISOTROPIC COSMOLOGICAL MODEL
OF SPACE – TIME WITH TORSION IN THE
EINSTEIN – CARTAN THEORY OF GRAVITATION

V. N. Tunyak

A systematic treatment is applied to the cosmological problem in the Einstein–Cartan theory of gravitation on the basis of the variational principle formulated previously for an ideal fluid in space with torsion. Exact solutions are obtained for homogeneous isotropic cosmological models with flat three-dimensional space filled with powdery matter and a fluid with an equation of state p = ε/3.

As is well known, one of the most interesting trends in the development of the relativistic theory of gravitation is the Einstein–Cartan affine theory of gravitation (ATG), which introduces non-Einstein material sources of non–Euclidean space–time geometry in the form of total nonsymmetric canonical tensors for the energy–momentum and spin momentum of nongravitational matter [1–3]. However, the problem of using the ATG to construct a specific cosmological model of space–time with nonzero torsion has still not been solved satisfactorily. It has been pointed out in [4] that the basic flaw in some cosmological models, for example those of [6–8], is that they postulate the sources of the gravitational field in a form that is inconsistent with the unified variational principle for the gravitational field and the nongravitational matter that is the basis of the ATG. In this paper, a consistent treatment of the cosmological problem in the ATG is attempted on the basis of the variational principle formulated in [4, 5] for an ideal fluid in space with torsion.

The complete system of equations for a self-consistent gravitational field and ideal spin fluid is written in the ATG [4, 5].


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\[ G_{\alpha\beta} = xT_{\alpha\beta} = \frac{x}{2}(t + p) u_\alpha u_\beta + x g_{\alpha\beta} + (\tau_\alpha + C_\alpha) u_\alpha u_\beta, \]  
\[ C_{\alpha\beta} = \alpha e 2 \kappa_x \kappa_y u_\beta, \]  
\[ (t + p) u_\alpha + \mu (\partial_\alpha + C_\alpha) \kappa_x = \kappa_x \partial_\alpha E - n_B \partial_\alpha X^b = 0, \]  
\[ \varepsilon = 0, \]  
\[ u_\alpha u^\alpha = 1, \]  
\[ u_\alpha \partial_\alpha E = 0, \]  
\[ (\tau_\alpha + C_\alpha) n_B u^\alpha = \mu (\partial_\Pi \partial E) + (\tau_\alpha + C_\alpha) \kappa_x u^\alpha = 0. \]

The notation for the above is as follows: the Einstein gravitation constant \( \kappa \); the geometrical variables of the given problem: the Einstein tensor \( G_{\alpha\beta} \) in curved metric space of the affine connection \( U_4 \), the torsion tensor \( T_{\alpha\beta} = 2I^{\lambda}_{[\alpha\beta]} \), \( C_\alpha = C_{\alpha B} \), \( \varepsilon_\alpha \) is the covariant derivative of the affine connection \( U_4 \); and also the field variables: \( T_{\alpha\beta} \) is the canonical energy-momentum tensor, \( S_{\alpha B} \) is the spin momentum, \( \mu \) is the invariant mass density, \( \varepsilon = \mu c^2 + \Pi (\mu, E) \) is the so-called total energy density, \( \Pi \) and \( E \) are the specific expressions for the internal energy and entropy per unit mass, respectively, \( p \) is the pressure, \( \kappa_x, \kappa_3, n_B \) (\( B = 1, 2, 3 \)) are the undetermined Lagrangian multipliers in the given variational principle \([4, 5]\), \( X^B \) are the scalar variables introduced to account for the so-called identity principle of the fluid particles, and \( u^\alpha \) is the four-vector of the fluid velocity. In analyzing the homogeneous isotropic cosmological model, we use the usual assumptions of an isentropic and nonrotational fluid motion, \( \partial_\alpha E = \partial_\alpha X^B = 0 \), the terms \( \mu, \kappa_x, \varepsilon, p \) are functions only of \( x^0 = ct \), and

\[ ds^2 = c^2 dt^2 - a^2(t) \delta_{\alpha\beta} dx^\alpha dx^\beta, \]

\[ C_{\alpha\beta} = \frac{2}{3} K(t) \delta_{[\alpha}, \delta_{\beta]}, \]

In the case of a fluid with an equation of state \( p = \varepsilon/3 \), the given cosmological problem is characterized by the following system of equations for the determination of the functions \( a \) and \( K \):

\[ \frac{\dot{a}}{a} + \frac{a^2}{9} + \frac{1}{K} K^2 = 0, \]

\[ \dot{K} + 3 \frac{\dot{a}}{a} K + 6 \frac{a^2}{a^3} - \frac{2}{3} K^3 = 0, \]

where the dot represents differentiation with respect to \( x^0 = ct \). Integrating the system of equations (10) and (11) and calculating the corresponding mass density \( \rho = c^{-2}T^\beta_{\alpha\beta} u^\alpha u^\beta \), which in the space of \( U_4 \) is generally different from \( \rho c^{-2} \), we find the following exact cosmological solution of the ATG:

\[ a = a_1 \gamma^\frac{1}{2} (1 - \gamma)^{\frac{1}{2}} (1 - 3\gamma)^{-\frac{1}{2}}, \]

\[ K = \frac{(3\gamma - 2)}{ct_1} \gamma^{\frac{1}{2}} (1 - \gamma)^{-\frac{1}{2}} (1 - 3\gamma)^{\frac{3}{2}}, \]

\[ \rho = \frac{3}{a^4 t_1^2} \gamma^\frac{1}{2} (1 - \gamma) (1 - 3\gamma)^2, \]

\[ t = t_1 \frac{1}{\delta} \xi (1 - \xi)^{-\frac{1}{2}} (1 - 3\xi)^{-\frac{1}{2}} d\xi, \]

where \( a_1 \) and \( t_1 \) are constants. The given solution is singular at the point \( t = \gamma = 0 \), as indicated by the limiting relations

\[ \lim_{t \to 0} a = 0, \quad \lim_{t \to 0} K = \infty, \quad \lim_{t \to 0} \rho = \infty. \]