Pulse compression and time delay of stimulated Raman scattering components in Ba(NO$_3$)$_2$ powder

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Temporal compression of stimulated Raman scattering (SRS) components was registered for random Raman lasing in Ba(NO3)2 powder consisting of micron-sized particles. SRS was excited in the 2 mm layer of barium nitrate powder by a Nd:YAG laser second harmonic radiation with a wavelength of 532 nm and pulse duration of 30 ps. Pumping light was focused into the sample. Under this excitation SRS occurred in non-stationary regime. For SRS registration we used monochromator and streak camera with a resolution of 4 ps. We registered radiation at the wavelength of exciting light (elastic scattering), 2 Stokes components and 1 anti-Stokes component. Elastic scattering pulse was longer than exciting pulse (38 ps) and all SRS pulses were shorter: duration of the first Stokes pulse was 32 ps, second Stokes 22 ps and first anti-Stokes 19 ps. Both elastic scattering ans SRS were delayed in time compared to the exciting pulse. It is consistent with the theory of non-stationary regime for bulk media. For the first Stokes component the delay time is few tens of picoseconds and it increases linearly with the increasing of the exciting radiation energy because of the substance nonlinear refractive index growth.

Scalar particle with the Cox structure and polarizability, in presence of the uniform magnetic field

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Within the general method by Gel'fand – Yaglom, starting with the extended set of representations of the Lorentz group, for a spin 0 particle, we construct a relativistic generalized system of the first order equations for a spin 0 particle with two additional characteristics, Cox structure and polarizability. In tensor form, we take into account the presence of external electromagnetic fields. After eliminating the accessory variables of the complete wave function, we derive the minimal 5-component form of equations, the last includes two additional interaction terms which are interpreted as related to Cox structure and polarizability. Applying the matrix form of the derived system we extend this approach to space-time models with pseudo-Riemannian structure within the tetrad method. We specify this equations to the cylindrical coordinates, and in presence of the external uniform magnetic field. After separating the variables, we derive the system of 5 first order differential equations in polar coordinate. This system may be reduced to a second order equation for a primary function, which is solved in terms of the confluent hypergeometric functions. We derive a formula for energy values, it depends on two additional characteristics, Cox structure and polarizability.

We develop alternative method of studying the problem that is based on the method by Fedorov – Gronskiy. Within this approach, the complete 5-component wave function is presented as some of three projective constituents, dependence of each constituent on the polar coordinate is determined by only one function. We find expression for this basic function $F_i(r)$ in terms of confluent hypergeometric equations; at this there arises a quantization rule for some spectral parameter. Within the method by Fedorov – Gronskiy, additionally arises algebraic homogenous system of 5 equations, its solutions determine the structure of 5-component wave functions. From this algebraic system there arises the formula for energy levels, that includes the previously introduced spectral parameter with the known quantization rule. The final formula for energies turns out to be the same for both methods.

Temperature reversal of the ratchet motion direction due to tunnel effect

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We consider a pulsating ratchet with a spatially periodic double-well potential profile undergoing shift fluctuations by half a period. In such a ratchet, the motion direction is determined by the answer the question: "For which of the barriers surrounding the shallow potential well the probability of

overcoming is greater?" At relatively high temperatures, in accordance with the Arrhenius law, the probabilities of overcoming the barriers are determined by their heights, and at temperatures close to absolute zero, when the ratchet moves according to the tunnel mechanism, the barrier shapes become important. Therefore, for narrow high and low wide barriers, the overcoming mechanism may turn out to be different and, moreover, dependent on temperature. As a result, a temperature-induced change in the direction of the ratchet motion may occur. We present a simple interpolation theory to illustrate this effect. We also formulate simple criteria for the choice of the shape of the potential relief at which one can experimentally observe motion reversal.

[1] V. M. Rozenbaum, I. V. Shapochkina, L. I. Trakhtenberg. Tunneling mechanism for changing the motion direction of a pulsating ratchet. Temperature effect. JETP Letters **118**, 369 (2023).

Spin 1 Particle with Anomalous Magnetic Moment and Polarizability in presence of the uniform magnetic field

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Within the general method by Gel'fand – Yaglom, starting with the extended set of representations of the Lorentz group, we have constructed a relativistic generalized system of the first order equations for a spin 1 particle with two additional characteristics, anomalous magnetic moment and polarizability. In tensor form, we have taken into account the presence of external electromagnetic fields. After eliminating the accessory variables of the complete wave function, we derive the minimal 10-component form of equations, the last includes two additional interaction terms which are interpreted as related to anomalous magnetic and moment and polarizability. This approach is extended to space-time models with pseudo-Riemannian structure, within the tetrad method. We specify the basic equation to the cylindrical coordinates and tetrad, and in presence of the external uniform magnetic field. After separating the variables, we derive the system of 10 first order differential equations in polar coordinate. To resolve this system, we apply the method by Fedorov – Gronskiy. Within this approach, the complete 10-component wave function is decomposed in three projective constituents, dependence of each on the polar coordinates is determined by only one function. We find expressions for this basic function $F_i(r)$ in terms of confluent hypergeometric equations; at this there arises a quantization rule for some spectral parameter. Within the method by Fedorov – Gronskiy, additionally arises algebraic homogenous system of 10 equations, which completely determines the structure of 10-component solutions. From vanishing the determinant of the algebraic system, we derive a cubic algebraic equation with respect to energy parameter ϵ^2. Its solutions are found in analytical form, and studied numerically.

Hardronic Decays of Heavy Lepton

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Two-particle decays of the τ-lepton: $\tau \to \pi\nu_\tau, \tau \to K\nu_\tau, \tau \to \rho\nu_\tau, \tau \to K^*\nu_\tau, \tau \to a_1(1250)\nu_\tau$ have been studied in the framework of the Quark Confined Model . The obtained branching values are in good agreement with the experimental data. The three-particle decay $\tau \to \pi\pi\nu_\tau$ has been studied. The contribution of the direct diagram and the diagram with the intermediate $\rho(770)$ meson have been considered separately. The obtained numerical value $Br(\tau \to \pi\pi\nu_\tau = 0,237$ is in good agreement with the existing experimental situation.

Leptonic and Semileptonic Interactions of Charmed Mesons

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Within the framework of the Covariant Model of Constituent Quarks (CMCQ), leptonic and semileptonic decays of D mesons have been studied. The widths of leptonic decays