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**ОПЕРАТОРНІ РІЗНИЦЕВІ РІВНЯННЯ, ЯКІ ЗАЛЕЖАТЬ НЕЛІНІЙНО
ВІД СПЕКТРАЛЬНОГО ПАРАМЕТРА**

V.I. Khrabustovskyi

**OPERATOR DIFFERENCE EQUATIONS DEPENDING ON SPECTRAL
PARAMETER NONLINEARLY**

We consider either in regular or singular case operator difference equations containing spectral parameter in Nevanlinna manner.

We obtain analogs of many statements for differential relation from [1] [2]. For example we obtain the eigenfunction expansions in various cases.

References

[1] V.I. Khrabustovskyi *Analogs of generalized resolvents for relations generated*

by pair of differential expressions one of which depends on spectral parameter in nonlinear manner *J. Math. Phys. Anal. Geom.* 9 (2013), no 4, 496-535.

[2] V.I. Khrabustovskyi, *Eigenfunction expansions associated with an operator differential equation nonlinearly depending on a spectral parameter*, *Methods Funct. Anal. Topol.* 20 (2014) no 1, 68-91.

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ФУНКЦІЇ ГРІНА УЗАГАЛЬНЕНИХ РІВНЯНЬ КЛЕЙНА-ГОРДОНА

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GREEN FUNCTIONS OF GENERALISED KLEIN-GORDON EQUATIONS

In [1, 2] it is shown that the four-fold integral corresponding to the Green function of the Klein-Gordon equation diverges. Fourier-components in this integral are the fraction with the $-q^2 + m^2$ -denominator, where m is a particle mass, the components of the 4-vector q are the integration variables. To avoid a divergence of this integral it is proposed to change the $-q^2 + m^2$ -factor in the denominator on the $(-q^2 + m_1^2)(-q^2 + m_2^2) \dots (-q^2 + m_N^2)$ -product, where $N \geq 3$, The proposed Green functions correspond to differential equations with the a product of the Klein-Gordon differential operators at different masses. The classical solution of corresponding homogeneous equation is sum of N terms. Such terms correspond to the solutions for the positive and the negative frequencies. The

proper fraction in the Fourier-components of new Green functions can be expanded as a sum of common fractions with A_k residues ($A_k = (-1)^{k+1} |A_k|, k = 1, 2, \dots, N$). The quantized free field is a sum of N terms. The number k term is proportional to $\sqrt{A_k}$ and includes the creation and the annihilation operators for the particle with the m_k -mass in usual manner. At such method of a quantization the T-product of free fields is not a Green function of the generalized Klein-Gordon equation.

1. Kulish Yu.V., Rybachuk E.V. *The Journal of Kharkiv National University*, 2011, n. 955, Is. 2(50), p. 4.

2. Kulish Yu.V., Rybachuk E.V. *Problems of atomic science and technology*, 2012, n. 1(77), p.16.