

2010 MSC 39A70, 47B39, 34B07

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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.

УДК 539.12

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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.