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ABSTRACT

This international scientific journal is created for new scientific research.

Articles are accepted in the following areas:

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- social directions
- directions of philology
- pedagogic directions
- directions of discovery and invention
- natural science majors

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Samarqand viloyati pedagoglarni yangi metodikalarga o'rgatish milliy markazi, Maktabgacha, boshlang'ich va maxsus ta'lim kafedrasi katta o'qituvchisi, "Xalq ta'limi a'lochisi", "Xalq ta'limi fidoiysi" unvonlari sohibasi.

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**DISKRET PARAMETRLI IKKINCHI TARTIBLI OPERATORLI
MATRITSANI CHIZIQLILIKKA TEKSHIRISH****Behzod Xolmurodov Botir o'g'li**

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Annotatsiya: Panjaradagi soni saqlanmaydigan zarrachalar sistemasiga mos keluvchi blok operatorli matritsalarining spektral xossalarni o'rganish bilan bog'liq masalalar statistik fizika, qattiq jismlar fizikasi, mexanika va gidrodinamikaning ko'plab sohalarida uchrab turadi. Shu nuqtai nazardan ushbu mavzu dolzarb hisoblanadi.

Kalit so'zlar: Gilbert fazosi, Fok fazosi, skalyar ko'paytma, kompleks fazo, qo'shma operatorlar, o'z – o'ziga qo'shma operator.

Annotation. Issues related to the study of the spectral properties of block-operator matrices corresponding to a system of particles whose number is not conserved in the lattice are found in many areas of statistical physics, solid-state physics, mechanics, and hydrodynamics. From this point of view, this topic is relevant.

Keywords: Gilbert space, Fok space, scalar product, complex space, additive operators, self – adjoint operator.

$H_0 := \mathbb{C}$ - bir o'lchamli kompleks fazo, $H_1 := L_2(\mathbb{T}^d)$ - $\mathbb{T}^d$ da aniqlangan kvadrati bilan integrallanuvchi, (umuman olganda, kompleks qiymatli) funksiyalar Gilbert fazosi bo'lsin. $H^{(2)}$ orqali H_0 va H_1 fazolarning to'g'ri yig'indisini belgilaymiz, ya'ni $H^{(2)} := H_0 \oplus H_1$ [1].

Odatda, $H^{(2)}$ Gilbert fazosiga Fok fazosining qirqilgan ikki zarrachali qism fazosi deyiladi. $H^{(2)}$ Gilbert fazosining ixtiyoriy f elementi $f = (f_0, f_1)$ kabi tasvirlanadi, bunda $f_0 \in H_0, f_1 \in H_1$ [1].

$f = (f_0, f_1) \in H^{(2)}$ elementning normasi

$$\|f\| = \sqrt{\|f_0\|_0^2 + \|f_1\|_1^2}$$

formula yordamida topiladi:

$$\|f_0\|_0 = |f_0|, \|f_1\|_1 = \sqrt{\int_{\mathbb{T}^d} |f_1(t)|^2 dt}.$$

Ikkita $f = (f_0, f_1), g = (g_0, g_1) \in H^{(2)}$ elementlarning skalyar ko'paytmasi
 $(f, g) = (f_0, g_0)_0 + (f_1, g_1)_1$

kabi topiladi:

$$(f_0, g_0)_0 = f_0 \cdot \overline{g_0}, (f_1, g_1)_1 = \int_{\mathbb{T}^d} f_1(t) \overline{g_1(t)} dt.$$

$H^{(2)}$ Gilbert fazosida quyidagi ikkinchi tartibli

$$A_2^{(s)} := \begin{pmatrix} \hat{A}_{00}^{(s)} & \hat{A}_{01} \\ \hat{A}_{01}^* & \hat{A}_{11}^{(s)} \end{pmatrix} \quad (1)$$

operatorli matritsani qaraymiz, bu yerda

$$A_{ii}: H_i \rightarrow H_i, \quad i = 0, 1, A_{01}: H_1 \rightarrow H_0$$

operatorlar quyidagicha aniqlangan:

$$\hat{A}_{00}^{(s)} f_0 = s \varepsilon f_0, f_0 \in H_0;$$

$$\hat{A}_{01} f_1 = \alpha \int_{\mathbb{T}^d} v(t) f_1(t) dt, f_1 \in H_1;$$

$$(\hat{A}_{11}^{(s)} f_1)(x) = (-s \varepsilon + u(x)) f_1(x), f_1 \in H_1.$$

Bunda, $s = \pm \varepsilon$ – haqiqiy son, $v(\cdot)$ va $u(\cdot)$ lar haqiqiy qiymatli uzluksiz funksiyalar, $\alpha > 0$ – esa “ta’sirlashuv parametri”, $\hat{A}_{01}^*$ operator mos ravishda $\hat{A}_{01}$ operatorga qo’shma operatorlar bo‘lib, ular quyidagicha aniqlanadi:

$$(\hat{A}_{01} f_1, f_0) = (f_1, f_0 \hat{A}_{01}^*)$$

$$\begin{aligned} (\hat{A}_{01} f_1, f_0) &= \left(\alpha \int_{\mathbb{T}^d} v(t) f_1(t) dt, f_0 \right) = \alpha \int_{\mathbb{T}^d} v(t) f_1(t) dt, \overline{f_0} = \\ &= \int_{\mathbb{T}^d} \overline{\alpha v(t) f_0} f_1(t) dt = \int_{\mathbb{T}^d} f_1(t) \overline{\alpha v(t) f_0} dt \end{aligned}$$

$$\hat{A}_{01}^* = \alpha v(t) f_0$$

$$(\hat{A}_{01}^* f_0)(x) = \alpha v(x) f_0, f_0 \in H_0.$$

1 – lemma. $H^{(2)}$ Gilbert fazosida (1) formula orqali ta’sir qiluvchi

ikkinchi tartibli $A_2^{(s)}$ operatorli matritsa chiziqli, chegaralangan va o‘z – o‘ziga qo’shma operator bo‘ladi [2].

Isbot. Ixtiyoriy $a, b \in \mathbb{C}$ kompleks sonlar va ixtiyoriy $f = (f_0, f_1), g = (g_0, g_1) \in H^{(2)}$ elementlar uchun

$$A_2^{(s)}(af + bg) = aA_2^{(s)}f + bA_2^{(s)}g$$

tenglikni tekshirish orqali $A_2^{(s)}$ operatorli matritsaning chiziqli operator ekanini isbotlaymiz.

Dastlab,

$$A_2^{(s)} f := \begin{pmatrix} \hat{A}_{00}^{(s)} & \hat{A}_{01} \\ \hat{A}_{01}^* & \hat{A}_{11}^{(s)} \end{pmatrix} \begin{pmatrix} f_0 \\ f_1 \end{pmatrix} = \begin{pmatrix} \hat{A}_{00}^{(s)} f_0 + \hat{A}_{01} f_1 \\ \hat{A}_{01}^* f_0 + \hat{A}_{11}^{(s)} f_1 \end{pmatrix} =$$

$$= \begin{pmatrix} s\varepsilon f_0 + \alpha \int_{\mathbb{T}^d} v(t)f_1(t)dt \\ \alpha v(x)f_0 + (-s\varepsilon + u(x))f_1(x) \end{pmatrix}$$

ekanligini ta'kidlab o'tamiz.

$$\begin{aligned} A_2^{(s)}(af + bg) &= \\ &= \begin{pmatrix} s\varepsilon(af_0 + bg_0) + \alpha \int_{\mathbb{T}^d} v(t)(af_1(t) + bg_1(t))dt \\ \alpha v(x)(af_0 + bg_0) + (-s\varepsilon + u(x))(af_1(x) + bg_1(x)) \end{pmatrix} = \\ &= \begin{pmatrix} s\varepsilon af_0 + \alpha \int_{\mathbb{T}^d} v(t)af_1(t)dt + s\varepsilon bf_0 + \alpha \int_{\mathbb{T}^d} v(t)bf_1(t)dt \\ \alpha v(x)af_0 + (-s\varepsilon + u(x))af_1(x) + \alpha v(x)bf_0 + (-s\varepsilon + u(x))bf_1(x) \end{pmatrix} = \\ &= a \begin{pmatrix} s\varepsilon f_0 + \alpha \int_{\mathbb{T}^d} v(t)f_1(t)dt \\ \alpha v(x)f_0 + (-s\varepsilon + u(x))f_1(x) \end{pmatrix} + \\ &+ b \begin{pmatrix} s\varepsilon g_0 + \alpha \int_{\mathbb{T}^d} v(t)g_1(t)dt \\ \alpha v(x)g_0 + (-s\varepsilon + u(x))g_1(x) \end{pmatrix} = \\ &= aA_2^{(s)}f + bA_2^{(s)}g. \end{aligned}$$

Demak, berilgan diskret parametrli ikkinchi tartibli operatorli matritsa $A_2^{(s)}$ chiziqli operator ekan.

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