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«AMALIY MATEMATIKA VA AXBOROT TEXNOLOGIYALARINING ZAMONAVIY MUAMMOLARI»
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АМАЛИЙ МАТЕМАТИКА ВА АХБОРОТ ТЕХНОЛОГИЯЛАРИНИНГ ЗАМОНАВИЙ МУАММОЛАРИ

ХАЛҚАРО ИЛМIIY-АМАЛИЙ АНЖУМАН

МАТЕРИАЛЛАРИ

2022 йил, 11-12 май

БУХОРО – 2022

**ЎЗБЕКИСТОН РЕСПУБЛИКАСИ
ОЛИЙ ВА ЎРТА МАХСУС ТАЪЛИМ ВАЗИРЛИГИ
ЎЗБЕКИСТОН РЕСПУБЛИКАСИ ФАНЛАР АКАДЕМИЯСИ
В.И. РОМАНОВСКИЙ НОМИДАГИ МАТЕМАТИКА ИНСТИТУТИ
ЎЗБЕКИСТОН МИЛЛИЙ УНИВЕРСИТЕТИ
ТОШКЕНТ ДАВЛАТ ТРАНСПОРТ УНИВЕРСИТЕТИ
БУХОРО ДАВЛАТ УНИВЕРСИТЕТИ**

Бухоро фарзанди, Беруний номидаги Давлат мукофоти лауреати, кўплаб ёш изланувчиларнинг ўз йўлини топиб олишида раҳнамолик қилган етук олим, физика-математика фанлари доктори Файбулла Назруллаевич Салиховнинг 90 йиллик юбилейларига бағишланади

**АМАЛИЙ МАТЕМАТИКА ВА
АХБОРОТ ТЕХНОЛОГИЯЛАРИНИНГ
ЗАМОНАВИЙ МУАММОЛАРИ**

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Theorem 1 (*The propagation theorem*). If the function $f(A)$ can be propagated to ordinary power series by the Z^{-1} levels of the $F(Z)$ image, i.e.

$$F(Z) = C_0 \cdot Z^{-1} + C_1 \cdot Z^{-2} + \dots + C_n \cdot Z^{-(n+1)} + \dots \quad (4)$$

as, if it approaches $F(Z)$ at $\{Z \in \mathbb{C}[m \times m]: |Z^{-1}| < R\}$, then the original is found by the following formula:

$$f(A) = C_0 + C_1 \frac{A}{1!} + C_2 \frac{A^2}{2!} + \dots + C_n \frac{A^n}{n!} + \dots \quad (5)$$

This series approaches for values $A > 0$ and at $A < 0$ is taken as $f(A) = 0$ **REFERENCES**

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BOUNDS OF THE ESSENTIAL SPECTRUM OF A THREE-PARTICLE MODEL HAMILTONIAN ON A 1D LATTICE

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Let T be the one-dimensional torus and $L_2^{sym}(T^2)$ be the Hilbert space of square-integrable symmetric (complex) functions with domain T^2 . We study the model Hamiltonian $H_{\mu,\lambda}$ defined by

$$H_{\mu,\lambda} := H_0 - \mu(V_1 + V_2) - \lambda V_3, \quad \mu, \lambda > 0, \quad (1)$$

in $L_2^{sym}(T^2)$, where H_0 is a non-perturbed operator, i.e. the multiplication operator:

$$(H_0 f)(x, y) = u(x, y) f(x, y);$$

the operators V_α , $\alpha = 1, 2, 3$ are the partial integral operators of the form:

$$(V_1 f)(x, y) = v(y) \int_T v(t) f(x, t) dt,$$

$$(V_2 f)(x, y) = v(x) \int_T v(t) f(t, y) dt,$$

$$(V_3 f)(x, y) = \int_T f(t, x + y - t) dt.$$

Here $f \in L_2^{sym}(T^2)$, the function $v(\cdot)$ is a real-valued analytic function on T and the function $w(\cdot, \cdot)$ is a real-valued symmetric analytic function on T^2 .

Under these assumptions the operator $H_{\mu,\lambda}$ is bounded and self-adjoint.

Throughout this note we assume that there exists a finite subset $\Lambda \subset T$ such that the function $u(\cdot, \cdot)$ has non-degenerate minima at the points of $\Lambda \times \Lambda$. Set

$$m := \min_{x, y \in T} u(x, y) \quad \text{and} \quad M := \max_{x, y \in T} u(x, y).$$

One can easily see that [1] if $v(x') = 0$ for all $x' \in \Lambda$, then the integral

$$\int_T \frac{v^2(t) dt}{u(x, t) - m}$$

is positive and finite for any $x \in T$. Under this assumption we define

$$\mu_0 := \left(\max_{x \in T} \int_T \frac{v^2(t) dt}{u(x, t) - m} \right)^{-1}.$$

We introduce two bounded and self-adjoint operators $H_\mu^{(1)}$ and $H_\lambda^{(2)}$ (so-called channel operators). They act in $L_2(T^2)$ by

$$H_\mu^{(1)} = H_0 - \mu V_1, \quad H_\lambda^{(2)} = H_0 - \lambda V_3.$$

Set

$$E_{\mu, \lambda} := \min\{\xi : \xi \in \sigma_{\text{ess}}(H_{\mu, \lambda})\}.$$

Then $E_{\mu, \lambda} \in \sigma_{\text{ess}}(H_{\mu, \lambda})$ is called the lower bound of the essential spectrum of $H_{\mu, \lambda}$.

The main result of the present note is the following theorem.

Theorem 1. *For the essential spectrum of $H_{\mu, \lambda}$ we have*

$$\sigma_{\text{ess}}(H_{\mu, \lambda}) = \sigma(H_\mu^{(1)}) \cup \sigma(H_\lambda^{(2)}).$$

For the lower bound $E_{\mu, \lambda}$ the following assertions hold:

- (i) If $v(x') \neq 0$ for some $x' \in \Lambda$, then for all $\mu, \lambda > 0$ we have $E_{\mu, \lambda} < m$;
- (ii) Let $v(x') = 0$ for all $x' \in \Lambda$.
 - (ii1) For any $\mu > \mu_0$ and $\lambda > 0$ we have $E_{\mu, \lambda} < m$;
 - (ii2) For any $\mu \leq \mu_0$ and $\lambda > 0$ we have $E_{\mu, \lambda} = \min \sigma(H_\lambda^{(2)})$.

Moreover, $\max(\sigma(H_{\mu, \lambda})) = M$ for any $\mu, \lambda > 0$.

This result plays a key role in the analysis of the discrete spectrum of $H_{\mu, \lambda}$. In [1] the discrete spectrum of $H_{\mu, 0}$ was discussed.

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CUBIC NUMERICAL RANGE OF 3×3 BLOCK OPERATOR MATRICES

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Block operator matrices are matrices the entries of which are linear operators between Banach or Hilbert spaces. They arise in various areas of mathematics and its applications. Let $\mathcal{H}_1, \mathcal{H}_2, \mathcal{H}_3$ be complex Hilbert spaces, and consider $\mathcal{H} := \mathcal{H}_1 \oplus \mathcal{H}_2 \oplus \mathcal{H}_3$. With respect to this decomposition, every bounded linear operator $\mathcal{A} \in L(\mathcal{H})$ has a 3×3 block operator matrix representation

$$\mathcal{A} := \begin{pmatrix} A_{11} & A_{12} & A_{13} \\ A_{12}^* & A_{22} & A_{23} \\ A_{13}^* & A_{23}^* & A_{33} \end{pmatrix} \quad (1)$$

with bounded linear entries $A_{ij} \in L(\mathcal{H}_j, \mathcal{H}_i)$, $i, j = 1, 2, 3$ such that $A_{ii}^* = A_{ii}$, $i = 1, 2, 3$. In the following we denote by

$$S_{\mathcal{H}_1 \oplus \mathcal{H}_2 \oplus \mathcal{H}_3} := S_{\mathcal{H}_1} \times S_{\mathcal{H}_2} \times S_{\mathcal{H}_3} = \{(f_1 f_2 f_3)^t \in \mathcal{H} : \|f_i\| = 1, i = 1, 2, 3\}$$

the product of the unit spheres $S_{\mathcal{H}_i}$ in \mathcal{H}_i ; we also write S^3 or $S_{\mathcal{H}}$ instead of $S_{\mathcal{H}_1 \oplus \mathcal{H}_2 \oplus \mathcal{H}_3}$ if the decomposition $H = \mathcal{H}_1 \oplus \mathcal{H}_2 \oplus \mathcal{H}_3$ is clear (note the slight difference in notation between $S_{\mathcal{H}_1 \oplus \mathcal{H}_2 \oplus \mathcal{H}_3}$ and the unit sphere $S_{\mathcal{H}_1 \oplus \mathcal{H}_2 \oplus \mathcal{H}_3}$ in $H_1 \oplus H_2 \oplus H_3$). In this case $S^3 := \{f = (f_1 f_2 f_3)^t \in H : \|f_i\| = 1, i = 1, 2, 3\}$.

Definition 1. For $f = (f_1 f_2 f_3)^t \in S_{\mathcal{H}_1 \oplus \mathcal{H}_2 \oplus \mathcal{H}_3}$ we introduce the 3×3 matrix

$$\mathcal{A}_f = \begin{pmatrix} (A_{11}f_1, f_1) & (A_{12}f_2, f_1) & (A_{13}f_3, f_1) \\ (A_{12}^*f_1, f_2) & (A_{22}f_2, f_2) & (A_{23}f_2, f_3) \\ (A_{13}^*f_1, f_3) & (A_{23}^*f_2, f_3) & (A_{33}f_3, f_3) \end{pmatrix} \in M_3(C).$$

Then the set

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