O'ZBEKISTON RESPUBLIKASI OLIY TA'LIM, FAN VA INNOVATSIYALAR VAZIRLIGI

1930 BUXORO DAVLAT UNIVERSITETI

FIZIKA, MATEMATIKA VA MEXANIKANING DOLZARB MUAMMOLARI XALQARO ILMIY-AMALIY ANJUMANI

MATERIALLARI

Buxoro - 2023

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xalqaro ilmiy-amaliy anjumani

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(I qism)

Buxoro, O‘zbekiston, 24-25-may, 2023-yil

МИНИСТЕРСТВО ВЫСШЕГО ОБРАЗОВАНИЯ, НАУКИ И ИННОВАЦИЙ РЕСПУБЛИКИ УЗБЕКИСТАН
БУХАРСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ

ТЕЗИСЫ ДОКЛАДОВ

(Часть I)

международной научно-практической конференции

АКТУАЛЬНЫЕ ПРОБЛЕМЫ ФИЗИКИ, МАТЕМАТИКИ И МЕХАНИКИ

Бухара, Узбекистан, 24-25 мая, 2023 год

MINISTRY OF HIGHER EDUCATION, SCIENCE AND INNOVATIONS OF THE REPUBLIC OF UZBEKISTAN
BUKHARA STATE UNIVERSITY

ABSTRACTS

(Part I)

of the international scientific and practical conference

ACTUAL PROBLEMS OF PHYSICS, MATHEMATICS AND MECHANICS

Bukhara, Uzbekistan, May 24-25, 2023

Fizika, matematika va mexanikaning dolzarb muammolari (Xalqaro ilmiy-amaliy konfferensiya materiallari to'plami, I qism) Buxoro-2023, 357 bet.

Mazkur to'plam “Fizika, matematika va mexanikaning dolzarb muammolari” Xalqaro ilmiy-amaliy konferensiyasi materiallari to'plami asosida tayyorlangan bo'lib, matematik analiz, differensial tenglamalar va matematik fizika, algebra va geometriya, hisoblash matematikasi va mexanika, geleofizika va qayta tiklanuvchi energiya manbalari, kondensirlangan holatlar fizikasi, zamonaviy ta'limda raqamli texnologiyalar, ehtimollar nazariyasi va matematik statistika yo'nalishlaridagi ilmiy ma'ruzalar o'rin olgan.

To'plamga kiritilgan maqola va tezislar mazmuni, ilmiyligi va dalillarining haqqoniyligi uchun mualliflar ma'suldirlar

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(b) $h_{\mu,\lambda}$ operator ko‘pi bilan uchta xos qiymatlarga ega bo‘lib, ulardan ko‘pi bilan ikkitasi a nuqtadan chapda, ko‘pi bilan bittasi $a+z$ dan o‘ngda joylashgan bo‘ladi.

FOYDALANILGAN ADABIYOTLAR RO‘YXATI

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BRANCHES OF THE ESSENTIAL SPECTRUM OF THE OPERATOR MATRIX OF ORDER THREE

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The essential spectrum of operator matrices is one of the topics that is deeply studied in the theory of operators, and the description of the location of the essential spectrum of this type of operators is studied among the important problems of spectral analysis [1,2].

$\mathbb{T}^1$ is a one-dimensional torus, $\mathcal{H}_0 \coloneqq \mathbb{C}$ is a space of complex numbers, $\mathcal{H}_1 \coloneqq L_2(\mathbb{T}^1)$ is a Hilbert space of square integrable (complex variable) functions on $\mathbb{T}^1$ and $\mathcal{H}_2 \coloneqq L_2^s(\mathbb{T}^2)$ be a Hilbert space of square-integrable (complex variable) symmetric functions on $\mathbb{T}^2$. Denote by $\mathcal{H}$, the direct sum of the spaces $\mathcal{H}_1, \mathcal{H}_2$ and $\mathcal{H}_3$, that is, $\mathcal{H} := \mathcal{H}_1 \oplus \mathcal{H}_2 \oplus \mathcal{H}_3$.

Let us consider a third-order operator matrix $\mathcal{A}_\mu$ acting $\mathcal{H}$ as

$$\mathcal{A}_\mu = \begin{pmatrix} A_{00} & \mu A_{01} & 0 \\ \mu A_{01}^* & A_{11} & \mu A_{12} \\ 0 & \mu A_{12}^* & A_{22} \end{pmatrix}, \mu > 0 \qquad (1)$$

with the entries:

$$A_{00}f_0 = \varepsilon f_0, \qquad A_{01}f_1 = \int_{\mathbb{T}^1} \sin(3t)\, f_1(t)\, dt;$$

$$(A_{11}f_1)(x) = (\varepsilon + 1 - \cos(3x))f_1(x), \;\; A_{12}f_2(x) = \int_{\mathbb{T}^1} \sin(3t)\, f_2(x,t) dt;$$

$$(A_{22}f_2)(x,y) = (\varepsilon + 2 - \cos(3x) - \cos(3y))f_2(x,y), \quad f_i \in \mathcal{H}_i, i = 0,1,2.$$

It should be noted that the operator matrix $\mathcal{A}_\mu$ given by (1) is a linear, bounded and self-adjoint operator in the Hilbert space $\mathcal{H}$.

In order to study the essential and discrete spectra of the operator matrix $\mathcal{A}_\mu$, we introduce the operator matrix $h_\mu, \mu > 0$ called the generalized Friedrichs model acting in the space $\mathcal{H}_0 \oplus \mathcal{H}_1$ as

$$h_\mu = \begin{pmatrix} A_{00} & \mu A_{01} \\ \mu A_{01}^* & A_{11} \end{pmatrix}, \mu > 0.$$

One can see that the operator matrix h_μ is a linear, bounded and self-adjoint in $\mathcal{H}_0 \oplus \mathcal{H}_1$.

Let us consider the operator matrix h_0 in the Hilbert space $\mathcal{H}_0 \oplus \mathcal{H}_1$ as

$$h_0 = \begin{pmatrix} A_{00} & 0 \\ 0 & A_{11} \end{pmatrix}.$$

The perturbation $h_\mu - h_0$ of the operator matrix h_0 is a self-adjoint operator of rank 2. According to the definition, for the spectrum of the operator h_0 the equality

$$\sigma(h_0) = \sigma(A_{00}) \cup \sigma(A_{11})$$

holds, here

$$\sigma(A_{00}) = \sigma_{\text{disc}}(A_{00}) = \{\varepsilon\}; \qquad \sigma(A_{11}) = \sigma_{\text{ess}}(A_{11}) = [\varepsilon; \varepsilon + 2].$$

Therefore, in accordance with the Weyl theorem about the invariance of the essential spectrum under finite rank perturbations, the essential spectrum of the operator matrix h_μ coincides with the essential spectrum of h_0. Therefore,

$$\sigma_{\text{ess}}(h_\mu) = \sigma_{\text{ess}}(h_0) = [\varepsilon, \varepsilon + 2].$$

For any fixed $\mu > 0$ we consider an analytic function in $\mathbb{C}\backslash[\varepsilon; \varepsilon + 2]$ by

$$\Delta_\mu(z) := \varepsilon - z - \mu^2 \int_{\mathbb{T}^1} \frac{\sin^2(3t)dt}{\varepsilon + 1 - \cos(3t) - z}.$$

Usually, the function $\Delta_\mu(\cdot)$ is called the Fredholm determinant corresponding to the operator matrix h_μ. The following lemma expresses the connection between the eigenvalues of the operator matrix h_μ and zeros of $\Delta_\mu(\cdot)$.

Lemma 1. For any $\mu > 0$ the operator h_μ has an eigenvalue $z_\mu \in \mathbb{C}\backslash[\varepsilon; \varepsilon + 2]$ if and only if $\Delta_\mu(z_\mu) = 0$.

Now, by studying the zeros of the function $\Delta_\mu(\cdot)$, we analyze the number and position of the eigenvalues of the operator matrix h_μ.

Lemma 2. The operator matrix h_μ has two simple eigenvalues, therefore one to the left of ε and the other to the right of $\varepsilon + 2$.

Let the numbers E_μ^1 and E_μ^2 are the eigenvalues of the operator matrix h_μ. For clearity, we take $E_\mu^1 \in (-\infty; \varepsilon)$ and $E_\mu^2 \in (\varepsilon + 2; +\infty)$.

The following theorem describes the essential spectrum of the operator matrix $\mathcal{A}_\mu$.

Theorem 1. The following equality holds for the essential spectrum of the operator matrix $\mathcal{A}_\mu$:

$$\sigma_{\text{ess}}(\mathcal{A}_\mu) = [E_\mu^1; E_\mu^1 + 2] \cup [\varepsilon; \varepsilon + 4] \cup [E_\mu^2; E_\mu^2 + 2].$$

Definition 1. The sets

$$[E_\mu^1; E_\mu^1 + 2] \cup [E_\mu^2; E_\mu^2 + 2] \text{ and } [\varepsilon; \varepsilon + 4]$$

are called two-particle and three-particle branches of the essential spectrum of the operator matrix $\mathcal{A}_\mu$, respectively. We denote these branches as $\sigma_{\text{two}}(\mathcal{A}_\mu)$ and $\sigma_{\text{three}}(\mathcal{A}_\mu)$, i.e.

$$\sigma_{\text{two}}(\mathcal{A}_\mu)=[E_\mu^1; E_\mu^1 + 2] \cup [E_\mu^2; E_\mu^2 + 2],$$

$$\sigma_{\text{three}}(\mathcal{A}_\mu) = [\varepsilon; \varepsilon + 4].$$

Since $E_\mu^1 < \varepsilon$ and $E_\mu^2 > \varepsilon + 2$ for all $\mu > 0$, one can conclude that

$$\min \sigma_{\text{two}}(\mathcal{A}_\mu) < \min \sigma_{\text{three}}(\mathcal{A}_\mu) \text{ and } \max \sigma_{\text{three}}(\mathcal{A}_\mu) < \max \sigma_{\text{two}}(\mathcal{A}_\mu)$$

for all $\mu > 0$.

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2.T.H.Rasulov, N.A.Tosheva. Analytic description of the essential spectrum of a family of 3×3 operator matrices. Nanosystems: Physics, chemistry, mathematics, 10:5(2019), pp. 511-519.

UCHNCHI TARTIBLI OPERATORLI MATRITSALAR OILASI UCHUN BIRMAN-SHVINGER PRINSIPI

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$\mathbb{C}$ orqali bir o‘lchamli kompleks fazoni, $L_2(\mathbb{T}^3)$ orqali $\mathbb{T}^3$ da aniqlangan kvadrati bilan integrallanuvchi (umuman olganda kompleks qiymatlarni qabul qiluvchi) funksiyalarning Hilbert fazosini, $L_2^{\mathrm{s}}((\mathbb{T}^3)^2)$ orqali $(\mathbb{T}^3)^2$ da aniqlangan kvadrati bilan integrallanuvchi (umuman olganda kompleks qiymatlarni qabul qiluvchi) simmetrik funksiyalarning Hilbert fazosini hamda $\mathcal{H}$ orqali $\mathcal{H}_0 := \mathbb{C}$, $\mathcal{H}_1 := L_2(\mathbb{T}^3)$ va $\mathcal{H}_2 := L_2^{\mathrm{s}}((\mathbb{T}^3)^2)$ fazolarning to‘g‘ri yig‘indisini belgilaymiz, ya’ni $\mathcal{H} := \mathcal{H}_0 \oplus \mathcal{H}_1 \oplus \mathcal{H}_2$. Bunda $\mathcal{H}_0$, $\mathcal{H}_1$ va $\mathcal{H}_2$ fazolarga $L_2(\mathbb{T}^3)$ fazo yordamida qurilgan $\mathcal{F}_{\mathrm{s}}(L_2(\mathbb{T}^3))$ bozonli Fok fazoning mos ravishda nol zarrachali, bir zarrachali va ikki zarrachali qism fazolari deyiladi.

$\mathcal{H}$ Hilbert fazosida ta’sir qiluvchi quyidagi