

MINISTRY OF HIGHER AND SECONDARY SPECIAL EDUCATION
OF THE REPUBLIC OF UZBEKISTAN

NATIONAL UNIVERSITY OF UZBEKISTAN

UZBEKISTAN ACADEMY OF SCIENCES
V.I.ROMANOVSKIY INSTITUTE OF MATHEMATICS

FERGANA STATE UNIVERSITY

INTERNATIONAL ENGINEERING ACADEMY

A B S T R A C T S

OF THE VII INTERNATIONAL SCIENTIFIC CONFERENCE
CONFERENCE

**MODERN PROBLEMS OF APPLIED MATHEMATICS AND
INFORMATION TECHNOLOGIES AL-KHWARIZMI 2021**

dedicated to the 100th anniversary of the academician
Vasil Kabulovich Kabulov

15-17 November, 2021, Fergana, Uzbekistan

THE NUMBER OF EIGENVALUE OF THE TWO PARTICLE SHRODINGER OPERATOR

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Let $\mathbb{T}^3 = (-\pi, \pi]^3$ be the three dimensional torus (Brillion zone) and let $L^2(\mathbb{T}^3)$ be the Hilbert space of square-integrable functions defined on the torus \mathbb{T}^3 . We define the two particle discrete Shrödinger operator as wollows: $H_\mu^\gamma(K) = H_\gamma^0(K) + \mu V, (H_\gamma^0(K)f)(p) = E_K^\gamma(p)f(p), f \in L^2(\mathbb{T}^3),$ where

$$E_K^\gamma(p) = \varepsilon(p) + \gamma\varepsilon(K - p), \gamma > 0 \quad \varepsilon(p) = \sum_{i=1}^3 (1 - \cos p^{(i)}), \quad p = (p^{(1)}, p^{(2)}, p^{(3)}) \in \mathbb{T}^3, \text{ and}$$

$$(Vf)(p) = \frac{1}{(2\pi)^3} \int_{\mathbb{T}^3} f(q) dq, \quad f \in L^2(\mathbb{T}^3).$$

The perturbation V is positive operator of finite rank. Thus, by the well-known Weyl theorem [1] the essential spectrum fills the following segment on the real axis:

$$\sigma_{ess}(H_\mu^\gamma(K)) = \sigma_{ess}(H_\gamma^0(K)) = [\min_{p \in \mathbb{T}^3} E_K^\gamma(p), \max_{p \in \mathbb{T}^3} E_K^\gamma(p)],$$

We define the following number (using convergent integral)

$$\frac{1}{\mu_0} = \nu(K) = \frac{1}{(2\pi)^3} \int_{\mathbb{T}^3} \frac{dq}{\max_{p \in \mathbb{T}^3} E_K^\gamma(p) - E_K^\gamma(q)}$$

For any $\mu > 0$ we set:

$$M_<(\mu) = \{K \in \mathbb{T}^3 : 1 - \mu\nu(K) < 0\}$$

$$M_=(\mu) = \{K \in \mathbb{T}^3 : 1 - \mu\nu(K) = 0\}$$

$$M_>(\mu) = \{K \in \mathbb{T}^3 : 1 - \mu\nu(K) > 0\}.$$

The main result is the following theorem

Theorem. For any $K \in M_<(\mu_0)$ and $\gamma \neq 1$ the operator $H_{\mu_0}^\gamma(K)$ has a unique eigenvalue $E_{\mu_0}^\gamma(K)$ lying outside the essential spectrum $\sigma_{ess}(H_{\mu_0}^\gamma(K))$ and this eigenvalue is even real analytic in $M_<(\mu_0)$

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5. **Rakhimov A., Nazarov Kh.** LOCAL AUTOMORPHISMS OF REAL $B(X)$ 241
6. **Rahmatullaev M.M., Tukhtabaev A.M.** ON G_2 - PERIODIC GIBBS MEASURES OF p -ADIC POTTS MODEL ON A CAYLEY TREE 242
7. **Sattarov I.A., Tukhtabaev A.M., Darvishaliyeva Z.R.** GRADIENT GENERALIZED GIBBS MEASURES FOR p -ADIC HARD-CORE MODEL ON A CAYLEY TREE 243
8. **Shergaziev B.U., Sattarov I.A.** ON p -ADIC $(3, 1)$ -RATIONAL DYNAMICAL SYSTEMS WITH TWO FIXED POINTS 244
9. **Ulashov S.S., Mardiyev A.Sh.** THE NUMBER OF EIGENVALUE OF THE TWO PARTICLE SHRODINGER OPERATOR 245
10. **Khakimov R.M., Umirzakova K.O.** PERIODIC GIBBS MEASURES FOR ONE FERTILE HC MODEL ON THE CAYLEY TREE OF ORDER $k > 1$ 246

13. GEOMETRY AND TOPOLOGY

1. **Artykbaev A., Nurbayev A.R.** THE TOTAL CURVATURE OF THE SURFACE IN FOUR-DIMENSIONAL GALILEAN SPACE 247
2. **Artikbaev A., Mamadaliyev B.M.** GEOMETRY OF TWO-DIMENSIONAL SURFACES IN THE FIVE-DIMENSIONAL PSEUDO-EUCLIDEAN SPACE OF INDEX TWO 248
3. **Aslonov J.O.** GEOMETRY OF SOME VECTOR FIELDS 249
4. **Khadjiev D., Beshimov G., Joraeva Z.** COMPLETE SYSTEMS OF INVARIANTS OF POLYNOMIAL PARAMETRIC CURVES FOR GROUPS $SO(2, R)$, $O(2, R)$ OF THE TWO-DIMENSIONAL EUCLIDEAN SPACE 250
5. **Narmanov A.Ya., Sharipov X.F.** ON THE GEOMETRY OF SUBMERSIONS 251
6. **Nuritdinov J.T.** ON THE MINKOWSKI DIFFERENCE OF LINES AND PLANES 252
7. **Safarov T.** ON THE PROPERTIES OF THE TOTAL CURVATURE OF THE SURFACE OF A GALILEAN SPACE 253
8. **Soliyeva M., Beshimov G.** A DESCRIPTION OF ALL NON-CONGRUENT SYMMETRIC BILINEAR FORMS ON THE TWO-DIMENSIONAL VECTOR SPACE OVER THE FIELD Z_7 254
9. **Topvoldiyev F.** ABOUT THE CONDITIONAL CURVATURE OF A SURFACE 255
10. **Zaitov A.** ON IMPROVEMENT OF HAUSDORFF-BEZIKOVICH FORMULA AND ITS APPLICATION IN BUILDING MATERIALS 256

14. COMPUTATIONAL AND DISCRETE MATHEMATICS

1. **Akhmadaliev G.N.** OPTIMIZATION OF APPROXIMATE INTEGRATION FORMULAS IN THE SPACE $K_{2,\omega}$ 257
2. **Akhmedov D.M., Boltaev E.K., Nazarova D.** OPTIMAL QUADRATURE FORMULAS WITH DERIVATIVES FOR SINGULAR INTEGRALS IN THE SPACE $L_2^{(3)}(0, 1)$ 258
3. **Akhmedov D.M., Nosirova N.A.** OPTIMAL QUADRATURE FORMULAS WITH DERIVATIVES FOR CALCULATING WEIGHTED SINGULAR INTEGRALS IN THE SPACE $L_2^{(2)}(-1, 1)$ 259
4. **Aripov M.M., Utebaev B.D.** INVESTIGATION OF DIFFERENCE SCHEMES OF HIGH ACCURACY FOR SOLVING THE BOUSSINESQ-L'OVE EQUATION 260
5. **Boltaev A., Aslonov U.** COEFFICIENTS OF THE OPTIMAL INTERPOLATION FORMULAS IN $W_2^{(3,0)}(0, 1)$ SPACE 261
6. **Aloev R.Dj., Dadabayev S.U., Ulashev A.E., Botirov I.B.** IMPLICIT UPWIND DIFFERENCE SCHEME FOR LINEAR HYPERBOLIC 2 EQUATIONS WITH LOWER ORDER TERMS 262
7. **Daliyev B.** NUMERICAL EXPERIMENTS OF AN APPROXIMATE ANALYTICAL METHOD FOR SOLVING THE ABEL INTEGRAL EQUATIONS 263
8. **Davronov J.R.** PROPERTIES OF THE DISCRETE ANALOGUE TO THE DIFFERENTIAL OPERATOR 264