# Report

On a competition for an academic position "Associated Professor", in the field of higher education 4. Natural sciences, mathematics and informatics, professional advancement, 4.5 "Mathematics", specialty Equations of Mathematical Physics.

by Prof. DSc. Tsvatko Rangelov, Member of the Scientific Jury, Institute of Mathematics and Informatics, BAS.

**1)** The competition, with a term of 2 months, was announced in the State Gazette no. 108 of 22.12.2020 for the needs of the Institute of Mathematics and Informatics (IMI), BAS. Assistant Professor PhD. Tihomir Ilchev Valchev has submitted documents for participation in it. He graduated from the Faculty of Physics, Sofia University, majoring in Theoretical and Mathematical Physics in 2003. In 2009, after postgraduate studies at Institute for Nuclear Research and Nuclear Energy (NRNE), BAS he defended his PhD thesis "Reduction of nonlinear equations of soliton type on homogeneous and symmetric spaces".

Assistant Prof. T. Valchev has been worked as a Physicist and Assistant Professor since 2008 until 2014 in INRNE, BAS, and from 2015 as an Assistant Professor at the Institute of Mathematics and Informatics, section "Differential Equations and Mathematical Physics".

**2)** Ass. Prof. T. Valchev's scientific activity is in the field continuous integrable systems, partial differential equations, spectral analysis and scattering theory. The result of this scientific activity is contemporary publications, some of which are submitted for participation in this competition.

There are presented a total list of 42 publications, 15 of which for participation in the competition. Articles are published since 2010 in renowned mathematics and mathematical physic's journals, such as: Journal of Nonlinear Mathematical Physics - 2; Journal of Mathematical Physics - 1 ;Journal of Physics A: Mathematical and Theoretical - 1; Theoretical and Mathematical Physics - 1; Physics Letters A: General, Atomic and Solid State Physics - 1; Journal of Geometry and Symmetry

in Physics - 1; Symmetry, Integrability and Geometry: Methods and Applications - 1; Proceedings of International conferences -7. With Impact Factor (IF) are 7 publications [5 - 7, 9, 13 - 15], with SJR are 4 publications [2, 3, 10, 12]. Eights of the publications were co-authored with: V. Gerdjikov, G. Granovski, M. Mikhailov, A. Yanovski, R. Myrzakulov, G. Nugmanova, K. Yesmakhanova. I accept that the candidate's contribution is equal to that of his co-authors.

It was presented a list of 28 citations (without self-citations) of the publications for the competition.

In connection with Art. 2 of the IMI Rules for the "minimum required score by set of indicators" for the candidate Ass. Prof. T. Valchev is obtained the following: А - 50 points; Б - 100 points; Г - 254 points; Д - 153 points; Е - 64 points, which means that this requirement was been fulfilled.

**3)** The author's report correctly reflects the content and contributions in the works of Ass. Prof. T. Valchev. He works in actual and complex domain of mathematical physics connected with nonlinear partial differential equations and systems of equations with application in physics. The main methods are based on solution of direct and inverse scattering problems and scattering matrix. The applicant demonstrates competence in the subject of the competition, good awareness in the areas in which he works, the publications are written in clear and precise language.

I will analyze shortly the presented for the competition works following the conditional division made in the author's report.

**3a)** In papers [7, 11] and in the conference report [10] are studied scattering operators, which depend quadratically on the spectral parameter with coefficients in a certain Lie algebra. A typical example is non-linear Schrödinger equation with derevative $iq_t + q_{xx} + i(|q|^2 q)_x = 0$ and its multicomponent version

$$i\mathbf{q}_t + \mathbf{q}_{xx} + \frac{2mi}{n+m}(\mathbf{q}\mathbf{q}^*\mathbf{q})_x = 0 \tag{1}$$

where $\mathbf{q}$ is smooth $n \times m$ matrix-valued function.

In these works it is studied direct scattering problem for quadratic bundles connected with Hermitian symmetric spaces. Particular solutions of equation (1)

are found by applying a modification of the dressing procedure of Zakharov-Shabat. Constructed are reflectionless potentials for the quadratic bundles and their corresponding soliton type solutions. The results in these publications are new and perspective.

**3б)** In the papers [5, 6, 13 - 15] (cited all together 16 times), as well as in the conference reports [1 - 4, 8, 12] non-linear evolution equations, analogue of the Heisenberg's ferromagnetic equation. For example, in [13] it is studied two-component coupled non-linear evolution system

$$\begin{aligned} &iu_t + uxx + (uu_x^* + vv_x^*)u_x + (uu_x^* + vv_x^*)u = 0, \\ &iv_t + v_{xx} + (uu_x^* + vv_x^*)v_x + (uu_x^* + vv_x^*)_x v = 0, \end{aligned} \tag{2}$$

where functions $u, v : R \times R \to C$ are smooth, satisfy the constraint $|u|^2 + |v|^2 = 1$ and boundary conditions: $\lim\limits_{x\to\pm\infty} u(x,t) = 0$, $\lim\limits_{x\to\pm\infty} v(x,t) = e^{i\phi_\pm}$, $\phi_\pm \in R$.

The paper [13] is characteristic of this group and the results obtained there are continued in publications [2 - 6, 12]. In [13] it is studied direct scattering problem in the Hermitian case with constant boundary conditions. By using the dressing method were constructed two types of soliton solutions of the system (2).

**3в)** In the paper [9] (cited 10 times) are studied nonlinear evolution equations, such as non-local non-linear Schrödinger's equation

$$iq_t + q_{xx} \pm 2q^2(x,t)q^*(-x,t) = 0, \quad q : R^2 \to C \tag{3}$$

A new approach has been proposed as a generalization of the notion of group of reduction, defined by the author as a non-local reduction. This approach provides transformation of the independent variables $x$ and $t$ and gives the possibility to study (with the methods of the inverse scattering problem) new classes of non-local equations as equation (3). Let us remark that the paper [9] is 4 pages and citing it 10 times is a confirmation for a new and perspective results in it.

**4)** Ass. Prof. T. Valchev is actively involved in funded international and local projects. He had participated in 4 projects after 2004 and he is Principle investigator in one project funded by NSF since 2019.

**5)** I have no critical remarks. I know Ass. Prof. T. Valchev as industrious and actively working in the current field of mathematical physics.

**6) Conclusion:** I give a positive assessment of the works of Ass. Prof. PhD Tihomir Valchev and I believe that he fully satisfies the requirements of the ZRASRB for the competitive position, also in the submitted ones for the competition articles have no plagiarism.

I recommend the Scientific Jury to propose to the Scientific Council of the Institute of Mathematics and Informatics to select Ass. Prof. PhD Tihomir Valchev for Associate Professor in the professional field 4.5 "Mathematics", specialty Equations of Mathematical Physics..

May 6, 2021 Signature

T. Rangelov