

## **REVIEW**

**by Professor M. M. Yanev, MD,  
Institute of Mathematics and Informatics, BAS,  
member of a scientific jury in an announced competition for  
"Associate Professor" at FMI-PU "Paisii Hilendarski"  
according to PN 4.5. Mathematics (Probabilities and Statistics),**

### **I. Review of documents and requirements for the candidate**

The competition refers to the academic position of "Associate Professor" in the scientific field 4. Natural Sciences, Mathematics and Informatics, professional field 4.5. Mathematics (Probabilities and Statistics), announced in SG no. 99 of 20.11.2020 for the needs of FMI at PU "Paisii Hilendarski". The jury was appointed by order of the Rector of PU - P33636 / 19.02.2021.

The only candidate in the competition announced in SG 99 / 20.11.2020 is Assistant Prof. Dr. Petar Ivanov Kopanov, who currently holds this position in the Department of Mathematical Analysis at the FMI of the University of Plovdiv.

For evaluation in the competition I received 26 documents, which are described in detail in the application for participation in the competition. Here are some of the more important ones: CV, diplomas, list of publications and copies of them on technical media, reference for contributions and citations, reference for fulfillment of the minimum national requirements and the additional requirements, etc., all duly prepared, which gives me grounds to accept them for consideration and to establish that all formal requirements of the procedure are met.

The candidate's CV is prepared in accordance with the requirements of the European model and contains data on a number of serious achievements. Here are some of them. P. Kopanov was born on October 5, 1962 in the town of Pazardzhik, where in 1976-1980 he studied at the Mathematical High School "Konstantin Velichkov". During the period 1981-1986 P. Kopanov was a student at FMI-Sofia University, where he graduated with a degree in Mathematics (bachelor's and master's program) with excellent results and with a specialization in Operations Research. In the period 09.1986-01.11.1986 and 01.11.1986 - 25.03.1988 he worked as a programmer in Plovdiv and Pazardzhik, respectively, and then in the period 25.03.1988–30.11.1989 he was in the Laboratory of Automated Training Systems at the FMI of Sofia University. After that the activity of P. Kopanov was connected with the Plovdiv University "Paisii Hilendarski", where in 1989-1998 he was successively assistant, senior assistant and Assistant-Professor in the department "Probability Theory and Mathematical Statistics" at the Faculty of Mathematics and Informatics of PU,

from 1998 to 2020 he was Assistant-Professor in the Department of Applied Mathematics and Modeling at FMI-PU, and from 2020 he was Assistant-Professor in the Department of Mathematical Analysis at FMI-PU. During the period 1992-1996 P. Kopanov was in graduate school of independent preparation at IMI-BAS with scientific consultant Associate Professor Dr. Yordan Stoyanov and on 19.12.1995 defended his dissertation on "Probabilistic analysis of methods for approximate calculation of integrals " for obtaining the scientific degree" Candidate of Mathematical Sciences "(which today is equated to Dr.), for which is attached Diploma № 24173 of the Higher Attestation Commission at the Council of Ministers, according to protocol 01 №2 from 09.02.1996, issued on 19.04 .1996. The autobiography mentions a number of other activities: participation in an international research project (2007-2010), management of the representative teams of the University of Mathematics and Informatics, member of the national commissions and the jury for the Mathematical Olympiads, etc.

P. Kopanov' s scientific interests are generally in the field of TP and MS, as well as their applications. Among them, special attention is paid to various aspects of the field of differential equations (DE) with pulses at random times, set by appropriate distributions. The general list of publications contains 28 titles in the period 1994-2020, of which 24 are presented in the competition, distributed as follows: 18 articles in scientific journals in English, 4 textbooks in the publishing house "Paisii Hilendarski" and two textbooks in electronic media ( in Bulgarian). The works presented in the competition are after the defense of a dissertation and have not participated in other similar competitions. These works will be analyzed in more detail in the next section of the review. Note only that 9 of the articles are in reputable international journals with IF and / or SJR, 2 of which are in Q1, 1 is in Q3 and 3 are in Q4.

Detailed annotations on the contributions of scientific papers in Bulgarian and English are presented. A separate reference is given to the scientific contributions ("self-assessment") of the scientific publications, which are divided into 6 sub-areas (also in Bulgarian and English). A separate reference for 16 citations is attached, 8 of which are indexed in the known Scopus databases and are estimated to carry 76 points. These documents will be discussed in detail in the next section of the review Attached is a reference on the implementation of the minimum national and additional faculty requirements in connection with participation in a competition for the academic position of "Associate Professor", which is also signed by the head of the Department of Mathematical Analysis and the Dean of FMI. Two separate lists of relevant national and faculty requirements are also presented in detail. In general, the attached reference to the minimum scientific requirements shows that they are undoubtedly exceeded.

Impressive is the report on the educational activity of P. Kopanov in PU, signed by the head of the Department of Mathematical Analysis and by the Dean

of FMI. Dr. P. Kopanov has given 9 different regular courses of lectures in the field of probability theory, mathematical statistics and operations research, as well as 10 elective courses. He has also led five different types of exercises in stochastic, operations research and statistical software. During this period, P. Kopanov was the scientific supervisor of 35 successfully defended graduates, and also wrote 20 reviews of other diploma theses. To this we must add that he is the author and co-author of 4 textbooks (on paper) and 2 - on electronic media. There are a number of other activities as a member of commissions for state exams and diploma theses, participation in conducting entrance exams and others.

From the inspection there is no finding of absence or presence of violations in the procedure and inadmissibility of the candidate to the competition. On the contrary, the high quality of the submitted materials for the competition and the full satisfaction of all formal regulatory requirements is obvious. All this gives me a reason to proceed to the next sections, according to ZRAS and the relevant regulations.

## **II. Analysis of research, education and scientific and applied activity**

First of all, it should be noted that the 18 articles presented in the competition have been published in a number of renowned international journals with an impact factor. Two articles in Mathematics, which are in Q1, one article in Acta Math.Scientica from Q2, three articles from Q4, published in Probability Theory and its applications, CRABS and Dynamic Systems & Appl, respectively, should be mentioned here. Two articles with SJR are in J.Pure & Appl.Math. and Mem.DE Math.Phys. Two other papers have been published in Int.J.Actor-Network Theory & Tech.Inn. One more article has been published in the following journals: EDULEARN Proceedings, Sociological Problems, Mathematics & Statistics, Int.J.Otorhinolaryngology, J.Sci.Research & Studies, SCIREA J. of Math. and SCIREA J. of Astronomy. The articles are distributed as follows: 4 - independent, 4 - with one co-author, 3 - with two co-authors, 7 - with three co-authors. The total number of co-authors is 14, of which 4 are foreigners, and the rest are from Bulgaria. Due to the lack of other grounds, I accept as natural at least the equal co-authorship of P. Kopanov in the joint works. These data well illustrate the possibilities of P. Kopanov to work with different authors in different topics.

The publications submitted in the competition (according to the attached list) could be mainly divided into four groups as follows:

- 1) Articles that address some fundamental issues of TP and MS [4, 5, 12, 17];
- 2) Articles in which stochastic methods are applied in differential equations with impulses at random moments [1, 2, 3, 6, 7, 8, 9];

3) Articles in which stochastic methods are applied in other scientific fields [11, 13, 14, 15, 16, 18];

4) Textbooks [19, 20, 21, 22, 23, 24] and an article [10], which is also in the field of education.

The attached scientific report, consisting of annotations and self-assessment of the contributions, briefly gives the main directions of research and explains some of the main results. Reading only these materials, one can be left with the impression that there are no proven theorems, as such are not cited. And this is not the case at all.

For example, the main results of the article [5] from the first group are presented in four theorems, the first two of which consider continuous distributions, and Theorems 3 and 4 - their discrete analogues. The work is dedicated to a classic topic related to the so-called "Problem of the moments", which was dealt with by P.L. Chebishev, but which is still relevant. In Theorem 1, two conditions are found (easily verifiable), which unambiguously determine by the moments an absolutely continuous distribution on the whole line (Hamburger case), and in Theorem 2 similar conditions are transferred in the case when the corresponding distribution is focused on the positive half-line (Stieltjes case). Here we should note that the article was published in the journal *Probability Theory and its applications*, founded by A.N. Kolmogorov, which has always been one of the main leaders in the field of fundamental Stochastics (despite the lower IF given to him by bibliographers, assigning it a group Q4). And it is no coincidence that the magazine is published immediately in English in SIAM. Rightly, every article there can be considered a top achievement for any author. To the same field we can refer the interesting article [4], published in CRABS, where now the main attention is focused on the so-called "Lin's condition." In article [12] (also from the first group) the object of research is the Bernoulli process. As is well known, this process is directly related to Poisson's random measures and many properties are obtained in this way. However, the article uses a direct approach to the respective distribution function. Lemma 4.2 is interesting in this respect, and Theorems 5, 6, and 7 establish some properties related to the probability density. The work was published in *Mathematics and Statistics*. The last article [17] of this first group was published in the SCIREA *Journal of Mathematics*. Some conditions for moments in some tangential transformations are shown, similar to the classical Cauchy distribution. As a general characteristic of this group of articles, it can be said that for some classes of random variables the distribution functions and the corresponding moments are studied.

The second group of articles [1, 2, 3, 6, 7, 8, 9] treats some more non-standard problems related to differential equations (DE) with impulse at random moments of time. Let us first note that the Plovdiv school of Prof. Drumi Baynov in the field of differential equations is well known, but now we see a new development in the field of randomized DEs, which are definitely of a higher level of complexity and naturally require a number of stochastic methods. Given the distributions of the random moments of the pulses, the solutions of the respective equations are investigated, focusing on problems related to existence, uniqueness and different types of stability. Thus, in article [1] a system of DE is studied, which describe the so-called Cohen – Grossberg neural networks, where the times between the individual pulses have an exponential distribution. The main results are given in Theorems 2 and 3, where it is shown that the corresponding equilibrium point is square exponentially stable or mean exponentially stable, respectively. An example of dimension 3 is considered, for which interesting graphs are presented. In the article [2] the times between the pulses are also exponentially distributed, but now the DEs are much more complex: they have the so-called fractional derivative of Riemann – Liouville (Riemann – Liouville fractional differential equations). The main result is contained in Theorem 1, where the so-called p-moment Mittag – Leffler stability is obtained, which in the usual integer case is reduced to p-moment exponential stability. Thus, Theorem 4.4 of Article [3] also proves p-moment exponential stability, but now for DEs with pulses at random moments have a  $\Gamma$ -distribution. An illustrative particular case is considered in Example 5.1, where interesting graphs are also given. In Article [6], we consider a Hopfield neural model given by a system of DEs (formulas (2)), where the times between random pulses have an exponential distribution. The main result is formulated as Theorem 2, where under certain conditions the p-moment exponential stability is proved. Finally, an example with dimension three is given. Article [7] is dedicated to the memory of Prof. Drumi Baynov and examines systems of nonlinear DEs with mixed type pulses. First, (1) defines a system with impulses that are not instantaneous, but are realized in some final interval (noninstantaneous impulsive differential equations). The moments are then randomized, assuming that they have an Erlang distribution, and thus we arrive at a system (6) of DEs (with noninstantaneous random moments of impulses), for which Theorem 1 shows that the trivial solution (at  $x(0) = 0$ ) is a p-moment exponentially stable. Previously, §4 examined the system (18) of linear equations, for which a number of interesting properties were found, which were then used in the proof of

Theorem 1. Article [8] considered a system (2.1) of nonlinear DEs with moment pulses ( impulsive differential equations), which are then assumed to be at random moments with Erlang distribution, and thus arrive at a system (2.2) for which Theorem 4.1 shows the p-moment exponential stability of the trivial solution. In the article [9] we study analogous DEs to those in the article [7], and it can be said that in a sense the studied model in [9] generalizes the one in [7], since the Erlang distribution is a special case of  $\Gamma$ -distribution used in [9]. The main results are given in Theorems 6.1 and 6.2, where p-moment exponential stability is also obtained, analogous to [7]. Finally, it should be noted that the articles in this second group have been published in reputable journals with IF and / or SJR. Stochastic methods are applied correctly, and some of the accounts are given in much more detail, given that perhaps some readers are not experts in the field of Stochastics.

The third group of articles [11, 13, 14, 15, 16, 18] gives some applications of TP and MS in other scientific fields. Such applications require, above all, collaboration with specialists in the field and a serious understanding of its issues in order to be able to construct an adequate mathematical model. Thus, in [11], [13], [15] P. Kopanov co-authored with sociologists, and the object of study are sociological networks, as the respective models are based mainly on a stochastic approach. In the article [11] the main attention is paid to the sociological aspects for the respective modeling, as some basic principles for the respective models of the so-called sociological agents. The corresponding mathematical models are set out in more detail in the following articles [13] and [15]. Especially in [13] the so-called the SAN (stacked actor-networks) model, which is further developed in [15], where other models specifically based on DEs and in particular Riccati equations are also mentioned. In an article [14] P. Kopanov co-authored with doctors, and the aim is to statistically compare two methods of treatment. For this purpose, the well-known “statistical criterion of signs” is applied, which, as shown, gives very good results and clearly confirms the advantage of the new method. In the article [16] P. Kopanov attacks one of the serious problems in theoretical informatics (computer science): whether  $P = NP$ , i.e. whether the complexity classes  $P$  and  $NP$  do not coincide. With some ingenuity, the author constructs a stochastic example related to a well-known combinatorial problem of splitting two parts of a set of natural numbers (partition), which shows polynomial-time insolvability for this known NP-complete problem, aptly using the term stochastic independence.

The fourth group of publications [19,20,21,22,23,24] has an educational character. We can also include an article [10], which is also in the field of education and deals with problems related to the Student Olympiad in Computer Mathematics in 2018. In fact, [19] is a collection of problems from different types of competitions for students of mathematics (at home and abroad), and [20] is a similar collection of computer mathematics, both manuals are presented on electronic media. The collections are provided with relevant theoretical notes. It can be seen that the author P. Kopanov has made commendable efforts in this activity. The textbooks [21,22, 23] are designed to serve the training in TP and MS in the bachelor's programs. They are provided with brief theoretical guidelines and tasks in these areas. Finally, some applications are given, as well as solutions, guidelines and answers. In fact, as the authors note, [22] is the second revised and supplemented edition of [21]. One common remark to these two editions is the lack of any literature in the field of TP and MS. And even in Bulgarian there is no lack of one. The same remark can be made to [23], where 14 titles are still mentioned, but in English. Even the famous Bulgarian Guide to TP Exercises with SMIT authors (by the first letters of the surnames) is given in its English translation. Otherwise, the tasks are interesting, well selected and sufficiently cover the requirements for a bachelor's program. Finally, [24] is a guide to working with Wolfram Mathematica, which is provided with extensive theoretical information, examples and literature with 21 titles. As the author P. Kopanov points out in the preface, all examples are worked out in the course "Software systems in mathematics". A really interesting and useful tutorial.

These educational works, as well as the attached impressive list of 9 compulsory courses and 10 additional ones in the bachelor's programs of FMI-PU, show that the candidate Dr. Kopanov fully meets the standards that can be applied to a habilitated person. The same applies to the scientific and applied research products analyzed above. And the attached reference to the minimum scientific requirements shows that they are undoubtedly exceeded. According to the requirements, I must explicitly state that I do not see any grounds for plagiarism or anything like that in the peer-reviewed works.

Everything stated in this section of the review gives me reason to conclude that the scientific output and scientific-metric indicators of the candidate are at a high level and undoubtedly fully meet all the conditions for holding the required academic position "Associate Professor".

### **III. Opinions, recommendations and notes**

I would like to make a remark to the candidate that he did not attach to the materials of the competition an abstract from his dissertation. This always gives a greater completeness of the presentation. Here I must note that upon additional request I was provided with the entire dissertation on electronic media.

As a constructive critique, I would recommend greater activity in the work of the National Seminar on Stochastics and participation in the International Conferences on TP and MS, which are traditionally organized in our country. And as can be seen from the analysis, there is something to report.

### **Conclusion**

The inspection of the submitted materials for the competition did not reveal any violations in the procedure, as all the above-mentioned requirements were met. Any suspicion of possible plagiarism must be categorically ruled out, on the contrary, the original contribution is not in doubt.

As already emphasized in the previous sections, the scientific production of P. Kopanov is at a high scientific level, as well as his scientific-metric indicators in the field of Stochastics with publications in renowned journals with impact factor and citation. He is a "doctor" in the field of the competition and his teaching activity in FMI at PU undoubtedly deserves admiration.

Everything presented so far gives me a definite reason to conclude that the only candidate Dr. Petar Ivanov Kopanov undoubtedly satisfies all the conditions of the announced competition for the academic position of "Associate Professor" at FMI PU "Paisii Hilendarski" and I call the scientific jury and the faculty council to vote positively for his election.

Date: March 20, 2021.

REVIEWER:

/ prof. dmn Nikolay M. Yanev /