REVIEW

in a competition for an academic position

"Professor"

in professional field 4.5 Mathematics (Probabilities and Statistics),

for the needs of Sofia University "St. Kliment Ohridski "(Sofia University),

Faculty of Mathematics and Informatics (FMI),

announced in SG no. 21 of 2020 and on the websites of FMI and Sofia University

The review was prepared by: Assoc. Prof. Dr. Doncho Stefanov Donchev FMI, Sofia University "St. Kliment Ohridski ", in my capacity as a member of the scientific jury of the competition according to Order № RD38-267/ 10.07.2020. of the Rector of Sofia University.

Only a candidate has submitted documents for participation in the announced competition:
Assoc. Prof. Mladen Svetoslavov Savvov, IMI-BAS

I. General description of the presented materials

1. Details of the application

The documents submitted for the competition by the candidate comply with the requirements of ZRASRB, PPZRASRB and the Regulations on the terms and conditions for acquiring scientific degrees and holding academic positions at Sofia University "St. Kliment Ohridski "(PURPNSZADSU).

For participation in the competition the candidate Assoc. Prof. Mladen Sveoslavov Savvov. has presented a list of a total of 14. titles, publications in foreign scientific journals. Also presented are 15 other documents, references for fulfilled minimum requirements under Art. 26 of the Law on Public Procurement, for the scientometric indicators of the publications, for the citations, for participation in and management of national and international projects, as well as documents reflecting the teaching experience and the management of doctoral students.

I have no notes or comment on the documents.

2. Details of the candidate

Mladen Svetoslavov Savov received a bachelor's degree in Mathematics at Sofia University. Kliment Ohridski in 2004. In 2008 he defended his dissertation on Small time behavior of Levy processes and received a doctorate in mathematics from the University of Manchester, UK under the supervision of Prof. R. Donnie. From 2008 to 2009 he was a postdoctoral fellow of Prof. J. Bertoin in the Laboratory of Probability and Random Processes at the University of Pierre and Marie Curie, Paris. From 2009 to 2012 he worked at New College, Oxford as Esmee Fairbairn Junior Research Fellow. From 2012 to 2014 he was an associate professor at the Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, and a researcher on the ACOMIN project at the Institute of Information and Communication Technologies. In 2017, he defended his dissertation and obtained the degree of Doctor of Science. At the same time he is a researcher on an individual grant under the Marie Skłodowska-Curie Program, under the Horizon 2020 program, EC, at the Institute of Mathematics and Informatics, Bulgarian Academy of Sciences. In 2004 he received the award for excellent achievements in mathematics at Sofia University, and in 2007 the award "Doctoral Student of the Year" in Great Britain. In 2011 he won the Scopus Award for Young Scientist. His research interests cover the following areas: probabilities and stochastic processes, processes of Left and Markov processes, fluctuation theory of Levy processes, Spectral theory of Markov processes, probabilistic methods of quantum mechanics and others.

3. General characteristics of the scientific works and achievements of the candidate

The candidate has submitted 14 articles. Of these, I have referred 9 works - those for which I think I can give an expert opinion.

In paper # 1 (in collaboration with M. Kolb) the authors obtains conditions for a.s. convergence of integrals of the form $\int_0^\infty f(\xi_t)dt$, $f(x) \geq 0$, where ξ_t is a transient Levy process. The criterion is in terms of the potential measure of the process. Namely, it is shown that the integral in question is diverging a.s. if and only if the integral of the function $f(x)$ w.r.t. the potential measure of the process, is divergent to any set, whose compliment is transient for the Levy process. This criterion is compared with the recent result of Döring and Kyprianou, in which the potential measure plays no role, but instead it is assumed that the process possesses a

local time. An example that shows that the existence of a local time is essential for Döring and Kyprianou's criterion is given. Thus, the answer to the authors' conjecture that this condition can be removed is negative.

In article #4 (in collaboration with L. Mutafchiev) is characterized the asymptotic behavior as $n \to \infty$ of $M_n = \max \mu(j)$, where $\mu(j)$ is the number of blocks of size j, when breaking a set with cardinality n into blocks. It is assumed that all breakdowns of the set into blocks have the same probability. It is shown that, after suitable norming of the variable M_{n_k}, where (n_k) is a subsequence of integers, there exist three types of limit behavior, depending on the fractional part of the number $W = W(n_k)$, which is a root of the equation $W \exp(W) = n_k$.

The main result **of article # 5 (in collaboration with R. Loeffen and P. Patie)** is a characterization of the first exit time from the positive half-line of a semi-Markov random process, which is obtained from a self-similar Markov process by a random time change. The time change is set by a random process, that is inverse to the β-stable subordinator. Such processes have been studied intensively in recent years, as the jumps of the subordinator correspond to intervals at which its inverse is constant, and thus slows down the dynamics of the initial self-similar Markov process. The main results are:

- an explicit formula for Melin's transform of the density of distribution the first exit time, which is shown to exist;

- the smoothness of the density of the first exit time is studied as well;

- it is shown that the tail of distribution of the first exit time decreases with a power rate as . Explicit formulas are obtained for both the exponent and the first asymptotic of the tail.

Moreover, it is described a class of exit times whose distribution is Frechet. Attention is paid to the interesting fact that this is the case of first exit distributions of self-similar Markov processes without positive jumps, while the considered class of exit times corresponds to processes with two-sided jumps.

The main idea is based on Lamperti's correspondence between self-similar Markov processes and Levy processes and on the Wiener-Hopf factorization of the Levi-Hinchin exponent.

In article №6 (in collaboration with S. Zaevsky nnd O. Kounchev) are obtained PDE for the price of a European option issued on a risky asset, which may lose its value at a random time preceding the maturity of the option. In the first approach, the pricing process of the risk asset is described in terms of the risk process $1_{\{\tau<t\}}$ introduced by M. Yor. The main difficulty here is that the moment τ is not Markov w.r.t. the filtration generated by the Brownian motion and the

risk process is not adapted. The second approach is to make use of the model of risky assets with random jumps, considered, e.g. in S. Shreeve's book. The derivation of the PDE is standard and is based on changing the measure, the Ito's formula and averaging w.r.t. the risk-neutral probability.

In article [9] (in collaboration with M. Kolb) is studied a Brownian motion, whose local time is forced to stay below a given deterministic function. The question of interest is when the resulting conditional process is transient or recurrent, respectively. The work is motivated by Benjamini and Berestycki's conjecture, who introduce the following integral criterion: the process is transient if and only if

$$I(f)=\int_1^{\infty}\frac{f(t)}{t^{3/2}}dt<\infty, \tag{0.1}$$

Here, the authors prove this conjecture. Moreover, the proof clarifies the reason for the transience or the recurrence of the process. It turns out that if the function $f(t)$ is such that (1.1) holds, then the conditional process has sufficiently large excursions at zero, and it is transient. In this case, the structure of the conditional process is also described. Namely, it is shown that after a certain time, it behaves like a three-dimensional Bessel diffusion.

Article # 11 (in collaboration with F. Aurzada and T. Kramm) is devoted to the problem of the first exit of Levy processes through an one-sided boundary. . Described is a class of boundaries $f(t), f(0)=1,$ such that the tail of the distribution of the first exit time has the same asymptotic as the distribution corresponding to the boundary $f(t)=1$. This characterization is made both for spectrally negative Levy processes and for Levy processes with two-sided jumps. These classes include the boundaries $f(t)=1\pm t^{\gamma}, 0<\gamma<1/2,$ for which similar results were obtained earlier by other authors.

Article # 12 (in collaboration with M. Kolb) studies both the semi-group and the transition function of some classes of Markov processes and Levy processes, up to their first exit from an open interval *(0, a).* Asymptotic formulas have been obtained, in which the first two eigenvalues as well as the first eigenfunction and cofunction of process's generators play an important role.

Article # 13 (in collaboration with F. Aurzada and L. Doering) describes the structure of the normalizing functions in the law of iterated logarithm for Levy processes. It is shown that it depends on the small time deviations of the process. The authors obtain a condition under which the law of iterated logarithm holds. In contrast to the Wee's condition, which is purely probabilistic, this condition is in terms of the triplet of the process. A number of examples

for normalizing functions are considered, both in the general case and for specific Levy processes.

In paper # 14 (in collaboration with M. Kolb and A. Wuebker) is studied a stochastic model of a manufacturing process in the textile industry that has been found to have a geometrically ergodic stationary distribution. The approach relates to the stochastic Lyapunov method. Different cases of working regimes depending on parameters of the model are considered in detail.

I can confidently assert that the scientific papers meet the minimum national requirements under Art. 2b, para. 2 and 3 of ZRASRB and the additional requirements of Sofia University "St. Kliment Ohridski " for holding the academic position "professor" in the scientific field and professional direction of the competition; that the scientific papers presented by the candidate do not repeat those of previous procedures for acquiring a scientific degree and an academic position, and that they present original and significant scientific achievements.

3. Characteristics and assesment of the teaching activity of the candidate

In the last years I have personal impressions of the teaching activities of Mladen Savov. His teaching style is characterized by clear and precise presentation of the material, immediacy in communicating with students and the ability to motivate them to set high goals and work independently and thoroughly.

4. Analysis of the scientific and scientific-applied achievements of the candidate according to the submitted papers for participation in the competition

The presented papers show an exceptional diversity and breadth of the candidate's scientific interests, as well as the rich mathematical tools he uses. They cover both areas related to classical fields of the theory of stochastic processes (works 1, 10, 11, 12, 13) and those that are related to modern applications of this theory such as. financial mathematics (article # 6), combinatorial probabilities (article # 4), etc. His results are characterized by non-triviality and depth, and often require the use of a complex mathematical tools, as well as the latest advances in areas such as fractal calculus, spectral theory and others. His style is characterized by brevity and clarity in setting the problems, emphasizing his own contributions, and clarifying the relationship with the research of other authors.

5. **I have no critical remarks and recommendations** regarding the presented works.

6. Personal impressions of the candidate

I have known Mladen Savov since his return to Bulgaria in 2013. I had the pleasure to be his reviewer for his associate professorship at IMI, BAS, and later of his doctor of sciences thesis. Reading his works enriches me a lot because it opened up new approaches and problems for me, and allowed me to follow the latest trends in many different and interesting fields. His character is characterized by modesty and responsiveness, but also by firmness when principled positions have to be defended.

7. Conclusion on the application

After getting acquainted with the materials and scientific papers presented in the competition and on the basis of the analysis of their significance and the scientific and scientific-applied contributions contained in them, I confirm that the scientific achievements meet the requirements of ZRASRB, the Regulations for its application and the respective Regulations of Sofia University "St. Kliment Ohridski "for holding the academic position of" professor "in the scientific field and professional direction of the competition. In particular, the candidate satisfies the minimum national requirements in the professional field and no plagiarism has been established in the scientific papers submitted at the competition.

I give my positive assessment of the candidacy.

OVERALL CONCLUSION

Based on the above, I recommend the scientific jury to propose to the competent authority for the selection of the Faculty of Mathematics and Informatics at Sofia University "St. Kliment Ohridski "to choose Mladen Svetoslavov Savov to take the academic position of" professor "in the professional field 4.5 Mathematics (Probabilities and Statistics).

05.09. 2020 г. Prepared by

Assoc. Prof. Dr. Doncho Stefanov Donchev