



EDITORIAL

FCAA SPECIAL ISSUE (FCAA-VOLUME 20-5-2017)

Guest Editors: Yuri Luchko and Igor Podlubny

Dear readers,

this is a special issue of our journal FCAA ("Fractional Calculus and Applied Analysis"), dedicated to its 20th year and Vol. 20, and the 65th anniversary of its Editor-in-Chief Prof. Virginia Kiryakova, Dr.Sc.

For this issue we have selected twelve papers that have been previously submitted to FCAA and accepted, and whose authors decided to dedicate them to these occasions.

The issue contains both survey and research papers, and nine of these twelve papers have been contributed by the long-term Associate Editors or members of the Editorial Board of FCAA in order to mark the significant dates in the life of Professor Virginia Kiryakova and in the life of FCAA. There is no need to duplicate the table of contents here, so the readers are kindly invited to enjoy the papers, which all are related to Professor Virginia Kiryakova's wide research interests.

1. 20 Years of FCAA Journal

Dear readers,

our journal has this year its 20th volume, as started in 1998 with Volume 1. It would be interesting to share how the idea to initiate it appeared.

During the 2nd International Workshop "TMSF '1996" in the town of Varna (Bulgarian resort on the Black Sea), we had a round table discussion "Physical and Geometrical Meanings and Applications of the Fractional Calculus Operators". It was provoked by some open problems in the field of Fractional Calculus (then, still standing open and discussible!), was attended by many participants and lasted for more than 2 hours. Active part in these discussions took: F. Mainardi, P. Butzer, R. Gorenflo, S.L. Kalla, A. Kilbas, J. Trujillo, S. Kempfle, I. Dimovski, I. Podlubny, P. Rusev, H.M. Srivastava, etc.

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Also the possible connection of FC to the appearing modern theories of Fractals (Mandelbrot, etc) and fractional Hausdorff dimension were discussed. In the Proceedings "TMSF '1996", Inst. Math. and Inform. – Bulg. Acad. Sci., Sofia – 1998, we published some notes taken during these discussions: by V. Kiryakova (Convenor of the RT Discussion), "A long standing conjecture failed?" (pp. 579–588) and also contributions by R. Gorenflo, "Afterthoughts on interrelation of fractional derivatives and integrals" (pp. 589–591), S. Kempfle, "Modelling viscous damped oscillations by fractional differential operators" (pp. 592–583), F. Mainardi, "Considerations on fractional calculus: interpretations and applications" (pp. 594–597).

No need to mention that nowadays, most of the open problems are close and sound nonsense, and the conjecture (stated by B. Ross on the 1st conference on FC, New have, 1974) as: "Is there a geometrical representation of a fractional derivative? If not, can one prove that a graphical representation of a fractional derivative does NOT exist? ... The consensus of the experts ... is that there is, in general, NO geometrical interpretation of a derivative of fractional order ... It can be asked, however at least for a geometrical meaning or a physical phenomena that can be represented by means of equations involving a derivative of a particular order such as 1/2 ..." failed!

Then, it was discussed also the need of a forum, like periodical journal, where the results in FC and its applications can be published, as well to host there the Proceedings of next TMSF meetings ...

Thus, in 1998 we started the Journal! Below, we re-publish a text from the journal's records:

PREFACE (to the 1st FCAA issue: Vol. 1, No 1, 1998)

Dear readers,

it is a pleasure to present the very first issue of our new international journal "Fractional Calculus and Applied Analysis" (or, in short, "FCAA" Journal). Its topics are Fractional Calculus, Special Functions, Integral Transforms and some closely related areas of Applied Analysis. I am indebted to the members of the Editorial Board (EB) for their support and backing in launching this journal. Their experience and prestige will no doubt ensure a successful start and gaining the confidence of the audience. I also extend my gratitude to all our colleagues and friends who during recent years have continuously expressed their interest in the above topics and in the international workshops "Transform Methods & Special Functions" ("TMSF, Sofia '1994", "TMSF, Varna '1996"), thus encouraging us

to provide a new forum for the discussion and exchange of results and open problems.

Special Functions and Integral Transforms are well established areas of Applied Analysis. Their recent revival has been driven by many new applications to problems, some of a purely theoretical kind and others of an essentially practical nature. The fractional derivatives and integrals, as a class of Integral Transforms, are the basis of Fractional Calculus (FC), nowadays greatly extended through the use of Special Functions as kernel-functions. This is a discipline as old as the Classical Calculus but with a different and controversial development and deserving to find now its appropriate place in the mentality of mathematicians and their clients from the practice - physicists, engineers, economists and other applied scientists.

This Journal is conceived as a supplement to and continuation of the existing periodicals and proceedings of several international conferences on these topics, starting with New Haven (1974), Glasgow (1984), Tokyo (1989) and continuing in the recent years with meetings in close areas in Poland, Belarus, Yugoslavia, and the "TMSF" Workshops in Bulgaria. In a sense, the Journal's aim is to continue the discussions of the Round Table "Physical and Geometrical Meanings and Applications of the Fractional Calculus Operators" during the Second Workshop "TMSF, Varna '96". As such, we welcome also papers emphasizing possible applications of the "FCAA" techniques to solving differential and integral equations, and problems arising from Physics, Chemistry, Astronomy, Statistics, Economics and Engineering; as well as interactions with Fractals and Fractal Geometry.

The policy of the Editorial Board is to process submitted papers rapidly. To this end, LATEX (TEX) files and e-mail are the most preferred means for all correspondence (submission of papers, reviewing, proofreading, etc.). Current information on the "FCAA" including the Editorial Board, contents, abstracts of published papers, style and template files, subscription prices, order forms and other details are available online: at editor's FCAA website (http://www.math.bas.bg/~fcaa, recently not updated) and by e-mail.

Welcome to our Journal. We hope it will be a cosy place for all who are fond of the topics of "FCAA" or eager to join the "family of fractional and applied analysts".

The Managing Editor, Virginia Kiryakova

March 1998

The founding and first publisher of FCAA was the Institute of Mathematics and Informatics – Bulgarian Academy of Sciences (IMI – BAS), with 10 volumes until 2010. After its great success, the journal was invited to be published by Versita (now De Gruyter Open) as nominated by Springer, and it was co-published by them 2011-2014 (Vol. 14 to Vol. 17). And since 2015, FCAA was passed to the mother company De Gruyter as publisher, with Vols. 18, 19, 20, etc., each of 6 issues, and yearly contents of more than 1500 pages, print copies and online at https://www.degruyter.com/view/j/fca.



In 2011, the journal was accepted for indexing in SCI by Thomson Reuters (TR) and in Scopus by Elsevier. In 2014 they appeared the first impact factor and impact rank. As one of editors, I. Podlubny then said, "we did expect FCAA to become a star, but it started with its first impact factor as a Superstar!". Because with JIF = 2.974 (for 2013), the journal appeared to be on 3rd and 4th places in the rank lists of TR for mathematical sciences. And it continues to be on the TR "Top 10" list in next years.

Thanks are due to the members of Editorial Board for their support and work, and specially to its Honorary Founding Editors. Without their moral support the journal would not have its first successful steps. Some of them are no more with us: A.A. Kilbas, E.R. Love, D. Przeworska-Rolewicz, G.F. Roach, I.N. Sneddon. Let us give them a well-deserved honor.

Happy 20th anniversary to FCAA!

Virginia Kiryakova, Ed.-in-Chief of FCAA,

On behalf of Editorial Board

 Report on the 8th International Conference TMSF 2017 ("Transform Methods and Special Functions", Sofia, Bulgaria, August 27–30, 2017)

Website: http://www.math.bas.bg/~tmsf/2017/

The main organizer and host was the Institute of Mathematics and Informatics – Bulgarian Academy of Sciences (IMI–BAS). The aim of this conference was to continue the traditions of the series of TMSF conferences in Bulgaria, http://www.math.bas.bg/~tmsf/, and to mark some jubilee

events: – the **70 years of IMI–BAS**; – the **20th volume of "Fractional Calculus and Applied Analysis"** journal; – the **65th anniversary** of its Ed.-in-Chief, Virginia Kiryakova.

Organizing Committee: Emilia Bazhlekova and Jordanka Paneva-Konovska (Co-Chairs), etc.

Scientific Program Committee: Virginia Kiryakova, Stepan Tersian (Co-Chairs), etc.

Topics and Scientific Program of TMSF 2017 were planned to include: – "Fractional Calculus and Applied Analysis" (FCAA) - the topics of this journal; – "Transform Methods and Special Functions" (TMSF) - topics as: Special Functions, Integral Transforms, Convolutional and Operational Calculus, Fractional and High Order Differential Equations, Numerical Methods, Generalized Functions, Complex Analysis, etc.; – "Geometric Function Theory and Applications" (GFTA); Applications etc. However, it happened that the vast majority of talks and participants were closely related to the FCAA topics!

The Scientific Program (28, 29, 30 August) and Abstracts Book are available at the conference website, with participants list and all other details. Post-conference publications of some papers presented at TMSF 2017 are planned in the journals FCAA and IJAM (*Int. J. Appl. Math.*).

The final countdown is that there were 70 participants and visitors, from 17 countries (44 - from abroad, 26 - from Bulgaria), distributed as follows: Serbia / Macedonia - 7; Poland - 6; Italy - 5; Oman - 3; China / Romania / Russia / Slovak R / Spain - 2; Croatia / France / Germany / Portugal / Ukraine / Uzbekistan - 1. Among participants, we had 11 representatives of FCAA Editorial Board: R. Garrappa, M. Kirane, Y. Luchko, J.A. Tenreiro Machado, F. Mainardi, I. Podlubny, and the Bulgarian members: E. Bazhlekova, I. Dimovski, V. Kiryakova, P. Rusev, S. Tersian.



The Social Program included a sightseeing tour in the downtown of Sofia, welcome cocktail and banquet party in a restaurant with typical Bulgarian atmosphere and folklore program, combined with tasting of local cuisine, rakia and wines.

Emilia Bazhlekova, Jordanka Paneva-Konovska,

On behalf of the Organizing Committee

Virginia Kiryakova, Stepan Tersian,

On behalf of the Program Committee

3. 65 Anniversary of Prof. Virginia Kiryakova

3.1. Congratulations to Virginia Kiryakova on her 65th Birthday

On March 26, 2017, Professor Virginia Kiryakova had her 65th birthday. On behalf of the Editorial Board of FCAA and the whole FC community, we take great pleasure in congratulating Prof. Kiryakova on this remarkable date, and send her our best wishes for strong health, happiness and success in all her activities.

With her numerous contributions of deep content and the highest quality, she is an outstanding expert on the fractional calculus and its generalizations, theory of the special functions, integral transforms, and operational calculus. Her book "Generalized Fractional Calculus and Applications" (co-published by Longman, Harlow - UK, and Wiley & Sons, Inc. N. York - USA, 1994) became a standard reference in the field of generalized fractional-order operators, and the series of her papers on multi-index Mittag-Leffler functions already became classics in the field of special functions. Adding to that her works on the Fox H-functions, the Erdélyi-Kober operators, various integral transforms, and other related fields makes her currently one of the most knowledgeable researchers in the field of special functions and integral transforms. She has a unique ability to present her top-level research in an attractive form; recall the titles of papers such as, "All the special functions are fractional differintegrals of elementary functions", or "A brief story about the operators of the generalized fractional calculus", or "Fractional calculus operators of special functions? -The result is well predictable!". Together with Professors Jose A. Tenreiro Machado and Francesco Mainardi, Professor Virginia Kiryakova is a leader in popularization of the fractional calculus. A combination of knowledge of the field and its history along with their creative artistic abilities resulted in the series of excellent posters: "A poster about the old history of fractional calculus", "A poster about the recent history of fractional calculus", and "Recent history of fractional calculus". Indeed, everybody knows that popularization is important for any field of science, but not everybody has Virginia's enthusiasm and dedication.

Her organizational abilities mean a lot to the mathematical community. During difficult times of social, political, and economic transformation in Bulgaria, she was able to create and maintain the series of conferences "Transform Methods and Special Functions" (TMSF). These conferences attracted a significant number of researchers from all over the world and led her to the founding this journal, "Fractional Calculus and Applied Analysis" (FCAA), in 1998, as a response to the discussion during TMSF '96 in Varna. That conference, in fact, can be compared in its importance to the famous 1974 conference in New Haven, organized by Bertram Ross, which was the first conference completely devoted to fractional calculus and its applications.

The FCAA journal is an outstanding creation of Professor Kiryakova, one of a kind, and it is inseparable from her for 20 years, which is another reason for celebration. It started as open-access, and successfully avoided all those troubles of which many newly-found journals suffer. Professor Kiryakova, who never relaxed in her efforts for selecting and publishing only top-quality research, played the key role in organizing and maintaining the journal. Using her well-established scientific connections, Virginia has attracted the leading experts in the field of fractional calculus and its applications either to join the editorial board of FCAA or/and to contribute to its success as authors of the published papers. Many groundbreaking and therefore highly cited papers were published in FCAA during the period from 1998 to 2011 (and of course, afterwards, too). As a result, after FCAA was included in SCI (Web of Science) and appeared in the Journal Citation Reports two years after that, in 2013, it immediately took (and still holds) the highest positions in the rankings in Mathematics, Applied Mathematics, and Mathematics – Interdisciplinary Applications.



A rare photo taken by Igor Podlubny at the ICCC '2003 conference. Prof. Virginia Kiryakova with Prof. Svante Westerlund (left) and Prof. Wen Chen (right)

All people who ever met Professor Virginia Kiryakova adore her for her human qualities, her sense of humor, her warm heart, and also for her wide interests that go far beyond mathematics and science. She writes poetry, loves her cats, swimming, painting, reading, and she is a great story-teller - and all that makes every minute spent in her company a real joy.

We wish Professor Virginia Kiryakova many further creative and successful years in all her diverse fields of interests, and the fulfillment of all the wishes in her own wish list!

Yuri Luchko and Igor Podlubny, Guest Editors of the Special Issue

3.2. Some CV Data for Prof. Virginia Kiryakova

Prof. Dr.Sc. Virginia Stoyneva Kiryakova (Institute of Mathematics and Informatics (IMI) – Bulgarian Academy of Sciences (BAS)), *Editor-in-Chief* of this "*FCAA*" Journal, is born March 26, 1952 in Sofia, Bulgaria. She graduated from the 1st Gimnazium in the town of Rousse and made her first successful steps in the famous Rousse Mathematical Pupils' School. Then obtained M.Sc. and Ph.D. degrees in Mathematical Analysis from the Sofia University, and Dr.Sc. (2nd Doctoral Degree) - from Bulgarian Higher Attestation Commission.

Her main research interests are in the field of Applied Mathematical Analysis: Fractional Calculus, Special Functions, Integral Transforms. Her results are published in a book and more than 120 papers in specialized periodical journals and proceedings of international conferences, and are cited by foreign authors more than 2000 times. Author of the monograph: V. Kiryakova, "Generalized Fractional Calculus and Applications", Longman, Harlow and John Wiley & Sons, New York, 1994. Among the other publications, she has some translations of mathematical books and edited several Proceedings of international meetings: "Complex Analysis & Applications, Varna '87" (BAS - Sofia, 1989); "Transform Methods & Special Functions, Sofia '94", "Transform Methods & Special Functions, Varna '96", "Transform Methods & Special Functions, AUBG '99", "Transform Methods & Special Functions, Borovets 2003" (Proc. of 1st, 2nd, 3rd and 4th TMSF Workshops); "Geometric Function Theory and Applications, Sofia 2010", "Complex Analysis and Applications, Sofia 2013", etc. Editor-in-Chief also of the journal "International J. of Applied Mathematics" (IJAM, ISSN 1311-1728, 1314-8060); member of Editorial Boards of other 10 international mathematical journals; reviewer for many other international mathematical journals and books projects, these and projects abroad.

Scholarships in Belarus (Minsk, 1990), UK (Glasgow, 1992) and Japan (Fukuoka, 1997). *Memberships*: SIAM, Edinburgh Mathematical Society, Union of Scientists in Bulgaria.

Invited lectures at several international conferences and Visiting Professor in foreign universities in Belarus, Germany, Hungary, Italy, Japan, Kuwait, Lebanon, Macedonia, the Netherlands, Poland, Portugal, Russia, Serbia, Slovak R., Spain, Tunisia, UAE, UK, USA, etc.

Organizer or member of *Organizing and International Program Committees*, Steering Committees etc. of several international mathematical conferences in Bulgaria and abroad, among them are the series of "TMSF", "CAA", "GFTA", "FDA", "AMADE", "FSS", "AMEE", etc.

Among her Administrative Activities in Bulgarian Science, are: member of Specialized Scientific Council on Mathematics; of the Scientific Council of Institute of Mathematics and Informatics, Chair of its Attestation Commission; member of the General Assembly of Bulgarian Academy of Sciences; Vice-chair of Mathematics and Informatics Experts' Commission at National Science Fund - Bulgarian Ministry of Education and Science; member of its Executive Council; coordinator and leading scientist of several research projects; member of many accreditation commissions and juries for theses defences, promotions, etc.

Awards: 3rd Prize at 11th International Mathematical Olympiad (Bucurest - Romania, 1969), Badge of Honour of the Town of Sofia (1995), Academical Prize for Mathematics - Bulgarian Academy of Sciences (Sofia, 1996); "FDA Dissemination Price" at "Fractional Differentiation and Applications" Conference (Nanjing - China, 2012), etc.

Social Activities: a member of the Sofia Town Council (Municipality Council, 1991-1995), secretary of the Sofia Municipality Commission for Education and Science (1991-1995), secretary of the Mathematics Section of the Union of Scientists in Bulgaria (1989-1995), member of "Association of Bulgarians Studied in Britain", "Lions Club - Sofia Izgrev" and their executive bodies, etc.

Hobbies: composing poetry, Reiki (Eastern healing practices), cats, swimming, painting, ...

Google Scholar Profile: http://scholar.google.bg/ citations?hl=en&user=HEuWjBAAAAAJ.

3.3. Virginia Kiryakova's Publications

Monograph:

V. Kiryakova, "Generalized Fractional Calculus and Applications", Longman Sci. & Techn., Harlow - UK, ISBN 0-582-21977-9 (Copubl. by J. Wiley & Sons Inc, USA, ISBN 0-470-23376-1), 1994, 402 p.

Research Papers: more than 120 items

List of Some Selected Papers:

- I.H. Dimovski, V. S. Kiryakova, On an integral transformation, due to N. Obrechkoff. Lecture Notes in Math. 798 (1980), 141–147; doi: 10.1007/BFb0097259.
- I.H. Dimovski, V. S. Kiryakova, Complex inversion formulas for the Obrechkoff transform. Pliska (Stud. Math. Bulg.) 4 (1981), 110–116.
- I. Dimovski, V. Kiryakova, Convolution and commutant of Gelfond-Leontiev operator of integration In: Proc. Conf. "Constr. Function Theory, Varna '1981", Sofia (1982), 288–294.
- I. Dimovski, V. Kiryakova, Convolution and differential property of Borel-Dzrbasjan transform In: Proc. Conf. "Complex Anal. and Appl., Varna '1981", Sofia (1984), 148–156.
- I.H. Dimovski, V. S. Kiryakova, Transmutations, convolutions and fractional powers of Bessel-type operators via Meijer G-functions. In: Proc. Conf. "Complex Anal. and Appl., Varna '1983", Sofia (1985), 45–66.
- 12. V.S. Kiryakova, On operators of fractional integration involving Meijer's G-functions. C. R. Acad. Bulg. Sci. 39, No 10 (1986), 25–28.
- I.H. Dimovski, V.S. Kiryakova, Generalized Poisson transmutations and corresponding representations of hyper-Bessel functions. C. R. Acad. Bulg. Sci. 39, No 10 (1986), 29–32.
- 15. V.S. Kiryakova, An application of the generalized operators of fractional integration to dual integral equations involving Meijer's *G*-function. *Pliska (Stud. Math. Bulg.)* **10** (1989), 93–107.
- 16. V. Kiryakova, Generalized Operators of Fractional Integration and Differentiation and Applications. Ph.D. Thesis, Sofia Univ., Sofia (1986).
- 23. V.S. Kiryakova, A generalized fractional calculus and integral transforms. In: *Proc. Conf. "GFCA, Dubrovnik'1987*", Plenum Publ. Co., New York (1988), 205–217; DOI: 10.1007/978-1-4613-1055-6_20.
- 24. V.S. Kiryakova, A new differential formula for Meijer's G-function. C. R. Acad. Bulg. Sci. 41, No 5 (1988), 27–30.
- D. Nikolic-Despotovic, V.S. Kiryakova, Abelian theorems for the Obrechkoff integral transform. Review Research Fac. Sci., Math. Ser., Univ. Novi Sad 18, No 2 (1988), 45–60.
- 27. V.S. Kiryakova, Fractional integration operators involving Fox's $H_{m,m}^{m,0}$ -function. C. R. Acad. Bulg. Sci. 41, No 11 (1988), 11–14.
- 28. V.S. Kiryakova, Generalized $H_{m,m}^{m,0}$ -function fractional integration operators in some classes of analytic functions. *Mat. Vesnik (Bulletin Mathematique, Beograd)* **40**, No 3-4 (1988), 259–266.

- 29. S.L. Kalla, V.S. Kiryakova, An H-function generalized fractional calculus based upon compositions of Erdélyi-Kober operators in L_p . Math. Japonicae 35, No 6 (1990), 1151–1171.
- 32. V.S. Kiryakova, Poisson and Rodrigues type fractional differintegral formulas for the generalized hypergeometric functions $_pF_q$. Atti Sem. Mat. Fis. Univ. Modena 39 (1990), 311–322.
- 41. L. Galue, V. Kiryakova, Further results on a family of generalized radiation integrals. *Radiat. Phys. Chem.* **43**, No 6 (1994), 573–579.
- 46. N. Hayek, V. Kiryakova, V. Hernandez Suarez, Laplace type integral transform for the third order Bessel-Clifford differential operator. *C. R. Acad. Bulg. Sci.* 48, No 7 (1995), 21–24.
- 51. V. Kiryakova, Multiple Dzrbashjan-Gelfond-Leontiev fractional differintegrals. In: "Recent Advances in Appl. Mathematics '96" (Proc. Intern. Workshop, Kuwait Univ.), Kuwait (1996), 281–294.
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- V. Kiryakova, M. Saigo, H.M. Srivastava, Some criteria for univalence of analytic functions involving generalized fractional calculus. Fract. Calc. Appl. Anal. 1, No 1 (1998), 79–104.
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 V. Kiryakova, Multiindex Mittag-Leffler functions, related Gelfond-Leontiev operators and Laplace type transforms. Fract. Calc. Appl. Anal. 2, No 4 (1999), 445–462.

- V. Kiryakova, M. Saigo, Sh. Owa, Distortion and characterization theorems for starlike and convex functions related to generalized fractional calculus. Korean J. Math. Sci. 5 (1998), 1–28.
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- 98. V. Kiryakova, Generalized Fractional Calculus and Applications in Analysis. Summary of Dr.Sc. Thesis, Sofia, IMI-BAS, 64 pp.
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