

## ON SQUARE-MEAN $S$ -ASYMPTOTICALLY BLOCH TYPE PERIODICITY OF SOME STOCHASTIC EVOLUTION EQUATIONS

AMADOU DIOP<sup>1</sup>, MAMADOU MOUSTAPHA MBAYE<sup>2</sup>, YONG-KUI CHANG<sup>3</sup> AND GASTON  
N'GUÉRÉKATA<sup>4</sup>

ABSTRACT. This paper introduces the concept of square-mean pseudo  $S$ -asymptotically Bloch type periodic for stochastic processes and establishes some composition and convolution theorems for such stochastic processes. In addition, it presents the notion and properties of square-mean weighted pseudo  $S$ -asymptotically Bloch-type periodic functions similarly. Finally, we investigate the existence and uniqueness of square-mean pseudo  $S$ -asymptotically  $\omega$ -periodic mild solutions of some stochastic integrodifferential equations driven by fractional Brownian motion.

### REFERENCES

- [1] A. Caicedo, C. Cuevas and H. R. Henríquez, *Asymptotic periodicity for a class of partial integrodifferential equations*. Int. Sch. Res. Notices, (2011).
- [2] B. De Andrade and C. Cuevas,  *$S$ -asymptotically  $\omega$ -periodic and asymptotically  $\omega$ -periodic solutions to semilinear Cauchy problems with non-dense domain*, Nonl. Anal. 72(6) (2010), pp. 3190–3208. DOI:10.1016/j.na.2009.12.016
- [3] B. B. Mandelbrot and J. W. Van Ness, *Fractional Brownian motions, fractional noises and applications*, SIAM Review, 10 (1968), pp. 422–437
- [4] C. Cuevas and J. C. De Souza, *Existence of  $S$ -asymptotically  $\omega$ -periodic solutions for fractional order functional integro-differential equations with infinite delay*, J. Nonl. Anal. 72(3) (2010), pp. 1683–1689.
- [5] C. Lizama and G. M. N'Guérékata, *Bounded mild solutions for semilinear integro-differential equations in Banach spaces*[J], Integr. Equat. Oper. Th., 68(2) (2010), pp. 207–227, DOI:10.1007/s00020-010-1799-2.
- [6] D. Brindle and G. M. N'Guérékata,  *$S$ -asymptotically  $\omega$ -periodic mild solutions to fractional differential equations*, Electron. J. Differ. Equ. 2020(30) (2020), pp. 1–12.
- [7] D. Brindle and G. M. N'Guérékata,  *$S$ -asymptotically  $\tau$ -periodic integrodifferential equations*, PanAmer. Math. J. 29(2) (2019), pp. 63–74.
- [8] D. Brindle and G. M. N'Guérékata,  *$S$ -asymptotically sequential solutions to difference equations*, Nonlinear Stud. 26(3) (2019), pp. 575–586.
- [9] E. R. Oueama-Guengai and G. M. N'Guérékata, *On  $S$ -asymptotically  $\omega$ -periodic and Bloch periodic mild solutions to some fractional differential equations in abstract spaces*, Math. Methods Appl. Sci. 41(18) (2018), pp. 9116–9122.
- [10] E. R. Oueama-Guengai and G. M. N'Guérékata,  *$S$ -asymptotically  $\omega$ -periodic mild solutions to some fractional integro-differential equations with infinite delay*, Lib. Math. (NS) 38(2) (2018), pp. 111–124.
- [11] F. Chen and X. Yang, *Almost automorphic solutions for stochastic differential equations driven by fractional Brownian motion*, Mathematische Nachrichten, 292(5) (2019), 983–995.
- [12] H. Henríquez, M. Pierri and P. Tàboas, *Existence of  $S$ -asymptotically  $\omega$ -periodic solutions for abstract neutral equations*, Bull. Austral. Math. Soc. 78(3) (2008), pp. 365–382. DOI:10.1017/S0004972708000713.
- [13] H. Henríquez, M. Pierri and P. Tàboas, *On  $S$ -asymptotically  $\omega$ -periodic functions on Banach spaces and applications*, J. Math. Anal. Appl. 343(2) (2008), pp. 1119–1130. DOI:10.1016/j.jmaa.2008.02.023

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- [14] J. P. C. Dos Santos and H. R. Henríquez, *Existence of  $S$ -asymptotically  $\omega$ -periodic solutions to abstract integro-differential equations*, Appl. Math. Comput. 256 (2015), pp. 109–118.
- [15] J. Pospíšil, *On ergodicity of stochastic evolution equations driven by fractional Brownian motion*, Proceedings of the Prague Stochastics, (2006), pp. 590–599.
- [16] Q. Li, L. Liu and M. Wei, *Existence of positive  $S$ -asymptotically periodic solutions of the fractional evolution equations in ordered Banach spaces*. Nonlinear Anal. Model. Control, 26(5) (2021), pp. 928–946.
- [17] Q. Li, L. Liu and M. Wei,  *$S$ -asymptotically Periodic Solutions for Time-Space Fractional Evolution Equation*, Mediterr. J. Math, 18(4) (2021), pp. 1–21.
- [18] M. F. Hasler and G. M. N'Guérékata, *Bloch-periodic functions and some applications*, Nonlinear Stud. 21 (2014), pp. 21–30.
- [19] M. Pierri and D. O'Regan,  *$S$ -asymptotically  $\omega$ -periodic solutions for abstract neutral differential equations*, Electron. J. Diff. Equ., 210 (2015), pp. 1–14.
- [20] M. Kostić and D. Velinov, *Asymptotically Bloch-periodic solutions of abstract fractional nonlinear differential inclusions with piecewise constant argument*, Funct. Anal. Approx. Comput. 9 (2017), pp. 27–36.
- [21] P. H. Bezandry, *Existence of almost periodic solutions for semilinear stochastic evolution equations driven by fractional Brownian motion*, Electron. J. Diff. Equ. 2012(156) (2012), pp. 1–21.
- [22] M. A. Diop, K. Ezzinbi and M. M. Mbaye, *Existence and global attractiveness of a pseudo almost periodic solution in  $p$ -th mean sense for stochastic evolution equation driven by a fractional Brownian motion*, Stochastics, 87:6 (2015), 1061-1093, DOI: 10.1080/17442508.2015.1026345
- [23] S. M. Manou-Abi, W. Dimbour and M. M. Mbaye, *Existence of an Asymptotically Periodic Solution for a Stochastic Fractional Integro-differential Equation*, Mathematical modeling of random and deterministic phenomena. Hoboken: Wiley; (2020). doi.org/10.1002/9781119706922.ch6
- [24] S. Nicola and M. Pierri, *A note on  $S$ -asymptotically  $\omega$ -periodic functions*, Nonl. Anal. 10(5) (2009), pp. 2937–2938. DOI:10.1016/j.nonrwa.2008.09.011
- [25] S. Zhao and M. Song,  *$S$ -asymptotically  $\omega$ -periodic solutions in distribution for a class of Stochastic fractional differential equations*, arXiv : 1609.01453v1 [math.DS]. (2016).
- [26] S. Zhao and M. Song, *Square-mean  $S$ -asymptotically  $\omega$ -periodic solutions for a Stochastic fractional evolution equation driven by Levy noise with piecewise constant argument*, arXiv : 1609.01444v1 [math.DS]. (2016).
- [27] X. Shu, F. Xu, and Y. Shi,  *$S$ -asymptotically  $\omega$ -positive periodic solutions for a class of neutral fractional differential equations*, Appl. Math. Comput., 270 (2015), pp. 768–776.
- [28] Y. Wei and Y. K. Chang *Generalized Bloch type periodicity and applications to semi-linear differential equations in Banach spaces*, Proc. Edinb. Math. Soc. 65 (2022), pp. 326–355.
- [29] Y. K. Chang and Y. Wei,  *$S$ -asymptotically Bloch type periodic solutions to some semi-linear evolution equations in Banach spaces*, Acta Math. Sci. Ser. 41B (2021), pp. 413–425.
- [30] Y. K. Chang and Y. Wei, *Pseudo  $S$ -asymptotically Bloch type periodicity with applications to some evolution equations*, Z. Anal. Anwend. 40 (2021), pp. 33–50.
- [31] Y. K. Chang and Y. Wei, *Pseudo  $S$ -asymptotically Bloch type periodic solutions to fractional integro-differential equations with Stepanov-like force terms*, Z. Angew. Math. Phys. 73 (2022), Art. 77, 17pp.
- [32] Y. K. Chang and R. Ponce, *Uniform exponential stability and its applications to bounded solutions of integro-differential equations in Banach spaces*, J. Integral Equ. Appl. 30 (2018), pp. 347–369.
- [33] Y. K. Chang, G. M. N'Guérékata, R. Ponce, *Bloch-type Periodic Functions: Theory and Applications to Evolution Equations*, World Scientific, NY, 2022.
- [34] Z. Alsheekhussain, J. Wang and A.G. Ibrahim, *Asymptotically periodic behavior of solutions to fractional non-instantaneous impulsive semilinear differential inclusions with sectorial operators*, Adv. Difference Equ. 2021(1) (2021), pp. 1–31.

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<sup>1</sup> LABORATORY OF NUMERICAL ANALYSIS AND COMPUTER SCIENCE, APPLIED MATHEMATICS SECTION, GASTON BERGER UNIVERSITY, B.P. 234, SAINT-LOUIS, SENEGAL.

<sup>2</sup> DÉPARTEMENT DE MATHÉMATIQUES, FACULTÉ DES SCIENCES ET TECHNIQUE, UNIVERSITÉ CHEIKH ANTA DIOP, BP-5005, DAKAR-FANN, SENEGAL.

<sup>3</sup> SCHOOL OF MATHEMATIC AND STATISTICS, XIDIAN UNIVERSITY, XI'AN 710071, SHAANXI, P. R. CHINA.

<sup>4</sup> NEERLAB DEPARTMENT OF MATHEMATICS, MORGAN STATE UNIVERSITY, BALTIMORE, MD 21251, USA.

*Email address:* <sup>1</sup> diop.amadou@ugb.edu.sn, <sup>2</sup> mamadoumoustapha3.mbaye@ucad.edu.sn,

<sup>3</sup> lzchangyk@163.com, <sup>4</sup> gaston.nguerekata@morgan.edu