

## APPROXIMATION PROPERTIES OF COMBINATION OF MULTIVARIATE AVERAGES ON TRIEBEL-LIZORKIN SPACES

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**Abstract.** The purpose of this paper is to establish the rate of approximation of the combination of some generalized multivariate average on Triebel-Lizorkin spaces and obtain its equivalent relation to the K-functionals. These results significantly generalize some known results in the literatures.

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### REFERENCES

- [1] R. ALABERN, J. MATEU AND J. VERDERA, *A new characterization of Sobolev spaces on  $\mathbb{R}^n$* , Math. Ann. **354**, 2 (2012), 589–626.
- [2] E. BELINSKY, F. DAI AND Z. DITZIAN, *Multivariate approximating average*, J. Approx. Theory **125**, 1 (2003), 85–105.
- [3] W. CAO, J. CHEN AND D. FAN, *Boundedness of an oscillating multiplier on Triebel-Lizorkin spaces*, Acta Math. Sin. (Engl. Ser.), **26**, 11 (2010), 2071–2084.
- [4] A. CARBERY, J. L. RUBIO DE FRANCIA AND L. VEGA, *Almost everywhere summability of Fourier integrals*, J. Lond. Math. Soc., **38**, 3 (1988), 513–524.
- [5] J. CHEN, D. FAN AND L. SUN, *Hardy space estimates for the wave equation on compact Lie groups*, J. Funct. Anal., **259**, 12 (2010), 3230–3264.
- [6] Y. K. CHO, *Continuous characterization of the Triebel-Lizorkin spaces and Fourier multipliers*, Bull. Korean Math. Soc., **47**, (2010), 839–857.
- [7] F. DAI AND Z. DITZIAN, *Combinations of multivariate average*, J. Approx. Theory, **131**, 2 (2004), 268–283.
- [8] Z. DITZIAN AND A. PRYMAK, *Convexity, moduli of smoothness and a Jackson-type inequality*, Acta Math. Hungar., **130**, 3 (2011), 254–285.
- [9] Z. DITZIAN AND K. RUNOVSKII, *Realization and smoothness related to the Laplacian*, Acta Math. Hungar., **93**, 3 (2001), 189–223.
- [10] D. FAN, Z. LOU AND Z. WANG, *A note on iterated spherical average on Lebesgue spaces*, Nonlinear Anal., **180**, (2019), 170–183.
- [11] D. FAN AND F. ZHAO, *Approximation properties of combination of multivariate averages on Hardy spaces*, J. Approx. Theory, **223**, (2017), 77–95.
- [12] M. FRASIER AND B. JAWERTH, *A discrete transform and decompositions of distribution spaces*, J. Funct. Anal., **93**, 1 (1990) 34–170.
- [13] L. GRAFAKOS, *Class Fourier Analysis, second ed.*, in Graduate Texts in math. vol. 249, Springer, New York, 2008.
- [14] Z. LIU AND S. LU, *Applications of Hörmander multiplier theorem to approximation in real Hardy space*, Lecture Notes in Math., **1494**, (1991), 119–129.
- [15] A. MIYACHI, *On some singular Fourier multipliers*, J. Fac. Sci. Univ. Tokyo Sect. IA Math., **28**, (1981) 267–315.
- [16] J. PERAL,  *$L^p$  estimates for the wave equation*, J. Funct. Anal., **36**, 1 (1980), 114–145.
- [17] J. L. RUBIO DE FRANCIA, *Weighted norm inequalities for homogeneous families of operators*, Trans. Amer. Math. Soc., **275**, 2 (1976), 2174–2175.

- [18] E. M. STEIN, *Maximal functions: Spherical means*, Proc. Nat. Acad. Sci. U.S.A. **73**, (1976), 2174–2175.
- [19] E. M. STEIN, *Harmonic Analysis: Real-Variable Methods, Orthogonality, and Oscillatory Integrals*, Princeton Univ. Press, Princeton, N.J., 1973.
- [20] E. M. STEIN AND G. WEISS, *Introduction to Fourier Analysis on Euclidean Spaces*, Princeton Univ. Press, Princeton, N.J., 1971.
- [21] D. YANG, YUAN, WEN AND C. ZHUO, *Fourier multipliers on Triebel-Lizorkin-type spaces*, J. Funct. Spaces Appl., 2012, Art. ID 431016, 37 pp.