

## STRONG CONVERGENCE THEOREMS OF STRONGLY RELATIVELY NONEXPANSIVE SEMI-GROUP IN BANACH SPACES

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Abstract. In this paper, we prove some strong convergence approximation theorems of strongly relatively nonexpansive semi-group in the framework of Banach spaces. Using the concept of duality theorems, we obtain analogue results for strongly generalized nonexpansive semi-group and for semi-group of firmly generalized nonexpansive type. The results presented in this paper improve and extend some corresponding results announced by some authors.

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## REFERENCES

- YA. I. Alber, Metric and generalized projection operators in Banach spaces: properties and applications, in: A. G. Kartsatos(Ed.), Theory and Applications of Nonlinear Operators of Accretive and Monotonic Type, Marcel Dekker, New York, 1996, pp. 15–50.
- [2] YA. I. Alber, S. Reich, An iterative method for solving a class of nonlinear operator equations in Banach spaces, Panamer. Math. J. 4, (2) 1994, 39–54.
- [3] R. E. BRUCK, S. REICH, Nonexpansive projections and resolvents of accretive operators in Banach spaces, Houston J. Math. 3, (1997) 459–470.
- [4] I. CIORANESCU, Geometry of Banach Spaces, Duality Mappings and Nonlinear Problems, Kluwer Academic Publishers, Dordrecht, 1990.
- [5] Y. CENSOR, S. REICH, Iterations of paracontractions and firmly nonexpansive operators with applications to feasibility and optimization, Optimization 37, (1996)323–339.
- [6] C. E. CHIDUME, E. U. OFOEDU, H. ZEGEYE, Strong and weak convergence theorems for asymptotically nonexpansive mappings, J. Math. Anal. Appl., 280, (2003), 364–374.
- [7] S.-S. CHANG, L. YANG, J. A. LIU, Strong convergence theorem for nonexpansive semi-groups in Banach spaces, Appl. Math. Mech., 28, (2007) 1287–1297.
- [8] S.-S. CHANG, H. W. JOSEPH LEE, C. K. CHAN, Convergence theorem of common fixed point for asymptotically nonexpansive semigroups in Banach spaces, Appl. Math. Comput., 212, (2009) 60–65.
- [9] S. S. CHANG, C. K. CHAN, H. W. JOSEPH LEE, Modified Block iterative algorithm for quasi-φasymptotically nonexpansive mappings and equilibrium problem in Banach spaces, Applied Math. Comput., (2011), 7520–7530.
- [10] S. S. CHANG, L. WANG, Y. K. TANG, Y. H. ZHAO, B. WANG, Strong convergence theorems for quasi-φ-asymptotically nonexpansive semi-groups in Banach spaces, Fixed Point Theory and Applications 2012, 2012:15, doi:10.1186/1687-1812-2012-15.
- [11] T. HONDA, T. IBARAKI, W. TAKAHASHI, Duality theorems and convergence theorems for nonlinear mappings in Banach spaces and applications, Int. J. Math. Stat., 6, (2010) 46–64.
- [12] T. IBARAKI, W. TAKAHASHI, A new projection and convergence theorems for projections in Banach spaces, J. Approx. Theory, 149, (2007)1–14.
- [13] S. KAMIMURA, W. TAKAHASHI, Strong convergence of a proximal-type algorithm in Banach space, SIAM J. O ptim. 13, (2002), 938–945.



- [14] F. KOHSAKA, W. TAKAHASHI, Existence and approximation of fixed points of firmly nonexpansivetype mappings in Banach spaces, SIAM J. Optim. 19, (2008) 824–835.
- [15] F. KOHSAKA, W. TAKAHASHI, Approximating common fixed points of countable families of strongly nonexpansive mappings, Nolinear Stud., 14, (2007) 219–234.
- [16] F. KOHSAKA, W. TAKAHASHI, Generalized nonexpansive retractions and a proximal-type algorithm in Banach spaces, J. Nonlinear Convex Anal., 8, (2007) 197–209.
- [17] S. MATSUSHITA, W. TAKAHASHI, Weak and strong convergence theorems for relatively nonexpansive mappings in Banach space, Fixed Point Theory Appl. 2004, (2004) 37–47.
- [18] S. MATSUSHITA, W. TAKAHASHI, A strong convergence theorem for relatively nonexpansive mappings in Banach space, J. Approx. Theory 134, (2005) 257–266.
- [19] P. E. MAINGE, Strong convergence of projected subgradient methods for nonsmooth and nonstrictly convex minimization, Set-Valued Anal. 16, (2008) 899–912.
- [20] W. NILSRAKOO, S. SAEJUNG, Strong convergence to common fixed points of countable relatively quasi-nonexpansive mappings, Fixed Point Theory Appl., 2008 (2008) Article ID 312454, 19 pages.
- [21] W. NILSRAKOO, Halpern-type iterations for strongly relatively nonexpansive mappings in Banach spaces, Computers and Mathmatics with Applications 62, (2011) 4656–4666.
- [22] W. NILSRAKOO, S. SAEJUNG, Strong convergence theorems by Halpern-Mann iterations for relatively nonexpansive mappings in Banach spaces, Applied Mathematics and computation 217, (2011) 6577–6586.
- [23] J. W. PENG AND J.-C. YAO, Two extragradient method for generalized mixed equilibrium problems, nonexpansive mappings and monotone mappings, Computers and Mathematics with Applications, 58, (2009), 1287–1301.
- [24] S. REICH, A weak convergence theorem for the alternating methor with Bregman distance, in: Theory and Applications of Nonlinear Operators of Accretive and Monotonic Type, in: Lecture Notes in Pure and Appl. Math., 178, Dekker, New York, 1996, pp. 313–318.
- [25] Y. F. Su, H. K. Xu, X. Zhang, Strong convergence theorems for two countable families of weak relatively nonexpansive mappings and applications, Nonlinear Anal., 73, (2010), 3890–3906.
- [26] T. SUZUKI, On strong convergence to common fixed points of nonexpansive semigroups in Hilbert spaces, Proc. Am. Math. Soc. 131, (2003) 2133–2136.
- [27] S. SAEJUNG, Halpern's iteration in Banach spaces, Nonlinear Anal., 73, (2010) 3431–3439.
- [28] W. TAKAHASHI, Nonlinear Functional Analysis, Yokohama Publishers, Yokohama, 2000.
- [29] K. K. TAN, H. K. Xu, Approximating fixed points of nonexpansive mappings by the Ishikawa iteration process, J. Math. Anal. Appl., 178, (1993) 301–308.
- [30] H. K. Xu, Another control condition in an iterative method for nonexpansive mappings, Bull. Austral. Math. Soc., 65, (2002) 109–113.