

EXISTENCE AND MULTIPLICITY OF SOLUTIONS FOR KIRCHHOFF TYPE PROBLEMS WITH PARAMETER

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Abstract. In this paper, we study Kirchhoff type problems with parameter on a bounded domain. By using variational methods, we prove the existence and multiplicity of weak solutions.

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REFERENCES

- [1] C. O. ALVES, F. J. S. A. CORRÊA, T. F. MA, *Positive solutions for a quasilinear elliptic equation of Kirchhoff type*, Comput. Math. Appl., 49, (1) (2005), 85–93.
- [2] C. CHEN, Y. KUO, T. WU, *The Nehari manifold for a Kirchhoff type problem involving sign-changing weight functions*, J. Differential Equations, 250 (2011), 1876–1908.
- [3] B. CHENG, *New existence and multiplicity of nontrivial solutions for nonlocal elliptic Kirchhoff type problems*, J. Math. Anal. Appl., 394 (2012), 488–495.
- [4] B. CHENG, X. WU, *Existence results of positive solutions of Kirchhoff type problems*, Nonlinear Anal., 71, (10)(2009), 4883–4892.
- [5] B. CHENG, X. WU, J. LIU, *Multiplicity of nontrivial solutions for Kirchhoff type problems*, Boundary Value Problems 2010, 2010:1.
- [6] F. JÚLIO, S. A. CORRÊA AND G.M. FIGUEIREDO, *On an elliptic equation of p -Kirchhoff type via variational methods*, Bull. Austral. Math. Soc., 74 (2006), 263–277.
- [7] F. FARACI, R. LIVERA, *Bifurcation theorems for nonlinear problems with lack of compactness*, Ann. Pol. Math., 82 (2003), 77–85.
- [8] X. HE, W. ZOU, *Existence and concentration behavior of positive solutions for a Kirchhoff equation in \mathbb{R}^3* , J. Differential Equations, 252, (2) (2012), 1813–1834.
- [9] J. JIN, X. WU, *Infinitely many radial solutions for Kirchhoff-type problems in \mathbb{R}^N* , J. Math. Anal. Appl., 369, (2) (2010), 564–574.
- [10] J.F. LIAO, P. ZHANG, J. LIU, C.L. TANG, *Existence and multiplicity of positive solutions for a class of Kirchhoff type problems with singularity*, J. Math. Anal. Appl., 430 (2015), 1124–1148.
- [11] C. LIU, J. WANG, Q. GAO, *Existence of nontrivial solutions for p -Kirchhoff type equations*, Boundary value problems 2013, 2013:279.
- [12] J. L. LIONS, *On some equations in boundary value problems of mathematical physics*, Contemporary Developments in Continuum Mechanics and Partial Differential equations (Proc. Internat. Sympos., Inst. Mat., Univ. fed. Rio de Janeiro, Riio de Janeiro, 1977), pp. 284–346. North-Holland Math. Stud., vol. 30, North-Holland, Amsterdam(1978)
- [13] R. MA, G. DAI, C. GAO, *Existence and multiplicity of positive solutions for a class of $p(x)$ -Kirchhoff type equations*, Boundary Value Problems, (2012), 2012:1–16.
- [14] A. MAO, Z. ZHANG, *Sign-changing and multiple solutions of Kirchhoff type problems without the P.S. condition*, Nonlinear Anal., 70, (3) (2009), 1275–1287.
- [15] K. PERERA, Z. ZHANG, *Nontrivial solutions of Kirchhoff-type problems via the Yang-index*, J. Differential Equations, 221, (1) (2006), 246–255.
- [16] B. RICCERI, *A general variational principle and some of its applications*, J. Comput. Appl. Math., 113 (2000), 401–410.

- [17] B. RICCERI, *On a classical existence theorem for nonlinear elliptic equations*, in *Experimental, constructive and nonlinear analysis*, M. Théra ed., 275–278, CMS Conf. Proc. 27, Canad. Math. Soc., 2000.
- [18] B. RICCERI, *A bifurcation theory for some nonlinear elliptic equations*, *Colloq. Math.*, 95 (2003), 139–151.
- [19] B. RICCERI, *A further refinement of a three critical points theorem*, *Nonlinear Anal.*, 74 (2011), 7446–7454
- [20] J.J. SUN, C.L. TANG, *Existence and multiplicity of solutions for Kirchhoff type equations*, *Nonlinear Anal.*, 74 (4), (2011), 1212–1222.
- [21] J. SUN, S. LIU, *Nontrivial solutions of Kirchhoff type problems*, *Appl. Math. Lett.*, 25, (3) (2012), 500–504.
- [22] L. WEI, X. HE, *Multiplicity of high energy solutions for superlinear Kirchhoff equations*, *J. Appl. Math. Comput.*, 39, (1-2) (2012), 473–487.
- [23] J. SUN, *On some problems about nonlinear operators*, Ph.D.Thesis, Shandong University, Jinan, 1984.
- [24] W. SHUAI, *Sign-changing solutions for a class of Kirchhoff-type problem in bounded domains*, *J. Differential Equations*, 259 (2015), 1256–1274.
- [25] Y. YANG, J. H. ZHANG, *Nontrivial solutions of a class of nonlocal problems via local linking theory*, *Appl. Math. Lett.*, 23 (2010), 377–380.
- [26] Y. YE, *Infinitely many solutions for Kirchhoff type problems*, *Differ. Equ. Appl.*, 5, (1) (2013), 83–92.