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Melnikov functions of arbitrary order for piecewise smooth differential systems in $\mathbb{R}^n$ and applications

Xingwu Chen [b], Tao Li [a,*], Jaume Llibre [c]

[a] *School of Economic Mathematics, Southwestern University of Finance and Economics, 611130 Chengdu, Sichuan, PR China*

[b] *Department of Mathematics, Sichuan University, 610064 Chengdu, Sichuan, PR China*

[c] *Departament de Matemàtiques, Universitat Autònoma de Barcelona, 08193 Bellaterra, Barcelona, Catalonia, Spain*

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Abstract

In this paper we develop an arbitrary order Melnikov function to study limit cycles bifurcating from a periodic submanifold for autonomous piecewise smooth differential systems in $\mathbb{R}^n$ with two zones separated by a hyperplane. This result not only extends some of the known results on the Melnikov theory in dimension and order but also compensates for some defects of the averaging theory in studying the limit cycle bifurcation of autonomous systems from a periodic submanifold. To demonstrate the application of our theoretical result and its superiority for some systems to the existing averaging theory, we study the maximum number of limit cycles bifurcating from an n-dimensional periodic submanifold caused by non-smooth centers of the fold-fold type, providing an upper bound for any order piecewise polynomial perturbations of degree m. Concerning the planar case of the unperturbed system, a piecewise Hamiltonian system, we obtain a better upper bound for piecewise polynomial Hamiltonian perturbations up to order two. The realizability of these upper bounds is also discussed.

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* Corresponding author at: School of Economic Mathematics, Southwestern University of Finance and Economics, 611130 Chengdu, Sichuan, PR China.

E-mail addresses: xingwu.chen@hotmail.com (X. Chen), litao@swufe.edu.cn (T. Li), jllibre@mat.uab.cat (J. Llibre).

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