J. Math. Anal. Appl. 467 (2018) 537–549

Contents lists available at ScienceDirect

Journal of Mathematical Analysis and Applications

www.elsevier.com/locate/jmaa

Limit cycles for discontinuous planar piecewise linear differential systems separated by one straight line and having a center

Jaume Llibre [a], Xiang Zhang [b,*]

[a] *Departament de Matemàtiques, Universitat Autònoma de Barcelona, 08193 Bellaterra, Barcelona, Catalonia, Spain*
[b] *School of Mathematical Sciences, Key Laboratory of Scientific and Engineering Computing (Ministry of Education), Shanghai Jiao Tong University, Shanghai, 200240, PR China*

ARTICLE INFO

Article history:
Received 14 October 2017
Available online 17 July 2018
Submitted by Y. Huang

Keywords:
Non-smooth differential system
Limit cycle
Discontinuous piecewise linear differential system

ABSTRACT

From the beginning of this century more than thirty papers have been published studying the limit cycles of the discontinuous piecewise linear differential systems with two pieces separated by a straight line, but it remains open the following question: *what is the maximum number of limit cycles that this class of differential systems can have?* Here we prove that when one of the linear differential systems has a center, real or virtual, then the discontinuous piecewise linear differential system has at most two limit cycles.

1. Introduction and statement of the main result

An isolated periodic orbit in the set of all periodic orbits of a differential system in the plane $\mathbb{R}^2$ is a *limit cycle*. The study of the limit cycles of the differential systems started at the end of the 19th century with Poincaré [25]. Many phenomena of the real world are related with the existence of limit cycles, some examples are the van der Pol oscillator [29,30], or the Belousov–Zhabotinskii reaction [3,31], and many other examples can be found in the book [6], or in the survey [22].

The objective of this paper is to study the limit cycles of the discontinuous piecewise linear differential systems separated by a straight line.

Some of the first studies on the discontinuous piecewise linear differential systems separated by straight lines appeared in the book of Andronov, Vitt and Khaikin [1]. The interest on such differential systems persist until nowadays, mainly for the applications that they have in electrical circuits, mechanics, economy, etc, see the books [6,27], and the surveys [22,28].

* Corresponding author.
E-mail addresses: jllibre@mat.uab.cat (J. Llibre), xzhang@sjtu.edu.cn (X. Zhang).

https://doi.org/10.1016/j.jmaa.2018.07.024
0022-247X/