Commun Nonlinear Sci Numer Simulat 81 (2020) 105018

Contents lists available at ScienceDirect

Commun Nonlinear Sci Numer Simulat

journal homepage: www.elsevier.com/locate/cnsns

Research paper

Strongly Ruelle-Takens, strongly Auslander-Yorke and Poincaré chaos on semiflows

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ARTICLE INFO

Article history:
Received 14 May 2019
Revised 30 July 2019
Accepted 16 September 2019
Available online 18 September 2019

MSC:
Primary 37B05
37B20
54H20
Secondary 37B99
37D45

Keywords:
Product semiflow
Strongly Ruelle–Takens chaos
Strongly Auslander–Yorke chaos
Poincaré chaos

ABSTRACT

In this paper, we study strongly Ruelle–Takens chaos, strongly Auslander–Yorke chaos and Poincaré chaos on the product of semiflows. It is proved that if the finite product or the countably infinite product of semiflows is chaotic then at least one of the factors is chaotic. We also provide necessary examples/counterexamples, wherever possible, related to our results.

1. Introduction

Throughout this paper, we are considering action of the non-negative integers or the non-negative real numbers on a metric space and calling it as a semiflow. Chaos is an important phenomenon studied in theory of semiflows. The main idea of chaos theory is that a minor difference at the start of a process can make a major change in it as time progresses. Among several definitions of chaos, Ruelle–Takens chaos [1], Auslander–Yorke chaos [2] and Devaney chaos [3] are well known. In these definitions, topological transitivity, sensitivity and denseness of periodic points are key ingredients. In 2016, Akhmet and Fen [4] initiated the description of chaos from a single motion. For doing this, they have introduced and studied the concepts of an unpredictable point and of Poincaré chaos. Recently, Miller [5] has generalized these concepts for a general semiflow, that is, for action of any topological monoid on a metric space. In the same paper, author has also introduced and studied the notions of strongly Ruelle-Takens chaos and strongly Auslander-Yorke chaos and justified giving examples that the ingredients of these chaos are independent.

Recently, many researchers have studied that how various types of chaos and their related properties carry over to their product semiflows [6–9] and vice versa. In [10], we have studied Devaney chaos, its related properties and stronger forms of sensitivity on the countably infinite product of semiflows. Moreover in [11], we have studied sensitivity of product

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https://doi.org/10.1016/j.cnsns.2019.105018
1007-5704/