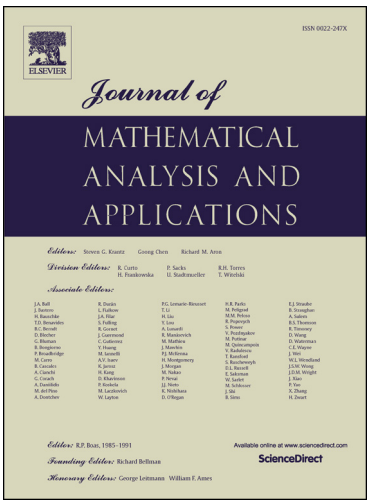
Accepted Manuscript



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PII: S0022-247X(17)30422-5
DOI: http://dx.doi.org/10.1016/j.jmaa.2017.04.059
Reference: YJMAA 21346

To appear in: *Journal of Mathematical Analysis and Applications*

Received date: 29 September 2016

Please cite this article in press as: S. Adly et al., Invariant sets and Lyapunov pairs for differential inclusions with maximal monotone operators, *J. Math. Anal. Appl.* (2017), http://dx.doi.org/10.1016/j.jmaa.2017.04.059

Invariant sets and Lyapunov pairs for differential inclusions with maximal monotone operators ☆

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Abstract

We give different conditions for the invariance of closed sets with respect to differential inclusions governed by a maximal monotone operator defined on Hilbert spaces, which is subject to a Lipschitz continuous perturbation depending on the state. These sets are not necessarily weakly closed as in [5, 6], while the invariance criteria are still written by using only the data of the system. So, no need to the explicit knowledge of neither the solution of this differential inclusion, nor the semi-group generated by the maximal monotone operator. These invariant/viability results are next applied to derive explicit criteria for a-Lyapunov pairs of lower semi-continuous (not necessarily weakly-lsc) functions associated to these differential inclusions. The lack of differentiability of the candidate Lyapunov functions and the consideration of general invariant sets (possibly not convex or smooth) are carried out by using techniques from nonsmooth analysis.

Keywords: Lyapunov stability, lsc Lyapunov pairs and functions, invariant sets, differential inclusions, maximal monotone operators, normal cones, subdifferentials
Mathematics Subject Classification (2010): 37B25, 47J35, 93B05

1. Introduction

We provide sufficient and, in many different interesting situations, necessary criteria for the invariance property of closed subsets with respect to the following differential inclusion, given in a Hilbert space H,

$$\dot{x}(t) \in f(x(t)) - Ax(t), \;\; x(0) = x_0 \in \overline{\operatorname{dom} A}, \;\; a.e.\; t \geq 0 \tag{1}$$

☆Research partially supported by Conicyt-Fondecyt grant no. 1151003, Conicyt-Pcha/Doctorado Nacional/2014-63140104, and Conicyt-Redes no. 150040.
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