Embedding smooth and formal diffeomorphisms through the Jordan-Chevalley decomposition

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(Submitted on 19 Jul 2011)

In [Xiang Zhang, The embedding flows of C^{∞} hyperbolic diffeomorphisms, J. Differential Equations 250 (2011), no. 5, 2283-2298] Zhang proved that any local smooth hyperbolic diffeomorphism whose eigenvalues are weakly nonresonant is embedded in the flow of a smooth vector field. We present a new, simpler and more conceptual proof of such result using the Jordan-Chevalley decomposition in algebraic groups and the properties of the exponential operator.
We characterize the hyperbolic smooth (resp. formal) diffeomorphisms that are embedded in a smooth (resp. formal) flow. We introduce a criterium showing that the presence of weak resonances for a diffeomorphism plus two natural conditions imply that it is not embeddable. This solves a conjecture of Zhang. The criterium is optimal, we provide a method to construct embeddable diffeomorphisms with weak resonances if we remove any of the conditions.

Comments:	25 pages
Subjects:	**Dynamical Systems (math.DS)**; Complex Variables (math.CV)
MSC classes:	Primary: 34C20, 37F75, Secondary: 34C41, 34M25
Cite as:	**arXiv:1107.3601 [math.DS]**
	(or **arXiv:1107.3601v1 [math.DS]** for this version)

Submission history

From: Javier Ribón [view email]
[v1] Tue, 19 Jul 2011 00:49:20 GMT (22kb)

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