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Cluster Synchrony in Systems of Coupled Phase Oscillators with Higher-Order Coupling

Per Sebastian Skardal, Edward Ott, Juan G. Restrepo

(Submitted on 7 Jul 2011 (v1), last revised 1 Sep 2011 (this version, v3))

We study the phenomenon of cluster synchrony that occurs in ensembles of coupled phase oscillators when higher-order modes dominate the coupling between oscillators. For the first time, we develop a complete analytic description of the dynamics in the limit of a large number of oscillators and use it to quantify the degree of cluster synchrony, cluster asymmetry, and switching. We use a variation of the recent dimensionality-reduction technique of Ott and Antonsen [Chaos {\bf 18}, 037113 (2008)] and find an analytic description of the degree of cluster synchrony valid on a globally attracting manifold. Shaped by this manifold, there is an infinite family of steady-state distributions of oscillators, resulting in a high degree of multi-stability in the cluster asymmetry. We also show how through external forcing the degree of asymmetry can be controlled, and suggest that systems displaying cluster synchrony can be used to encode and store data.

Comments:	9 pages, 9 figures
Subjects:	**Chaotic Dynamics (nlin.CD)**; Dynamical Systems (math.DS); Adaptation and Self-Organizing Systems (nlin.AO); Pattern Formation and Solitons (nlin.PS); Exactly Solvable and Integrable Systems (nlin.SI)
Journal reference:	Phys. Rev. E, Vol 84, No. 3 (2011)
DOI:	10.1103/PhysRevE.84.036208
Cite as:	**arXiv:1107.1511 [nlin.CD]**
	(or **arXiv:1107.1511v3 [nlin.CD]** for this version)

Submission history

From: Per Sebastian Skardal [view email]
[v1] Thu, 7 Jul 2011 20:19:55 GMT (1102kb)
[v2] Mon, 25 Jul 2011 04:00:43 GMT (1090kb)
[v3] Thu, 1 Sep 2011 16:09:13 GMT (1088kb)

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