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Topic: Synchronization of Nonlinear Systems

Testing for phase synchronization

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Synchronization analysis is frequently applied to data originating for example from physics and life sciences. It has been observed that several different types of nonlinear self-sustained oscillators may exhibit synchronization if these systems are sufficiently coupled. Besides lag synchronization and generalized or complete synchrony, phase synchronization can be consided as being the weakest form of synchronization [1, 2].

Thereby, phase synchronization analysis has gained particular interest since it relies only on weak coupling between the oscillators. To infer the presence of phase synchronization from measured data, several measures have been defined. However, the statistical properies of these measures have not been revealed so far. Focussing on the mean phase coherence [3] as measure, a statistical test is presented to distinguish between absence and emergence of phase synchronization from measured data. Therefore, providing a proper statistical assessment of results obtained by phase synchronization analysis which is an indispensable prerequisite for a reliable application to empirical data. We derive a statistical test for phase synchronization which takes into account that the data are of finite length or that they might be corrupted with either observational or dynamic noise. Finally, the performance of the derived statistical test is illustrated in an application to stochastic synchronizing Rössler oscillators.

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[1] M. G. Rosenblum, A. S. Pikovsky, and J. Kurths *Phys. Rev. Lett.* **76**, 1804 (1996).

[2] M. G. Rosenblum, A. S. Pikovsky, and J. Kurths *Phys. Rev. Lett.* **78**, 4193 (1997).

[3] F. Mormann, K. Lehnertz, P. David and C. Elger, *Physica D* **144**, 358 (2000).