Sparse identification of a predator-prey system from simulation data of a convection model

The use of low-dimensional dynamical systems as reduced models for plasma dynamics is useful as solving an initial value problem requires much less computational resources than fluid simulations. We utilize a data-driven modeling approach to identify a reduced model from simulation data of a convection problem. A convection model with a pressure source centered at the inner boundary models the edge dynamics of a magnetically confined plasma. The convection problem undergoes a sequence of bifurcations as the strength of the pressure source increases. The time evolution of the energies of the pressure profile, the turbulent flow, and the zonal flow capture the fundamental dynamic behavior of the full system. By applying the sparse identification of nonlinear dynamics (SINDy) method, we identify a predator-prey type dynamical system that approximates the underlying dynamics of the three energy state variables. A bifurcation analysis of the system reveals consistency between the bifurcation structures, observed for the simulation data, and the identified underlying system.

General information
Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Mathematics, Plasma Physics and Fusion Energy, Department of Physics, Swiss Federal Institute of Technology Lausanne
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Number of pages: 10
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Physics of Plasmas
Volume: 24
Issue number: 2
Article number: 022310
ISSN (Print): 1070-664X
Ratings:
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.17 SJR 0.576 SNIP 1.04
Web of Science (2017): Impact factor 1.941
Web of Science (2017): Indexed yes
Original language: English
Electronic versions:
Untitled.pdf. Embargo ended: 28/02/2018
DOIs:
10.1063/1.4977057
Source: FindIt
Source ID: 2355415037
Research output: Contribution to journal › Journal article – Annual report year: 2017 › Research › peer-review