

ANNUAL REPORT 2019-2020

Neelima M Gupte
Dept of Physics

SPECIALIZATION

- Dynamical Systems, Statistical Physics

RESEARCH TOPICS

- Networks and Climate Networks
- Chimeras
- Kuramoto Dynamics
- Bird Song
- Synchronization

NETWORKS

- Time series Networks: Built out of time series data
- Climate networks built out of correlations between time series

CLIMATE

- El Nino 2014
- Cyclone Cyclone Nada (29th Nov -2nd Dec)
1st Oct -15 Oct 2016
- Collaborators Rupali Sonone , Ruby Saha

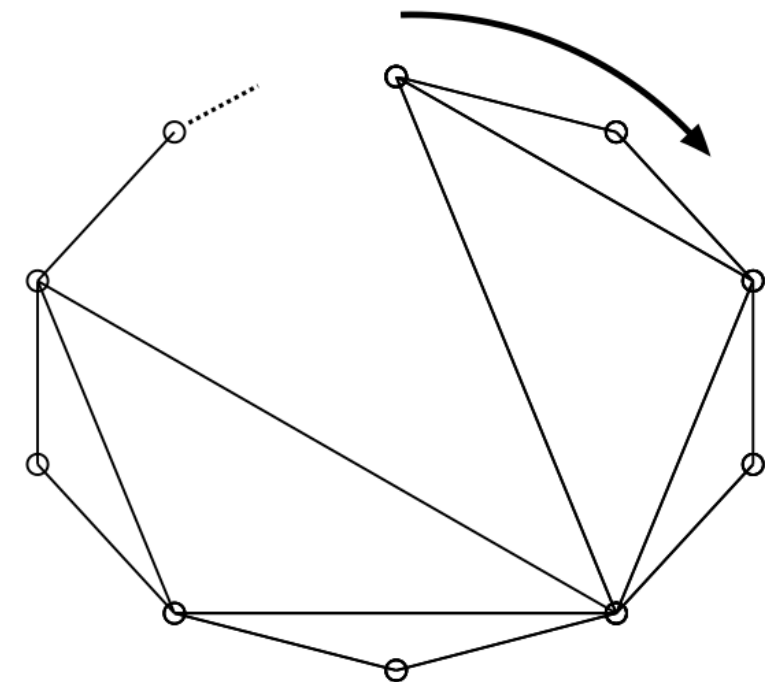
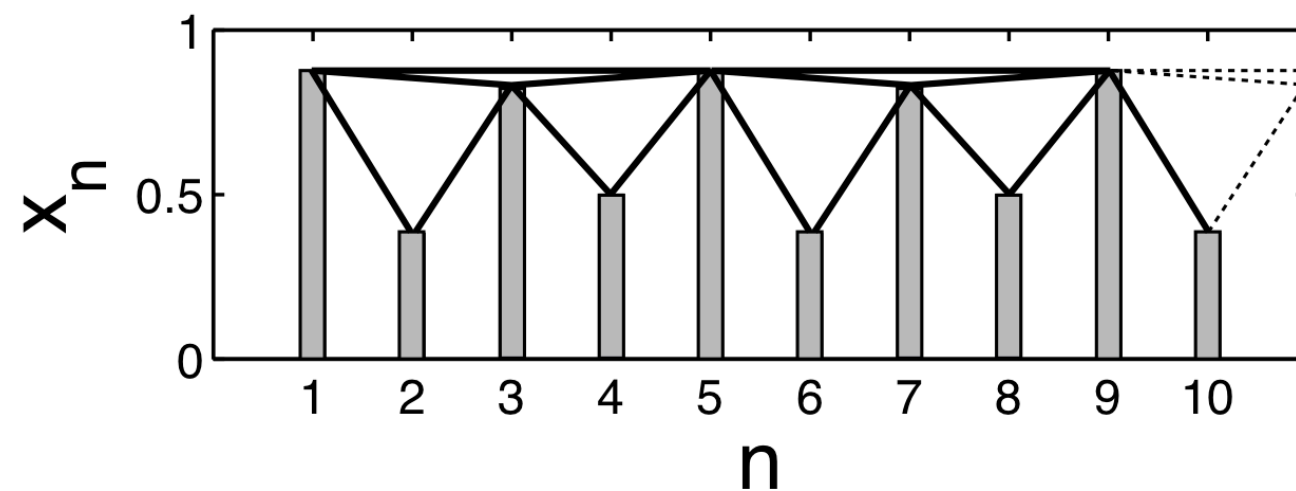
TIME SERIES NETWORKS

- Visibility algorithm
- Topological characterisers
- Effective characterisers of dynamics
- Collaborators: Malayaja Chutani, Nithyanand Rao, Nirmal Thyagu

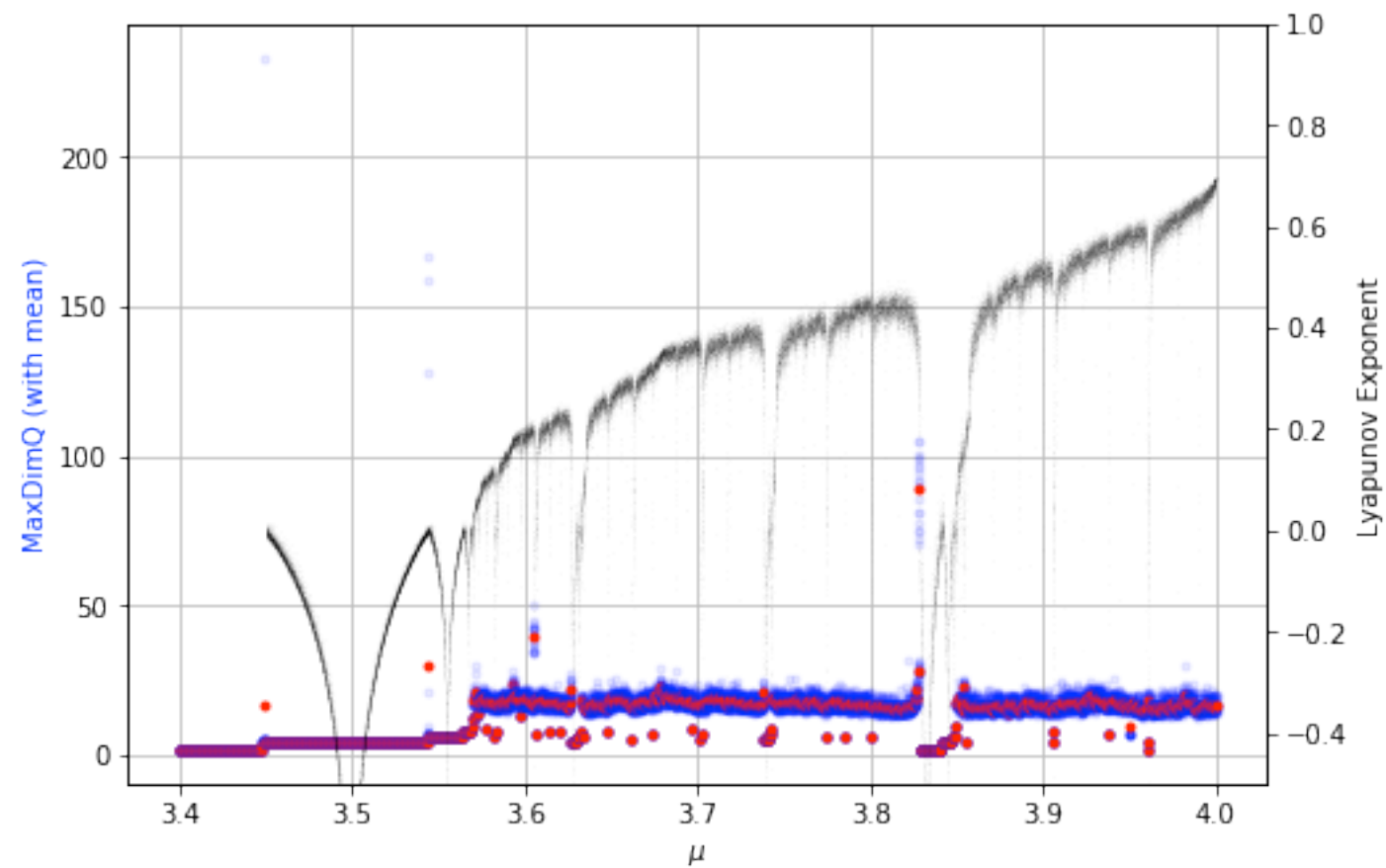
The TS Network

$$\mu = 3.5$$

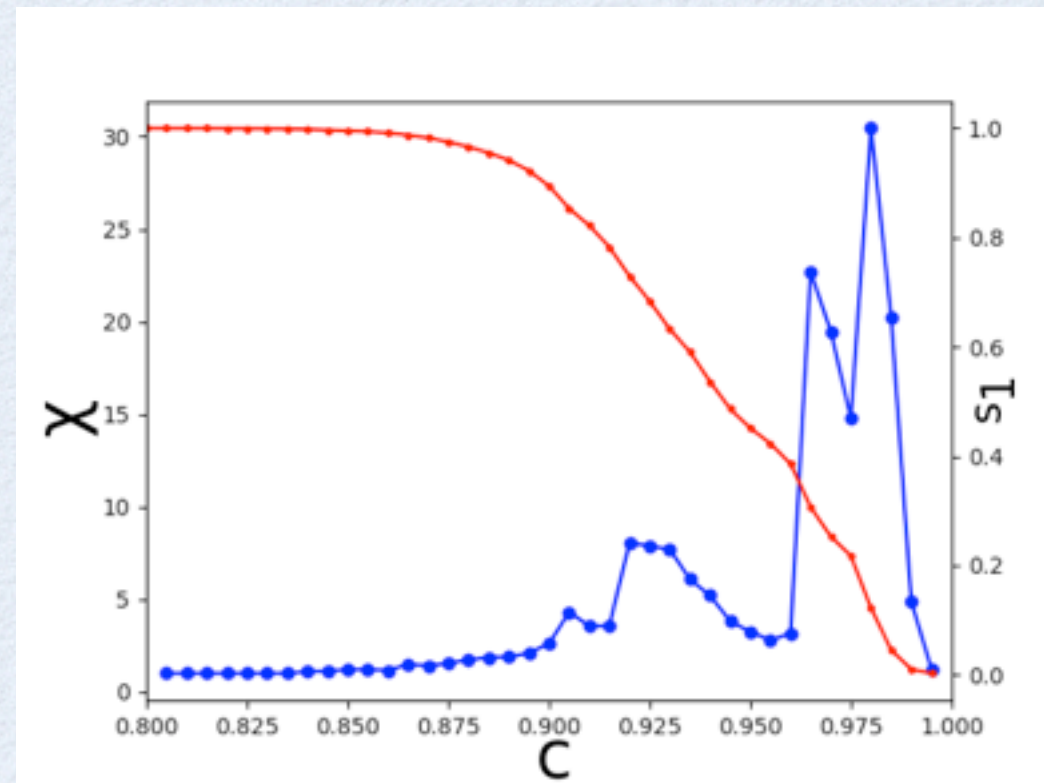
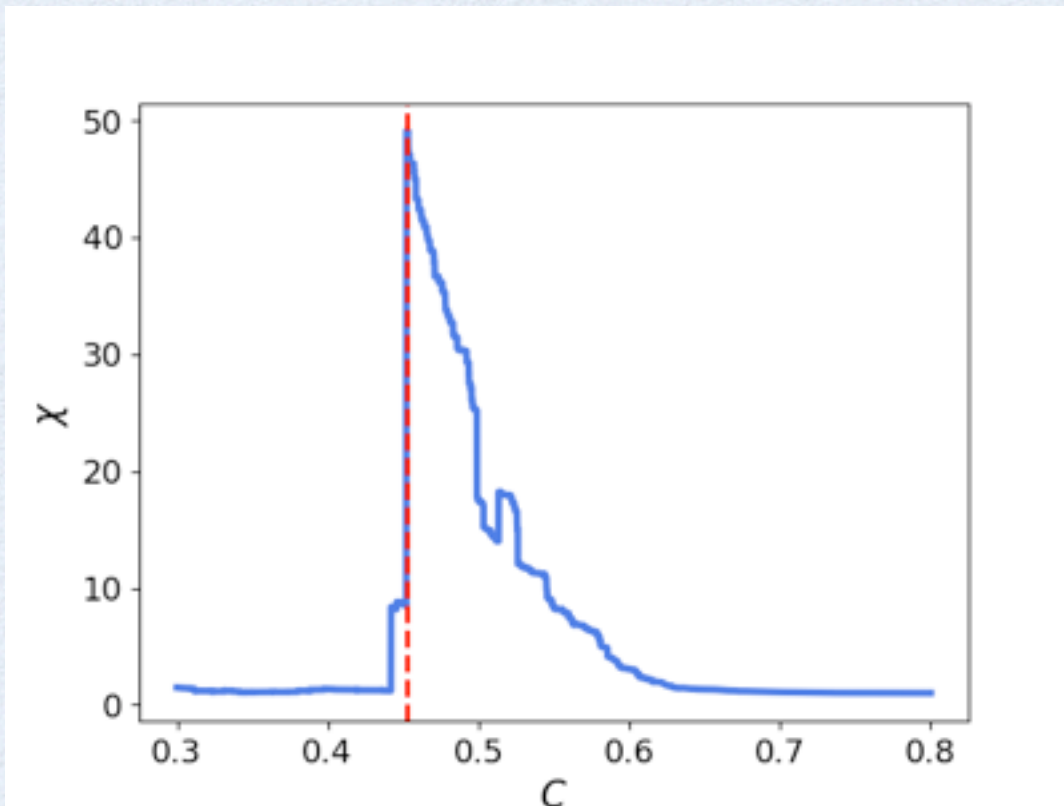
- Periodic time series at $\mu = 3.5$



Lyapunov exponent and Max dim Q



EL NINO , CYCLONE



EXTENDED SYSTEMS

- Chimeras
- Kuramoto dynamics and vortices

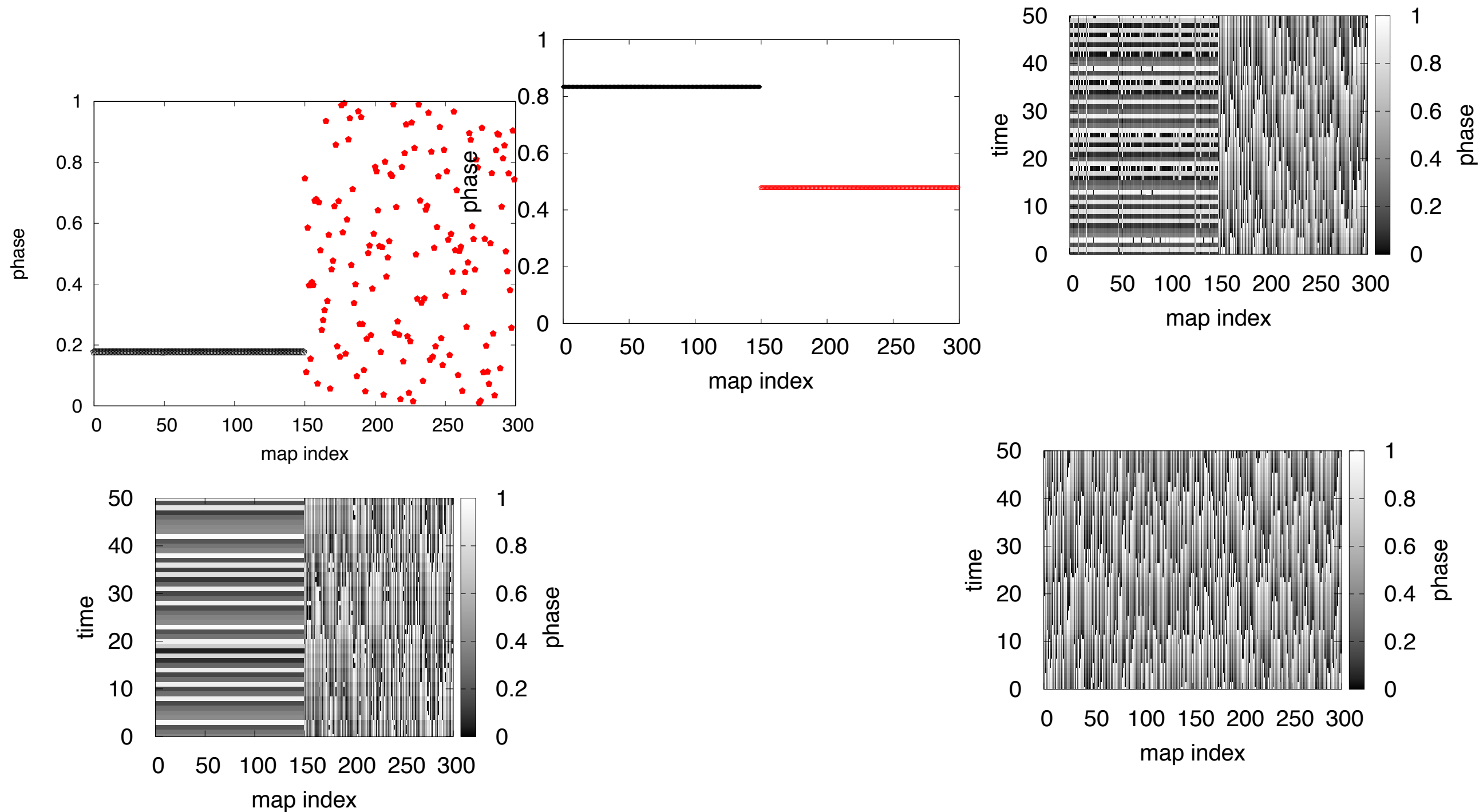
THE SYSTEM

$$\theta_{n+1}^{\sigma}(i) = \theta_n^{\sigma}(i) + \Omega - \frac{K}{2\pi} \sin(2\pi\theta_n^{\sigma}(i)) + \sum_{\sigma'=1}^2 \frac{\epsilon_{\sigma\sigma'}}{N_{\sigma'}} \left[\sum_{j=1}^{N_{\sigma'}} (\theta_n^{\sigma'}(i) + \Omega - \frac{K}{2\pi} \sin(2\pi\theta_n^{\sigma'}(i))) \right] \mod 1$$

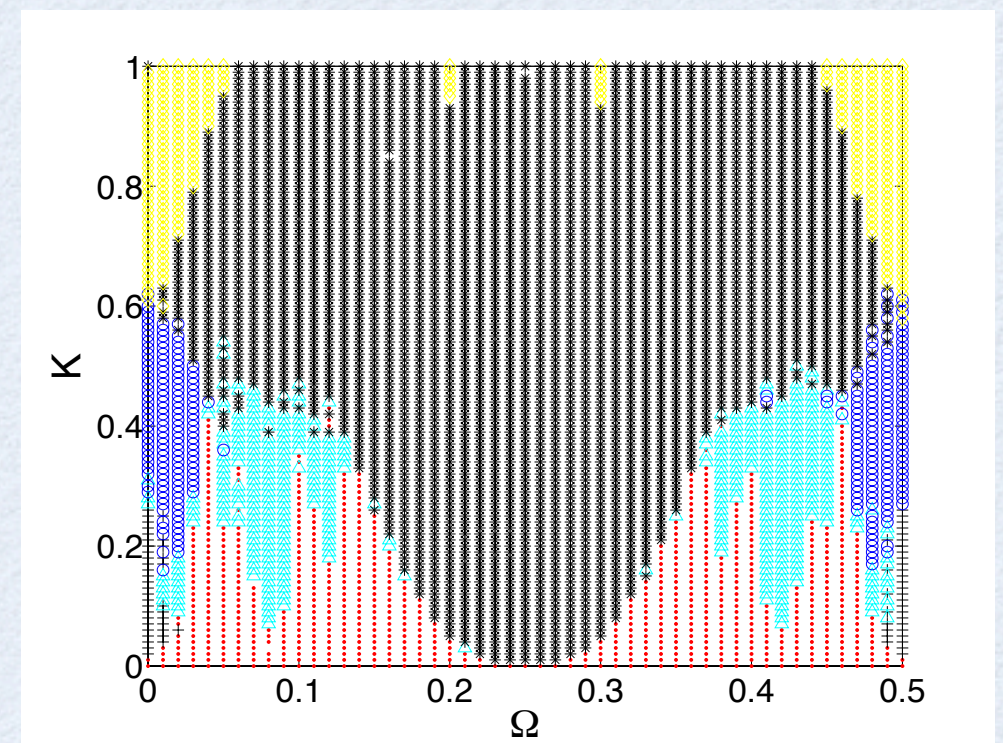
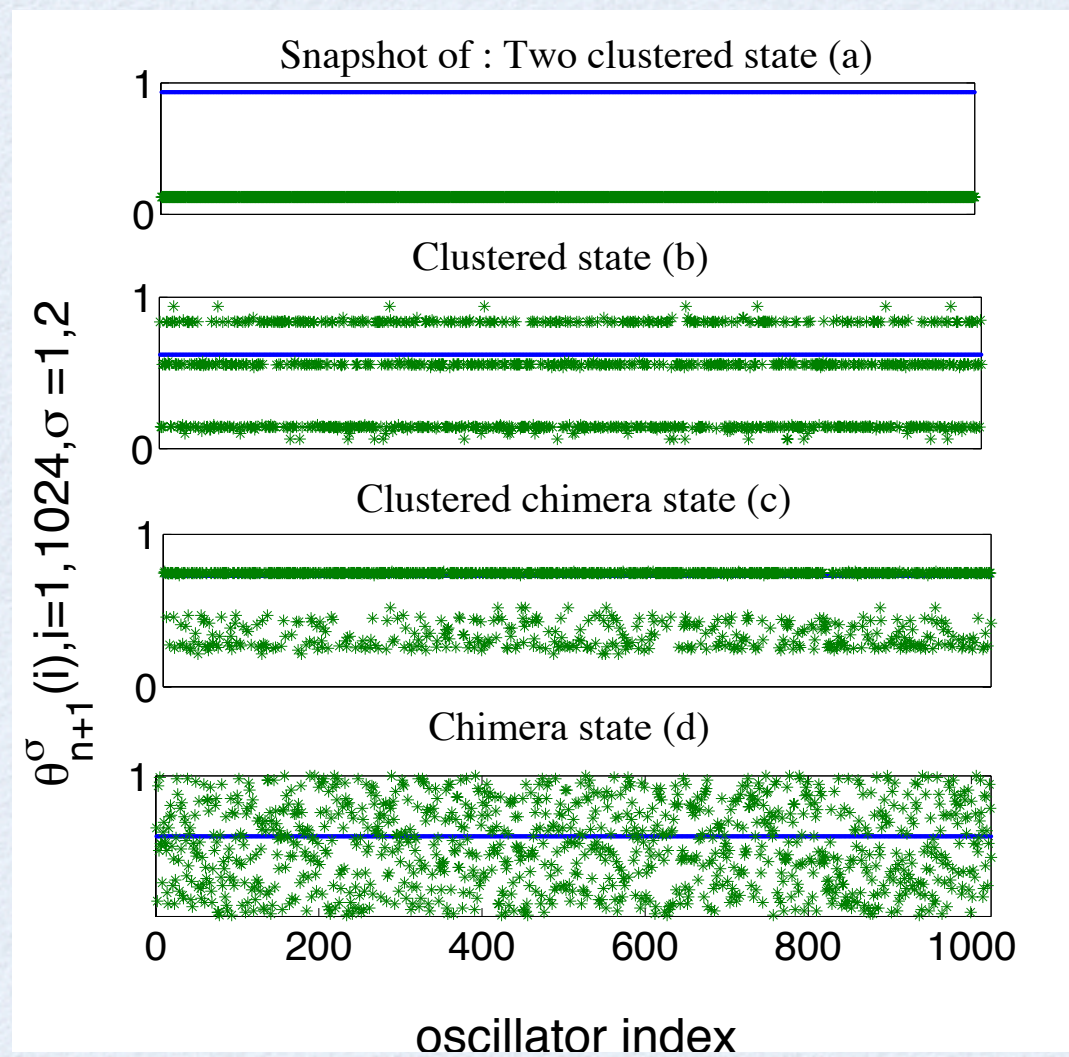
Chimera states



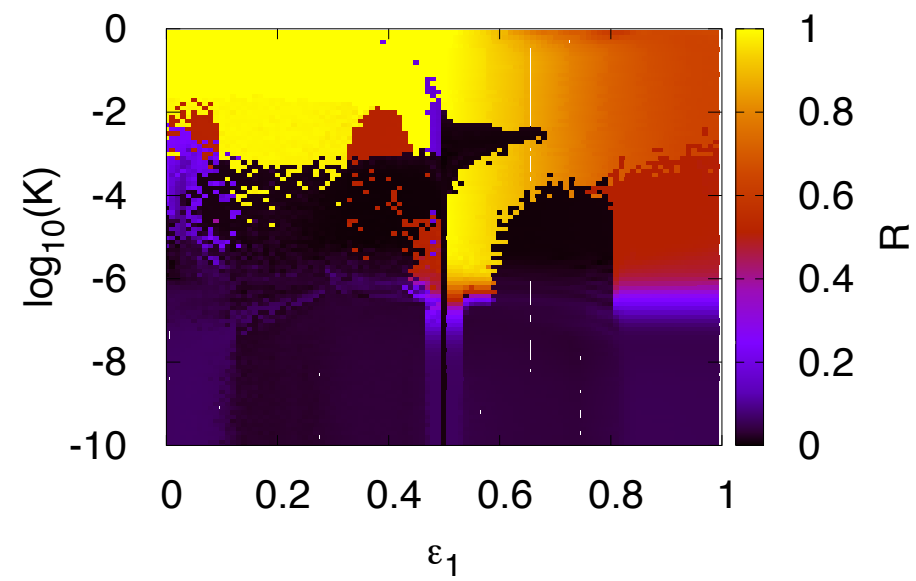
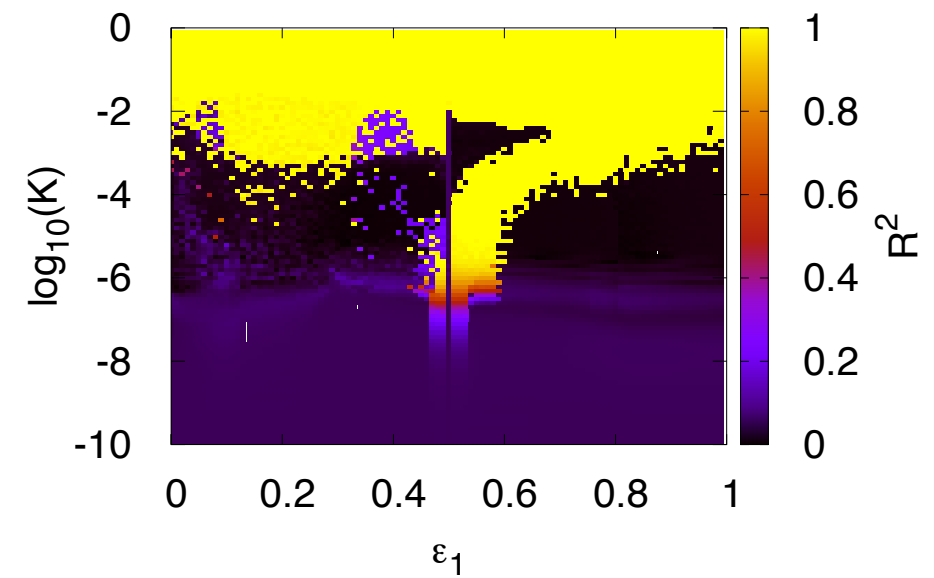
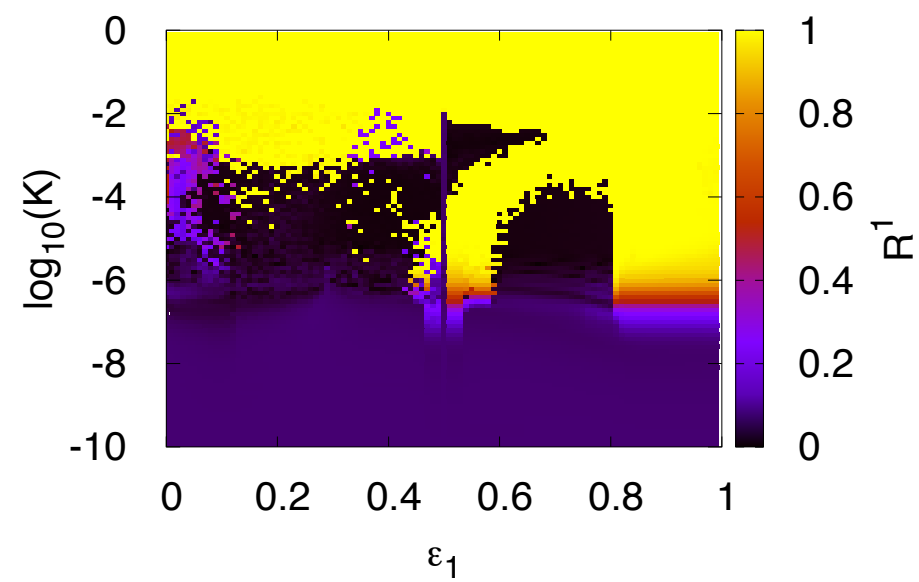
States seen : Chimeras/Two cluster states



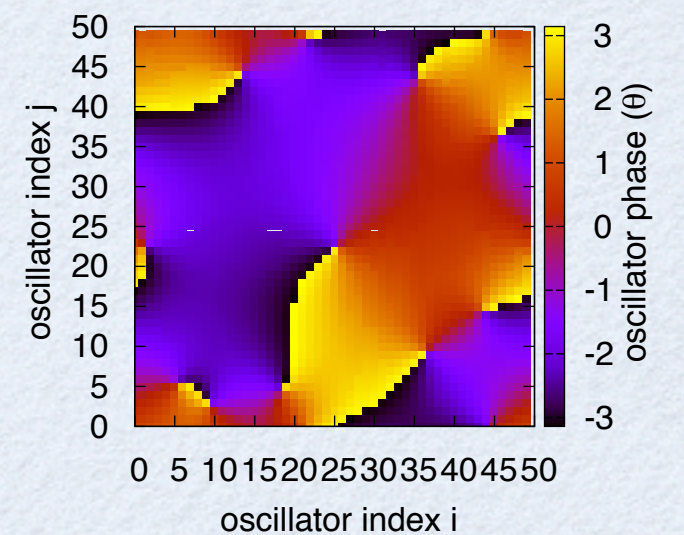
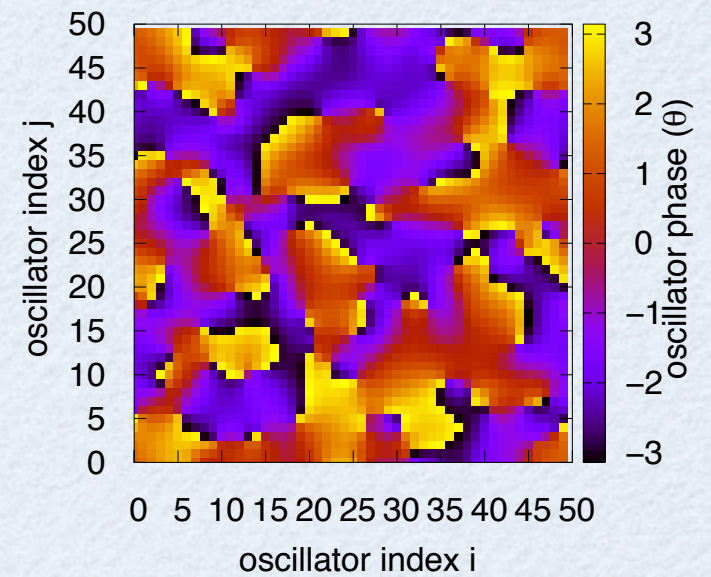
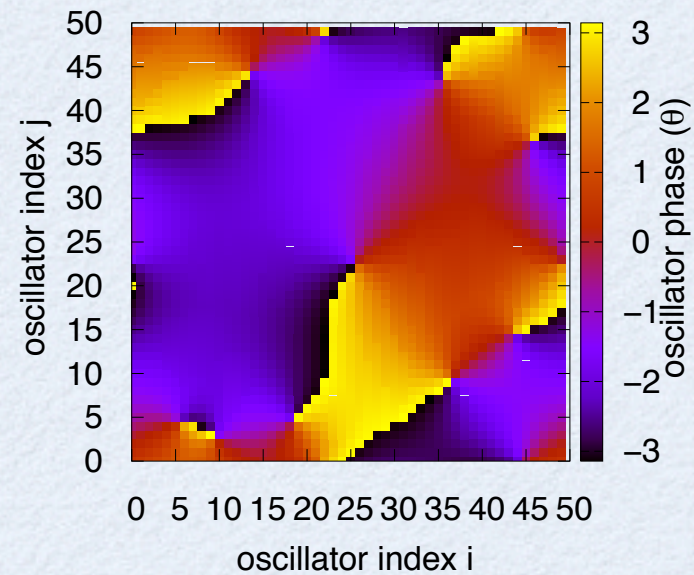
CHIMERA STATES



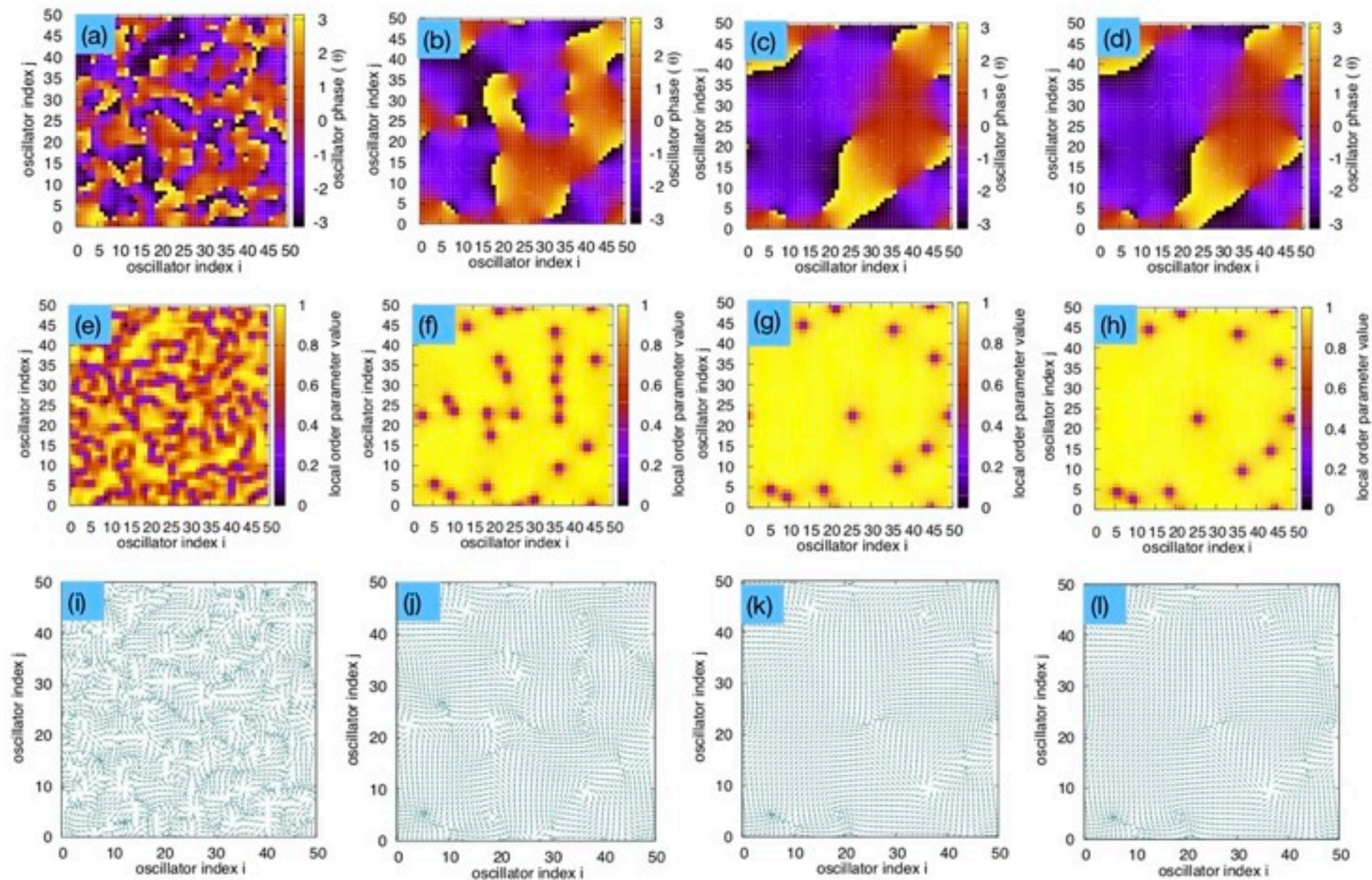
Phase diagram



PHASE LOCKED STATES



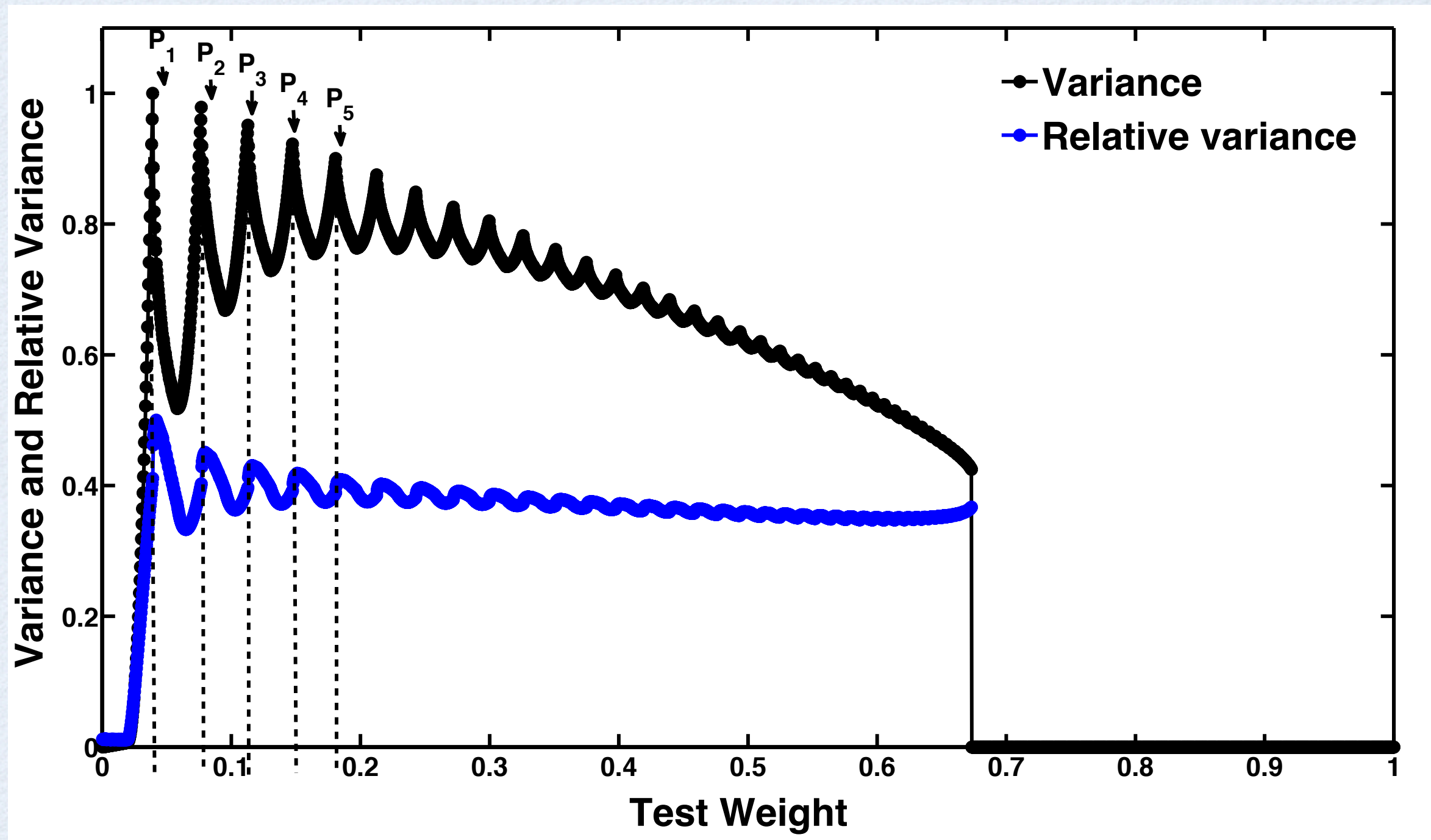
KURAMOTO DYNAMICS



SYNCHRONIZATION

- Branching hierarchical systems
- Microtransitions

MICROTRANSITIONS



PUBLICATIONS

- Microtransitions in a 2-d load-bearing network, A Roy and N. Gupte, Phys. Letts. A 383,967 (2019).
- 2. Microtransitions in hierarchical and climate networks, N Gupte, A Roy and R Sonone, Indian Academy of Sciences Conference Series 2, 152 (2019).
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PUBLICATIONS

- 3. Characterizing the complexity of time series networks of dynamical systems: A simplicial approach, M. Chutani, N. Rao, N. N. Thyagu, and N. Gupte, Chaos, 30, 013109 (2020); <https://doi.org/10.1063/1.5100362>. (Editor's pick).

PUBLICATIONS

- Chimera states in globally coupled sine circle map lattices: Spatiotemporal intermittency and hyperchaos, J. Singha and N. Gupte, Phys. Letts. A 384, 126225, (2020).
- 5. Nonlinear Chemical Reactions: A Comparison Between an Experiment and a Theoretical Model, A. Rajans, N. Gupte and P.C. Deshmukh, Resonance 25 381 (2020).

CONFERENCE ORGANIZED

- Perspectives in Nonlinear Dynamics, 16-19 July 2019, ICTP-SAIFR, Sao Paulo, Brazil, satellite of STATPHYS 27 at Buenos Aires.



CONFERENCE TALKS

- 1. Microtransitions on branching hierarchical networks and Climate networks: Statphys 27 July 8-12, 2019, Buenos Aires, Argentina. 2.
- Climate Networks: Predictions of the El Nino using microtransitions, Perspectives in Nonlinear Dynamics, 16-19 July 2019, Sao Paulo, Brazil.

CONFERENCE TALKS

- CNSD Conference on Nonlinear Systems and Dynamics, IIT Kanpur, 12-15th December 2019
- CDSA, Complex Dynamical Systems and Applications, Central University of Rajasthan, Ajmer, February 21-23, 2020.

LECTURES IN SCHOOLS

- 1. SERB School on Nonlinear Dynamics, IIT Patna, December 3-30, 2019.
- 2. National Workshop on Network science, NetSci, Univ of Hyderabad, March 13-15, 2020.

COMMITTEES

- 1. Organising committee of conference Perspectives in Nonlinear Dynamics, to be held at the ICTP-SAIFR in São Paulo, Brazil from 16 to 19 July 2019.
- 2. International Organising Committee, StatPhys 27, Buenos Aires, Argentina, 8th-12th July, 2019.

NEW PROJECTS

- DST-DAAD project: Network models for climate studies. Rs. 13.6 lakhs, October 2019.

TEACHING

- Dynamical systems
- Computational Physics

RESEARCH GUIDANCE

- Ph. D. thesis : Joydeep Singha, February 2020.
- Dept. Synopsis: Anupama Roy, July 2020
- M.Sc project, V. Sivaprasad, July 2020
- B. Tech Project, V. Ashwin, July 2020.

FUTURE PLANS

- Research Plans:
- Analysis of Birdsong : Complexity and Development
- Prediction : Cyclones, El Nino, La Nina
- Topological Characterisers: Intermittency and Complexity

FUTURE PLANS

- Proposals:
- Center for Complex Systems and Dynamics
- Collaboration with Shastri institute
- ICTS Program : Turing Conference
- GIAN Course: G. Mindlin, Analysis of Bird Song (with V. Srinivas Chakravarty)