



# Complexity

Rahul Pandit

Centre for Condensed Matter Theory  
Department of Physics  
Indian Institute of Science  
Bangalore, India.

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# Quotations



- ▶ "The more complex a thing is, the more you can talk about it." - attributed to Giorgio Parisi.
- ▶ "C'est magnifique, mais ce n'est pas de la science." (It is magnificent, but not all of it is science.) - attributed to Dave Feldman.

# Complex Systems: Some Characteristics



- ▶ Lack of perfect predictability: must often use statistical methods.
- ▶ Emergent phenomena: e.g., self-organised patterns or coherent structures (often not easily surmised from the equations of motion or the local interactions between agents).
- ▶ Interactions between a system's components are important role.

# Complex Systems: Some Characteristics



- ▶ Most complex systems can display ordered and disordered states and, in some cases, coexistence of such states.
- ▶ The elements of a complex system may or may not be identical.
- ▶ Complex systems are adaptive or dynamic so their properties change over time.
- ▶ Complex systems often display long-range correlations in space and time.

# Complex Systems: Some Examples



- ▶ Immune systems.
- ▶ Ecosystems.
- ▶ Economies and markets.
- ▶ The brain; neural networks; other biological networks.

# Complex Systems: Some Examples

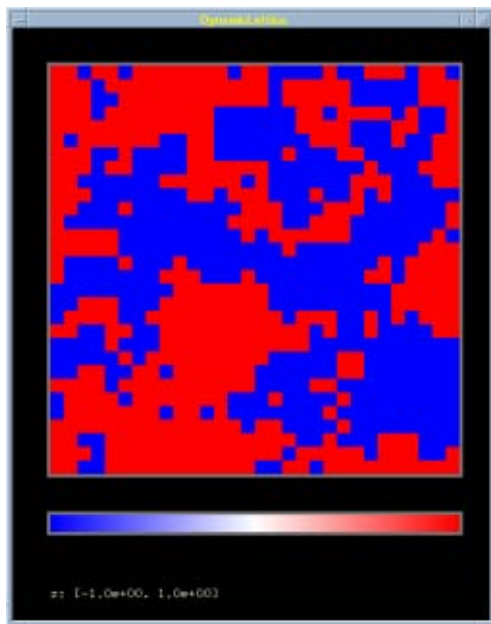


- ▶ Ant colonies, shoals of fish, or flocks of birds.
- ▶ **Turbulence.**
- ▶ Scale-free networks in, say, social networks or the world-wide web.
- ▶ A system, such as a magnet, at a critical point.
- ▶ **Climate studies.**

A flock



# Ising model critical point



# Measures of Complexity



- ▶ Earliest examples: theoretical computer science, algorithmic complexity, etc.
- ▶ Rapid progress after the development of computers and computational models for the systems mentioned above and the natural application of methods from statistical mechanics, dynamical systems, etc.
- ▶ The field is vast; in this symposium we will be able to touch upon only four areas.

# Complexity: The Symposium



- ▶ Mustansir Barma: Complexity in stochastic processes and statistical physics.
- ▶ Somdatta Sinha: A simple approach to studying designs in complex biochemical pathways.
- ▶ B.N. Goswami: Computing grand challenge of projecting the Indian monsoon in a changing climate.
- ▶ Rahul Pandit: Complexity in turbulence.