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Synchronization of Stochastically Coupled Oscillators: Dynamical Phase Transitions and Large Deviations Theory (or Birds and Frogs)

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Systems of oscillators coupled non-linearly (stochastically or not) are ubiquitous in nature and can explain many complex phenomena: coupled Josephson junction arrays, cardiac pacemaker cells, swarms or flocks of insects and birds, etc. They are know to have a non-trivial phase diagram, which includes chaotic, partially synchronized, and fully synchronized phases. A traditional model for this class of problems is the Kuramoto system of oscillators, which has been studied extensively for the last three decades. The model is a canonical example for non-equilibrium, dynamical phase transitions, so little understood in physics. From a stochastic analysis point of view, the transition is described by the large deviations principle, which offers little information on the scaling behavior near the critical point. I will discuss a special case of the model, which allows a rigorous analysis of the critical properties of the model, and reveals a new, anomalous scaling behavior in the vicinity of the critical point.