Transmission of energy in complex networks

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A fundamental motivation in Complexity Sciences is to understand and predict the implicit relationship between the structure and the behaviour of a complex system. The structure is a topological representation of how the units in the complex system are interconnected, i.e., the

system's connectivity skeleton. It constitutes the backbone of the system's interactions and it is formally described by the theory of graphs. Behaviour is a functional observable of the collective dynamics that the units in the network have. It shows how the dynamical properties of the complex system evolve and can be measured by a variety of different methodologies. The importance of understanding this relationship is because, in nature and society, both quantities are usually not simultaneously known. For example, in the brain, the behaviour can be measured (e.g., EEG and fMRI) but the exact structure is unknown. On the other hand, the structure of the modern power-grids are known, but the behaviour sometimes is unpredictable (e.g., black-outs and power drops). In this work I am going to focus on the derivation of explicit relationships between the structure and the dynamics of supply-demand networks, in particular, in the results we find for a phase-oscillator model of the power-grid transmission of energy known as the swing equations. Despite our particular choice, the results are unrestricted to power-grids and can be extended to other complex systems of interacting oscillators.