

Electrical networks dynamics via a quantum analogy

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Context

Electrical energy production and consumption are undergoing a profound transformation, driven by two factors whose impact is steadily increasing: (i) the growing share of intermittent sources (solar, wind) in the energy mix; (ii) technological advances making it possible to monitor the use of electrical appliances in households. Adapting the irregular and diffuse production to an increasingly flexible consumption will pose a significant challenge to energy distribution and regulation in the coming decades, for instance regarding the stability of the electrical network [1]. Modelling the dynamics of an heterogeneous electric network with an increasing number of producers and consumers becomes challenging.

Project

The goal of this project is to build on the analogy between the electrical grid linearized equations and a Schrödinger like equation [2, 3], opening the way to use numerical techniques designed for quantum systems in the physics of powergrids. Indeed, network dynamics can be effectively addressed by considering that, for energetic reasons, the network is expected to function in a regime where the phase differences between connected nodes are small. In this regime, many tools developed in the context of condensed matter physics can be used to develop highly effective numerical codes, or to analyze nontrivial properties of complex networks (see for instance the analogies between the localization of network disturbances and Anderson localization discussed in [4]). Using, these tools, we wish to study the propagation of fluctuations in the network but also see how one could tackle the dynamics in the non-linear regime by extending these methods.

Environment

This project is part of a collaboration involving members from LPTMS (<https://www.lptms.universite-paris-saclay.fr/>), SPEC (<https://iramis.cea.fr/spec/>), and IJCLab (<https://www.ijclab.in2p3.fr/>) .

Bibliography

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