

**Award Abstract # 2406942****Collaborative Research: Emerging Applications of Self-Similarity in Dynamical Networks****NSF Org:** [DMS](#)
[Division Of Mathematical Sciences](#)**Recipient:** COLLEGE OF NEW JERSEY**Initial Amendment Date:** August 15, 2024**Latest Amendment Date:** August 15, 2024**Award Number:** 2406942**Award Instrument:** Standard Grant**Program Manager:** Stacey Levine
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DMS Division Of Mathematical Sciences
MPS Directorate for Mathematical and Physical Sciences**Start Date:** August 15, 2024**End Date:** July 31, 2027 (Estimated)**Total Intended Award Amount:** \$128,950.00**Total Awarded Amount to Date:** \$128,950.00**Funds Obligated to Date:** FY 2024 = \$128,950.00**History of Investigator:** Matthew Mizuhara (Principal Investigator)
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ABSTRACT

Networks of various kinds and scales arise across biological, social, and physical systems. Moreover, self-similarity manifests in real-world networks in multiple ways, from the hierarchical self-similarity of the Internet, to the fractal-like structure of dendritic trees of neurons and protein interaction networks, and to the multiscale organization of social and epidemiological networks. Mathematical modeling helps to understand the principles underlying network dynamics, which can be used for effective prediction and control of real-world networks. This research studies the implications of self-similar structure of networks on their emergent dynamics. It aims to bridge analytical theories of fractals and differential equations on fractals with applications in network science. A combination of techniques from the analysis on fractals and dynamical systems will be used to develop new tools for the analysis, prediction, and control of self-similar network dynamics. Graduate and undergraduate students will be trained and contribute to these research activities.

The principal investigators will develop a set of model problems aimed at elucidating dynamics of self-similar networks. They will consider the Kuramoto model of coupled phase oscillators on graphs approximating the Sierpinski Gasket and other fractals and analyze them using a combination of analytical and numerical techniques. The goal of the first project is to develop a geometric approach to the construction of harmonic maps from post-critically finite fractals to a circle. The outcomes of this project will be used to construct stable steady states of coupled oscillator models on graphs approximating these fractals. The second project is focused on synchronization and bifurcations in self-similar networks. The third project studies epidemiological networks based on an SIR (Susceptible-Infected-Removed) model on graphs approximating fractals. Combined these projects are expected to deliver a new set of tools for studying interacting dynamical systems on self-similar sets.

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