



A Joint Talk between
the **Quantum Biology Laboratory** at **Howard University**
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Allen Discovery Center 



10:00am Eastern Time (ET)
on 14th August, 2023

Amoeba-inspired Combinatorial Optimization Engine for Trajectory Planning of Thousands of Self-driving Robots

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In the evolving landscape of smart societies, efficiently managing large-scale systems is paramount. This presentation explores a pioneering amoeba-inspired combinatorial optimization engine, crafted with a primary focus on next-generation manufacturing and logistics. Our unique approach mirrors the problem-solving techniques of the true slime mold, *Physarum polycephalum*, a single-celled amoeboid organism that exhibits complex spatiotemporal oscillatory dynamics. This organism optimizes its shape to balance efficient foraging and minimal light exposure [1], a process that inspired the development of our "AmoebaTSP" and "AmoebaSAT" algorithms [2]. These algorithms, formulated to address the Traveling Salesman Problem (TSP) and the Boolean Satisfiability Problem (SAT) respectively, form the basis of our "electronic amoebae." These are implemented using analog [3] and digital [4] electronic circuits for rapid search performance. The presentation will emphasize the real-world application of our AmoebaSAT-based electronic amoeba, specifically designed for trajectory planning to avoid collisions and congestion among thousands of self-driving robots in smart factories and warehouses. We will delve into the transformative potential of this complex-systems-inspired technology in reshaping the manufacturing and logistics sectors and its capacity to meet the challenges of contemporary smart societies.

[1] Zhu, Kim, Aono et al., **Royal Soc. Open Sci.** (2018),

[2] Aono, **Jpn. J. Appl. Phys.** (2020),

[3] Saito, Aono, Kasai, **Sci. Rep.** (2020),

[4] Okuyama, Amano, Ohkoda, Aono, **HEART** (2023)