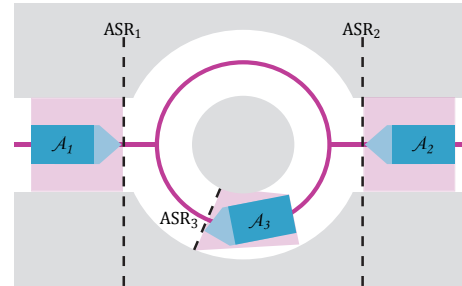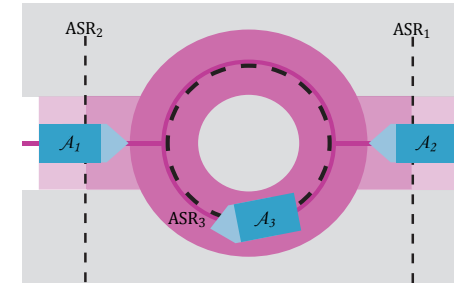# A Novel Relationship Between Dynamics and Complexity in Multi-agent Collision Avoidance

Question: "How can one have faith in a model predicting that a group of agents will solve an intractable problem?"

Konstantinos Daskalakis, Christos H. Papadimitriou, The Complexity of Games on Highly Regular Graphs.
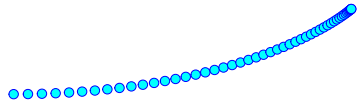
Terms:

Stopping Path: Region of space swept out while coming to a stop along a path

Stopping Region: Union of all stopping paths for all feasible paths

1st order: Dynamics guarantee a coordination-free contingency plan.

2nd order: Dynamics preclude a coordination-free contingency plan.

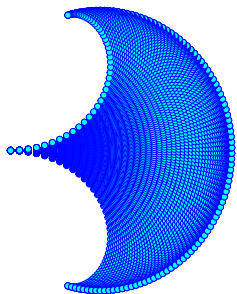## Main:

- Disjoint stopping regions guaranteed the existence of contingency plans

- Contingency plans guarantee collision avoidance is possible without coordination

- Stopping region disjointness is dependent on system dynamics

- Dynamics can induce a requirement for coordination

- Such a requirement changes problem space and, therefore, problem complexity

- **A move between P and NEXP can result from changing system dynamics**

Answer: You can't. In order to be solved, these problems must be modeled in a way that is tractable rather than intractable.

Takeaways:

- Principled approaches to solving probabilistic multi-agent systems are intractable

- But the agent has control over the complexity of planning problem

- Prediction becomes (almost) unnecessary

- Instead, the need becomes:
  - Yield classification
  - Reactive control

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