[Working towards pluripotent materials]

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Broad thesis: Information can be encoded and retrieved from colloidal materials to guide their behavior.

Committee chair: Prof. Sharon Glotzer
Committee members (currently):
Prof. Michael Solomon
Prof. Ronald Larson
Prof. Xiaoming Mao

Note: Total length must be less than 15 pages of text. Includes figures, excludes title page, list of references, and CV.

1 Introduction and motivation (1pg)

Thesis: Reconfigurability-induced switching of a material's structure could be explored as a way of storing information ("memory") in a material. We can consider this pluripotency.

Goal: Predictively and reliably encode information in materials systems. (I know this is too broad)

Problem statement:

- *Engineering*: Designing functional, reconfigurable materials will require some method of storing information in a material– we might call this "memory"
- *Science*: Understanding how to "store information" in a material that embeds a response is a fundamental problem; further understanding the linkage between information-theoretic entropy and thermodynamic entropy concepts (accessible states, heat) could further our understand of dynamics of biological, etc processes

Ideas:

- Reconfigurable systems may be the key for unlocking adaptive material applications
- At a particle level, we can think of this as building pluripotent building blocks that contain some response to a stimulus
- At a system level, we can think of this as having metastable configurations in response to some stimulus
- At an assembly-level, we can think of this as building blocks that can be engineered to form specifically-ordered arrays

Key line from Simons proposal: "A coherent framework of thermodynamic and non-equilibrium processes seen through information theoretic eyes could lead to new theories for encoding information in matter– which would allow for the design of novel materials and novel material behavioral control."

2 Background - Literature survey (2-3 pg)

Placeholder.

3 Background - Research already completed (2-3 pg)

3.1 Role of particle shape on the emergent behavior of active systems

Take selections from in-preparation paper.

Relation to proposed thesis topic: If we define information broadly as any quality of a building block that impacts the emergent behavior of a system of those particles (in this case, force direction and shape), then we can argue this work is looking at a few aspects of information in active systems.

3.2 Mention work on NSF grant proposal?

Using DNA-mediated assembly to store information in nanoparticle arrays.

4 Description of proposed research (7-8 pg, 2-3 pg per aim)

High-level: "Information" are those factors that impact the yield and kinetics of self-assembly. To engineer them, we must continue to understand them.

Need to figure out what angle I want to approach this from:

- Pathway engineering?
- "Smart"particle building blocks?
- Algorithmically-designed interactions/patterned structures?
- ... something else?

For each aim:

- Goal and significance
- Hypothesis
- Approach, methods, analysis to be used (including relevant citations)

5 Time table

Will put together a Gantt chart with associated milestones through 2020.

6 Conclusion

Long, long-term goal: Instead of simply observing emergent behavior as an outcome of collective motion of individuals, we could instead engineer such behavior as a quantifiable outcome of the interaction of an information-rich network of agents.