Dynamics of Active Particle Diffusion-Limited Aggregation

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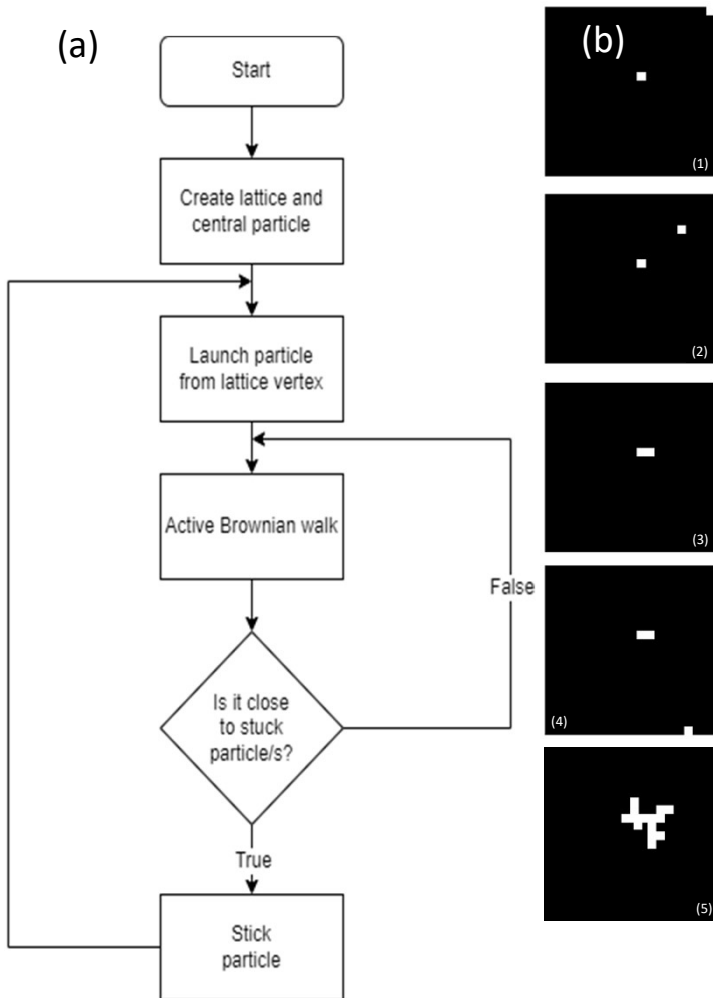
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ABSTRACT

Diffusion-limited aggregation refers to the scheme where particles travelling in Brownian motion get stuck and aggregate afterwards to a point. Here we do numerical experiments for the case of having self-propelling particles (SPPs) instead of purely random ones in diffusion-limited aggregation. The SPPs are self-propelled with varying propulsion velocities. The structure produced by multiple particles aggregating, one after another is a Brownian tree. The radius of the smallest circle that encompasses the Brownian tree and the Levy's Stochastic Area using a convex hull algorithm are then measured. The relations between these quantities are then studied for different propulsive velocities

Key words: active Brownian motion, diffusion-limited aggregation, Brownian tree, self-propelling particles
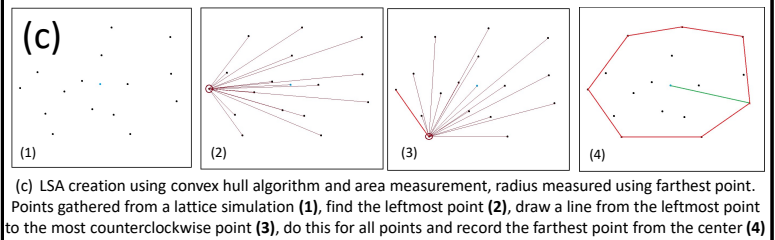
Motivation

- Active matter refers to collection of self-propelling particles that consumes energy from its environment. The thermodynamics of such systems is still lacking
- Elucidate the dynamics of a Brownian tree formed by an active diffusion-limited aggregation
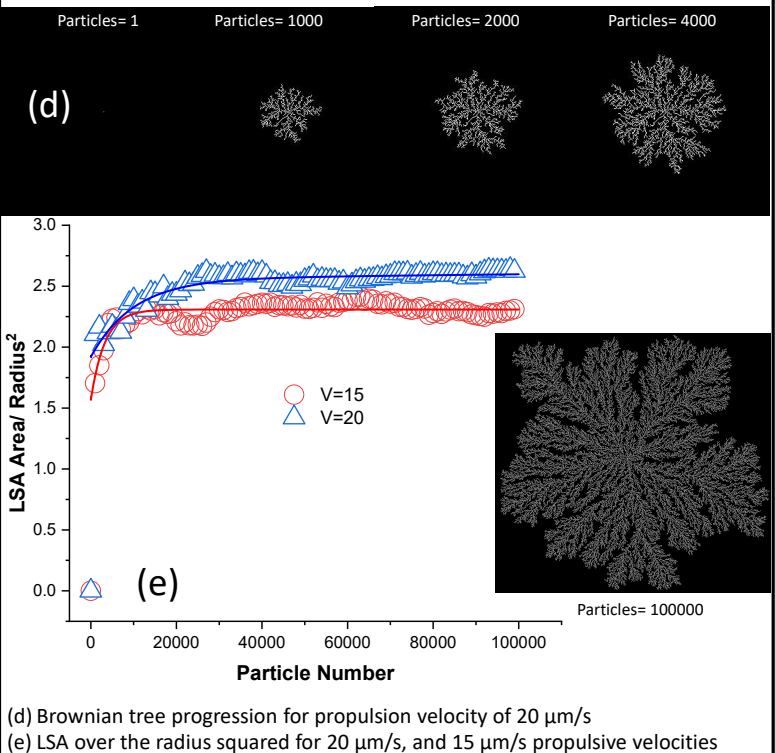
Methodology

Levy's Stochastic Area (LSA) and Radius

(c) LSA creation using convex hull algorithm and area measurement, radius measured using farthest point. Points gathered from a lattice simulation (1), find the leftmost point (2), draw a line from the leftmost point to the most counterclockwise point (3), do this for all points and record the farthest point from the center (4)

Initial Results

(d) Brownian tree progression for propulsion velocity of 20 μm/s
(e) LSA over the radius squared for 20 μm/s, and 15 μm/s propulsive velocities

(a) Flowchart of the algorithm for the creation of the Brownian tree
(b) Diagram of the aggregation process. Center particle creation and launching a particle on a vertex (1), active Brownian motion of the travelling particle (2), particle sticking (3), launching another particle (4), multiple particles aggregated (5).

Summary

- We performed simulations for an active diffusion-limited aggregation
- A non-equilibrium steady state via the ratio of the LSA to that of the DLA radius is achieved at long times

Acknowledgement