ICME Experiment - 7: Diffusion Limited Aggregation

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Diffusion Limited Aggreagation (DLA)

DLA is the process whereby particles undergoing a random walk (diffusion) cluster together to form aggregates of such particles. DLA can be observed in many systems such as electrodeposition, Hele-Shaw flow, mineral deposits, and dielectric breakdown.

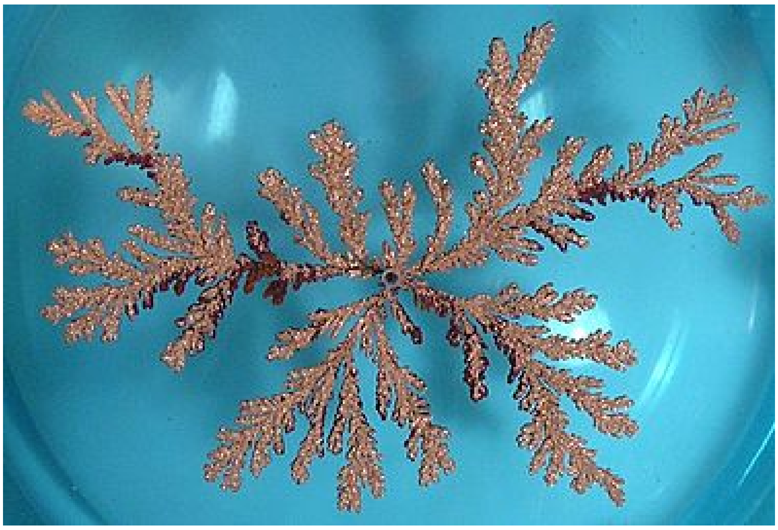


Figure 1: DLA cluster grown in an electrodeposition cell

A MatLab code was designed to simulate such a process.

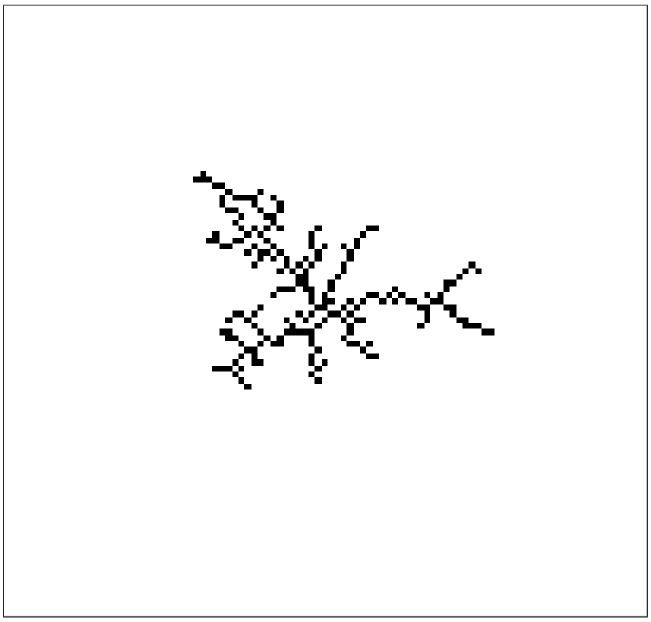
```
%% Diffusion Limited Aggregation - KP
%% Created on 5 October 2018
%% Size of 2D matrix = 101, No. of particles = 200
clear all
close all
clc

%% Initialisation
size = 101;                 % Size of matrix
mat = zeros(size,size);     % Zeros matrix
mat(51,51) = 1;             % Centre of DLA
n = 0;
%% Simulation
while(n<200)                                % No. of particles
    theta = 2*pi*rand;                      % Random particle on edge of circle
    x = ceil(51 + 30*cos(theta));
    y = ceil(51 + 30*sin(theta));
```

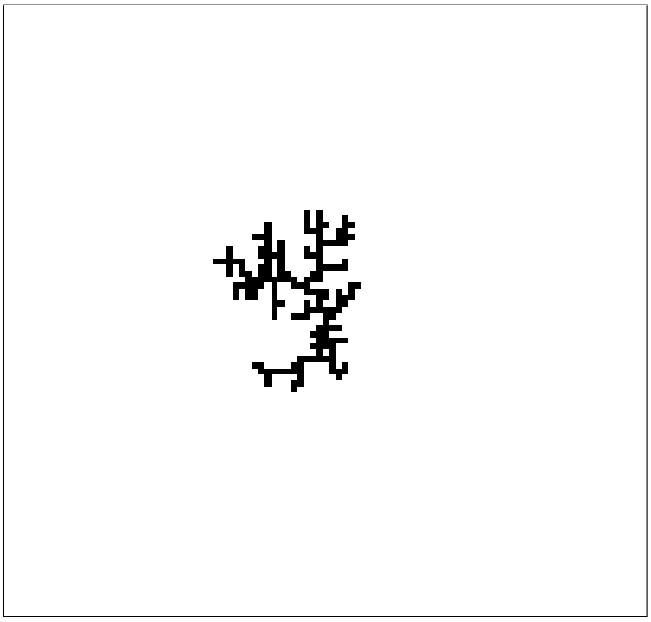
```
    while(1)
        neig = [x-1 y+1; x y+1; x+1 y+1; x-1 y;...
            x+1 y; x-1 y-1; x y-1; x+1 y-1];    % Immediate neighbours
        r = randi([1,8]);                       % Random movement
        x = neig(r,1);
        y = neig(r,2);
        if (x-51)^2 + (y-51)^2 > 901            % Boundary condition
            break
        end
        % Conditions for attachment
        if mat(x-1, y+1)==1
            mat(x,y) = 1;
            n = n+1;
            break
        end
        if mat(x, y+1)==1
            mat(x,y) = 1;
            n = n+1;
            break
        end
        if mat(x+1, y+1)==1
            mat(x,y) = 1;
            n = n+1;
            break
        end
        if mat(x-1, y)==1
            mat(x,y) = 1;
            n = n+1;
            break
        end
        if mat(x+1, y)==1
            mat(x,y) = 1;
            n = n+1;
            break
        end
        if mat(x-1, y-1)==1
            mat(x,y) = 1;
            n = n+1;
            break
        end
        if mat(x, y-1)==1
            mat(x,y) = 1;
            n = n+1;
            break
        end
        if mat(x+1, y-1)==1
            mat(x,y) = 1;
            n = n+1;
            break
        end
    end
end
imshow(not(mat)); % Visualisizing the DLA cluster
```

The main idea of the algorithm is to create random particles on the edge of a 2D disk and allow it to walk till it reaches another particle and adheres to it. One particle at a time is allowed in this simulation, however in practical sense it may differ and small aggregates may already form before attaching to the main structure i.e. the *Brownian tree.* The result of the simulation run for 200 particles is shown in fig 2a.

Anisotropy was introduced into the DLA process by having the particle to look at only four of its nearest neighbours in the x-y direction. Such an anisotropic cluster is shown in fig 2b.



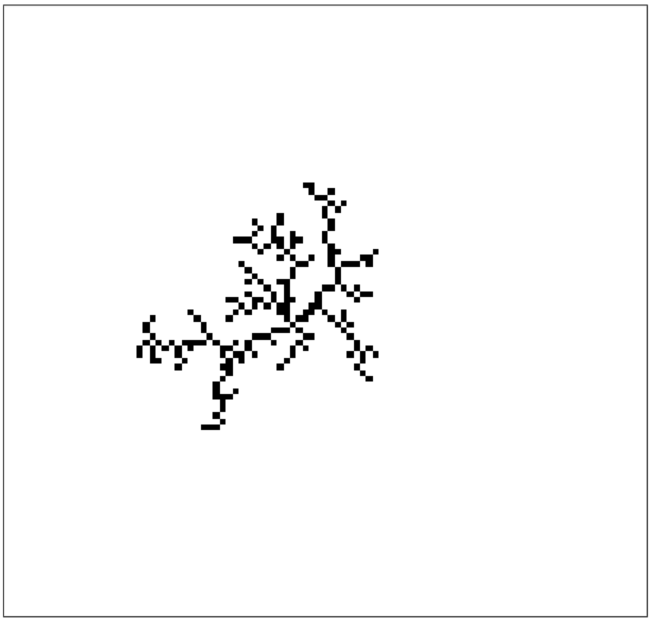
(a) Isotropic DLA with 200 particles



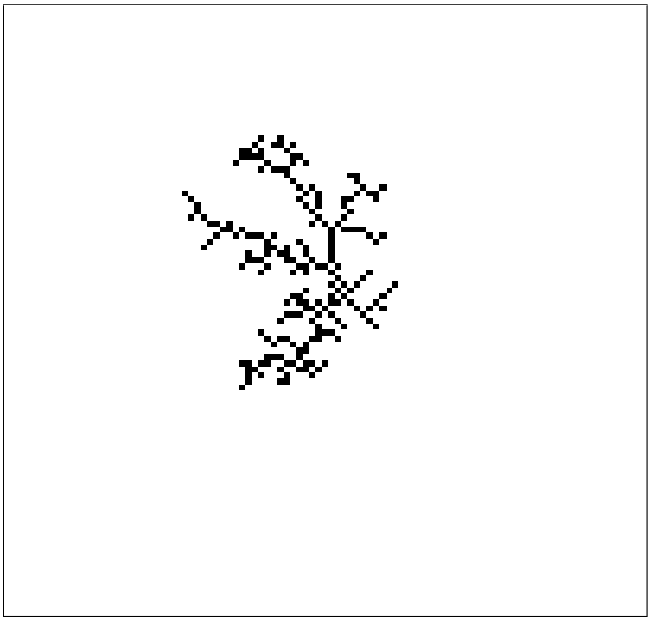
(b) Anisotropic DLA with 200 particles

Figure 2: Simulated DLA process results

The random nature of the process was investigated and successfully verified by carrying out more simulations.



(a) Isotropic DLA with 200 particles



(b) Isotropic DLA with 200 particles

Figure 3: Some more DLA process results