BACTERIAL BEHAVIOR

■ How does simple bacteria behave?

when all flagella in a bundle rotate the same direction, the bacterium 'runs' in a straight line, whereas if one of the flagella in the bundle switches direction, the bundle separates, leading to a tumble in which the bacterium reorients to face in a random direction before beginning another run.

■ How do Bacteria behave as swarm?

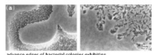
(i) Quorum Sensing

Bacteria use Quorum Sensing to coordinate certain behaviors based on the local density of the their population. When they are in low density, they do not act. However, they are in high density, they swarm and make Biofilm around themselves.

(ii) The process of making Biofilm

The biofilm life cycle

1: individual cells populate the surface.
2: EPS is produced and attachment becomes irreversible.
3, 4: biofilm architecture develops and matures.
5: single cells are released from the biofilm.

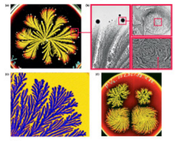


advance edges of bacterial colonies exhibiting
(a) swarming and (b) twitching

Bacteria propel themselves along a surface in rafts or tendrils, and are capable of sensing and reacting to other groups of cells and secreting extracellular factors to modulate their movement.

The shorter B bacteria are ramdomly positioned and oriented.
These reflect each other with random swimming and tumbling in the lubricating biofilm surface.
The boundaries of the branch are set by the lubricating fluid within which the bacteria can move.
The flexible structure of the branches is due to **repulsive chemical signaling from pre-spore bacteria close to the colony of the center**.

■ The process of making patterns



(a)
The color shades indicate the cell density: red for low and yellow/white for high. The vortices, the bright dots in (a), contain thousands of bacteria that rotate around a common center while they move forward as a foraging unit

(b)
they are pushed forward by repulsive signals sent from the mother colony.

(c)
Cell replicate and organize within initial spread of the growth fluid. Then several groups leave the center region at the same time.

(d)
The bottom of the vortexies are transfered from top coloneis and expand patterns. The differences in the growth patterns indicate that the cells altered epigenetic traits as compared to the mother colony which are nutrient, number of themselves, etc.

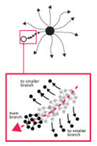
DIAGRAM

simple bacteria is a particle agent

connect with each other

make biofilm around themselves

repulsive force from the center

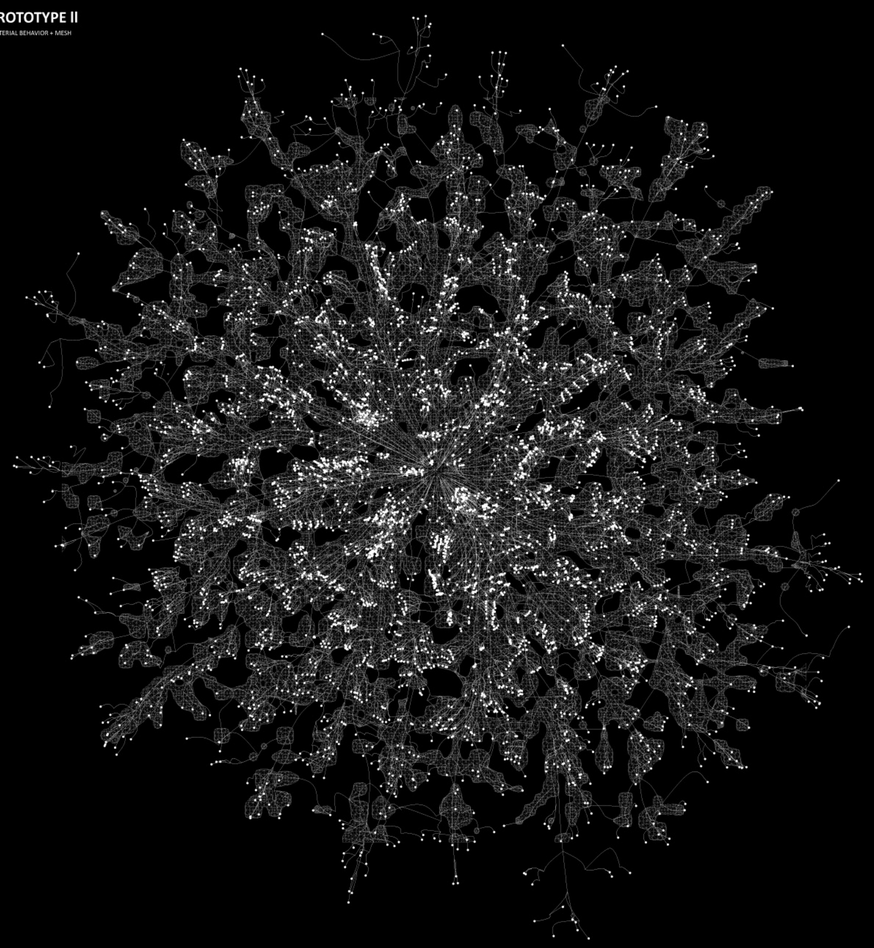


second mother colony moves forward

2 DIMENTIONAL BEHAVIOR SIMULATION

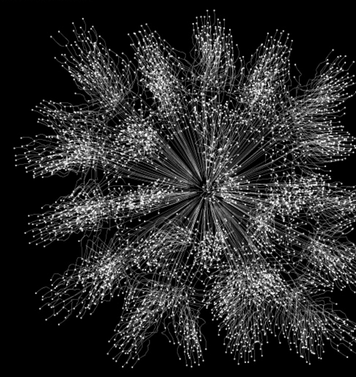
PROTOTYPE II

BACTERIAL BEHAVIOR + MESH

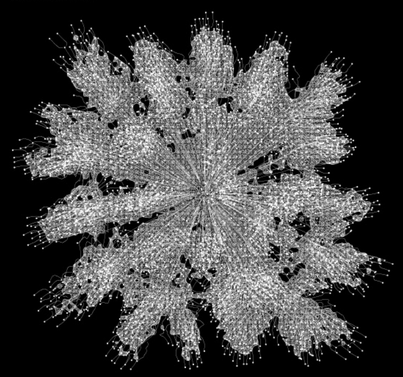


PROTOTYPE I

BACTERIAL BEHAVIOR SIMULATION



BACTERIAL BEHAVIOR + MESH



```
SCRIPT FOR SWARM BEHAVIOR OF PROTOTYPE II ==============

import spec.*;
import spec.a.*;
import spec.co.*;
import spec.gui.*;

import processing.opengl.*;

void setup(){
  size(500, 500, 3D);
  smooth(8);
  frame(true);
  fill(0);
  ellipseMode(CENTER);
  attractor = new Attractor(0,0,0, intensity:50);
  attractor.targetGroup(MyParticle.class);
  for(int i=0; i<200; i++){
    new MyParticle(new Point(pr.10,-10,0),10,0,new Jitter());
  }
}

class MyParticle extends ThreeParticle{
  boolean firstTime = true;

  MyParticle(Point p, Jitter v){
    super(p,v);
    mass(1.0);
    fric(0.1);
    noboundaryCol(0);
    noparticleCol(0);
    nobondCol(0);
    separationCol(0);
    alignmentCol(0);
    cohesionCol(0);
    alignmentStr(0);

    targetClass(MyParticle.class);
  }

  void interact(Agent[int i ISystem[int s agents){
    if(firstTime == 1){
      for(int j=0; j<agents.size(); j++){
        ((Agent)s.get(j)).interact(MyParticle[]
          MyParticle p = (MyParticle)agents.get(j);
          if(p.isSelf(this)){
            if(true){
              Point d = new Point(0,0,0);
              d.sub(this.getPos(),p.getPos());
              fric.inc(1);
              p.addForce(d);
            }
          }
        }
      }
    }
  }

  void update(){
    if(lifeLeft>0){
      pushTrace(pr.rnd(-100,-100,0,100,100,0));

    if(lifeLeft == time) // 60 sec(30 sec)
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0),40);

    if(lifeLeft == time/2 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0),40);
    }
    if(lifeLeft == time/4 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/8 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/16 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/32 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/64 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/128 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/256 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/512 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1024 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2048 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/4096 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/8192 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/16384 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/32768 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/65536 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/131072 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/262144 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/524288 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1048576 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2097152 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/4194304 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/8388608 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/16777216 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/33554432 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/67108864 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/134217728 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/268435456 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/536870912 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1073741824 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2147483648 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/4294967296 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/8589934592 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/17179869184 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/34359738368 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/68719476736 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/137438953472 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/274877906944 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/549755813888 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1099511627776 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2199023255552 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/4398046511104 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/8796093022208 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/17592186044416 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/35184372088832 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/70368744177664 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/140737488355328 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/281474976710656 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/562949953421312 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1125899906842624 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2251799813685248 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/4503599627370496 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/9007199254740992 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/18014398509481984 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/36028797018963968 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/72057594037927936 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/144115188075855872 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/288230376151711744 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/576460752303423488 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1152921504606846976 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2305843009213693952 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/4611686018427387904 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/9223372036854775808 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/18446744073709551616 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/36893488147419103232 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/73786976294838206464 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/147573952589676412928 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/295147905179352825856 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/590295810358705651712 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1180591620717411303424 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2361183241434822606848 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/4722366482869645213696 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/9444732965739290427392 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/18889465931478580854784 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/37778931862957161709568 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/75557863725914323419136 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/151115727451828646838272 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/302231454903657293676544 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/604462909807314587353088 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1208925819614629174706176 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2417851639229258349412352 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/4835703278458516698824704 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/9671406556917033397649408 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/19342813113834066795298816 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/38685626227668133590597632 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/77371252455336267181195264 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/154742504910672534362390528 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/309485009821345068724781056 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/618970019642690137449562112 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1237940039285380274899124224 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2475880078570760549798248448 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/4951760157141521099596496896 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/9903520314283042199192993792 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/19807040628566084398385987584 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/39614081257132168796771975168 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/79228162514264337593543950336 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/158456325028528675187087900672 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/316912650057057350374175801344 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/633825300114114700748351602688 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1267650600228229401496703205376 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2535301200456458802993406410752 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/5070602400912917605986812821504 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/10141204801825835211973625643008 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/20282409603651670423947251286016 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/40564819207303340847894502572032 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/81129638414606681695789005144064 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/162259276829213363391578010288128 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/324518553658426726783156020576256 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/649037107316853453566312041152512 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1298074214633706907132624082305024 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2596148429267413814265248164610048 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/5192296858534827628530496329220096 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/10384593717069655257060992658440192 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/20769187434139310514121985316880384 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/41538374868278621028243970633760768 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/83076749736557242056487941267521536 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/166153499473114484112975882535043072 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/332306998946228968225951765070086144 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/664613997892457936451903530140172288 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1329227995784915872903807060280344576 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2658455991569831745807614120560689152 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/5316911983139663491615228241121378304 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/10633823966279326983230456482242756608 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/21267647932558653966460912964485513216 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/42535295865117307932921825928971026432 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/85070591730234615865843651857942052864 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/170141183460469231731687303715884105728 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/340282366920938463463374607431768211456 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/680564733841876926926749214863536422912 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1361129467683753853853498429727072845824 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2722258935367507707706996859454145691648 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/5444517870735015415413993718908291383296 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/10889035741470030830827987437816582766592 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/21778071482940061661655974875633165533184 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/43556142965880123323311949751266331066368 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/87112285931760246646623899502532662132736 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/174224571863520493293247799005065324265472 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/348449143727040986586495598010130648530944 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/696898287454081973172991196020261297061888 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1393796574908163946345982392040522594123776 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2787593149816327892691964784081045188247552 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/5575186299632655785383929568162090376495104 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/11150372599265311570767859136324180752990208 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/22300745198530623141535718272648361505980416 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/44601490397061246283071436544296722991960832 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/89202980794122492566142873088593445983921664 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/178405961588244985132285746177186891967843328 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/356811923176489970264571492354373783935686656 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/713623846352979940529142984708747567871373312 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1427247692705959881058285969417495135742746624 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2854495385411919762116571938834990271485493248 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/5708990770823839524233143877669980542970986496 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/11417981541647679048466287755339961085941972992 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/22835963083295358096932575511679922171883945984 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/45671926166590716193865151022359844343767891968 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/91343852333181432387730302044767688728535783936 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/182687704666362864775460604089535377456991567872 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/365375409332725729550921208179070754913983135744 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/730750818665451459101842416358141509827966271488 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1461501637330902918203684832716283019655932542976 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2923003274661805836407369665432566039311865085952 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/5846006549323611672814739330865132078623730171904 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/11692013098647223345629478661730264157247460343808 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/23384026197294446691258957323460528314494920687616 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/46768052394588893382517914646921056628989841375232 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/93536104789177786765035829293842113257979682750464 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/187072209578355573530071658587684226515959365500928 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/374144419156711147060143317175368453031918731001856 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/748288838313422294120286634350736906063837462003712 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/1496577676627845588240573268701473812127674924007424 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/2993155353255691176481146537402947624255349848014848 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e11(-0.2,0.2),0.2),0);
    }
    if(lifeLeft == time/5986310706511382352962293074805895248510699696029696 || lifeLeft == 0){
      new MyParticle(mkVec3(0 (pos().y, 0e
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