

Assignment 9: Particle Systems

1 代码实现

1.1 ForceField及子类

```
class ForceField
{
public:
    virtual Vec3f getAcceleration(const Vec3f& position, float mass, float t)
    const = 0;

};

class GravityForceField : public ForceField
{
public:
    GravityForceField(Vec3f gravity):gravity(gravity)
    {
    }
    virtual Vec3f getAcceleration(const Vec3f& position, float mass, float t)
    const
    {
        return gravity;
    }
private:
    Vec3f gravity;
};

class ConstantForceField : public ForceField
{
public:

    ConstantForceField(Vec3f force):force(force)
    {
    }

    virtual Vec3f getAcceleration(const Vec3f& position, float mass, float t)
    const
    {
        return (1.0f / mass)* force;
    }

private:
    Vec3f force;
};
```

```
};
```

```
class RadialForceField : public ForceField
{
public:

    RadialForceField(float magnitude):magnitude(magnitude)
    {
    }

    virtual Vec3f getAcceleration(const Vec3f& position, float mass, float t)
const
    {
        Vec3f direction = -1*position;
        direction.Normalize();
        float distance = position.Length();
        return magnitude * distance * (1.0f / mass)*direction;
    }

private:
    float magnitude;
};
```

```
class VerticalForceField : public ForceField
{
public:

    VerticalForceField(float magnitude) :magnitude(magnitude)
    {
    }

    virtual Vec3f getAcceleration(const Vec3f& position, float mass, float t)
const
    {
        Vec3f direction(0, -position.y(), 0);
        direction.Normalize();
        float distance = fabs(position.y());
        return magnitude * distance * (1.0f / mass) * direction;
    }

private:
    float magnitude;
};
```

1.2 Iterator及子类

```
class Integrator
{
public:
    virtual void Update(Particle* particle, ForceField* forcefield, float t,
float dt) = 0;
    virtual Vec3f getColor() = 0;
};

//pn+1 = pn + vn * dt
//vn + 1 = vn + a(pn, t) * dt
class EulerIntegrator : public Integrator
{
public:
    virtual void Update(Particle* particle, ForceField* forcefield, float t,
float dt)
    {
        particle->increaseAge(dt);
        Vec3f velocityN = particle->getVelocity();
        Vec3f positionN = particle->getPosition();
        float mass = particle->getMass();

        Vec3f newPosition = positionN + velocityN * dt;
        Vec3f newVelocity = velocityN + forcefield->getAcceleration(positionN,
mass, t)*dt;

        particle->setPosition(newPosition);
        particle->setVelocity(newVelocity);
    }

    virtual Vec3f getColor()
    {
        return Vec3f(1, 0, 0);
    }
};

//pm = pn + vn * dt / 2
//vm = vn + a(pn, t) * dt / 2
//
//pn + 1 = pn + vm * dt
//vn + 1 = vn + a(pm, t + dt / 2) * dt
class MidpointIntegrator : public Integrator
{
public:
    virtual void Update(Particle* particle, ForceField* forcefield, float t,
float dt)
    {
        particle->increaseAge(dt);

        Vec3f velocityN = particle->getVelocity();
        Vec3f positionN = particle->getPosition();
```

```

        float mass = particle->getMass();

        Vec3f positionM = positionN + velocityN * (dt / 2.0f);
        Vec3f velocityM = velocityN + forcefield->getAcceleration(positionN,
mass, t) * (dt / 2.0f);

        Vec3f newPosition = positionN + velocityM * dt;
        Vec3f newVelocity = velocityN + forcefield->getAcceleration(positionM,
mass, t + dt/2.0f) * dt;

        particle->setPosition(newPosition);
        particle->setVelocity(newVelocity);
    }

    virtual Vec3f getColor()
    {
        return Vec3f(0, 1, 0);
    }

};

```

1.3 Generator及子类

```

class Generator
{
public:

    ~Generator()
    {
        delete(random);
    }

    // initialization
    void SetColors(Vec3f color, Vec3f dead_color, float color_randomness)
    {
        this->color = color;
        this->deadColor = dead_color;
        this->colorRandomness = color_randomness;
    }

    void SetLifespan(float lifespan, float lifespan_randomness, int
desired_num_particles)
    {
        this->lifespan = lifespan;
        this->lifespanRandomness = lifespan_randomness;
        this->desiredNumParticles = desired_num_particles;
    }

    void SetMass(float mass, float mass_randomness)
    {
        this->mass = mass;
        this->massRandomness = mass_randomness;
    }
}

```

```

    // on each timestep, create some particles
    // (desired_num_particles), dt * desired_num_particles / lifespan particles
    should be created on each timestep.
    virtual int numNewParticles(float current_time, float dt) const
    {
        return ceilf(dt * (float)desiredNumParticles / lifespan);
    }
    virtual Particle* Generate(float current_time, int i) = 0;

    // for the gui
    virtual void Paint() const
    {
    }

    void Restart()
    {
        delete random;
        random = new Random;
    }

protected:
    Vec3f color;
    Vec3f deadColor;
    float colorRandomness;
    float lifespan;
    float lifespanRandomness;
    int desiredNumParticles;
    float mass;
    float massRandomness;
    Random* random;

};

class HoseGenerator : public Generator
{
public:
    HoseGenerator(Vec3f position, float position_randomness, Vec3f velocity,
float velocity_randomness):
        position(position),
positionRandomness(position_randomness), velocity(velocity),
velocityRandomness(velocity_randomness)
    {
    }

    virtual Particle* Generate(float current_time, int i)
    {
        Vec3f pPosition = position + positionRandomness * random-
>randomVector();
        Vec3f pVelocity = velocity + velocityRandomness * random-
>randomVector();
        Vec3f pColor = color + colorRandomness * random->randomVector();
        Vec3f pDeadColor = deadColor + colorRandomness * random->randomVector();
        float pMass = mass + massRandomness * random->next();
        float pLifespan = lifespan + lifespanRandomness * random->next();
    }
};

```

```

        return new Particle(pPosition, pVelocity, pColor, pDeadColor, pMass,
pLifespan);
    }

private:
    Vec3f position;
    float positionRandomness;
    Vec3f velocity;
    float velocityRandomness;

};

class RingGenerator : public Generator
{
public:
    RingGenerator(float position_randomness, Vec3f velocity, float
velocity_randomness):

positionRandomness(position_randomness), velocity(velocity), velocityRandomness(ve
locity_randomness)
    {
    }

    virtual Particle* Generate(float current_time, int i)
    {
        float radius = current_time;
        Vec3f pPosition(radius*sinf(i)+positionRandomness*random-
>next(),0,radius*cosf(i)+positionRandomness*random->next());
        Vec3f pVelocity = velocity + velocityRandomness * random-
>randomVector();
        Vec3f pColor = color + colorRandomness * random->randomVector();
        Vec3f pDeadColor = deadColor + colorRandomness * random->randomVector();
        float pMass = mass + massRandomness * random->next();
        float pLifespan = lifespan + lifespanRandomness * random->next();

        return new Particle(pPosition, pVelocity, pColor, pDeadColor, pMass,
pLifespan);
    }

    virtual int numNewParticles(float current_time, float dt) const
    {
        return ceilf(current_time*(dt * (float)desiredNumParticles / lifespan));
    }

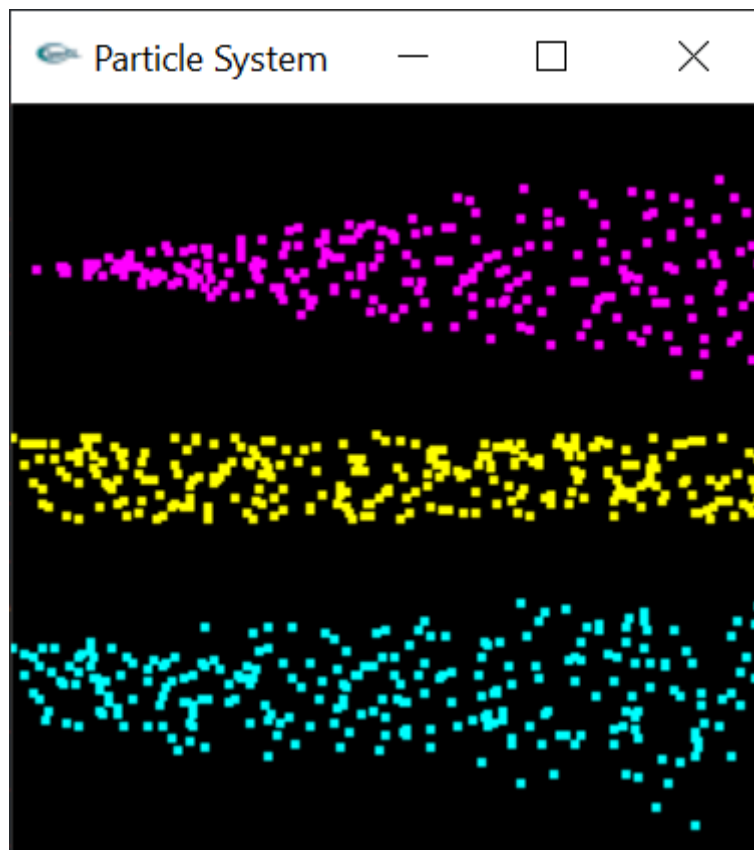
    virtual void Paint() const
    {
        glColor3f(1.0, 1.0, 1.0);
        glBegin(GL_QUADS);
        glVertex3f(10, 0, 10);
        glVertex3f(10, 0, -10);
        glVertex3f(-10, 0, -10);
        glVertex3f(-10, 0, 10);
    }
};

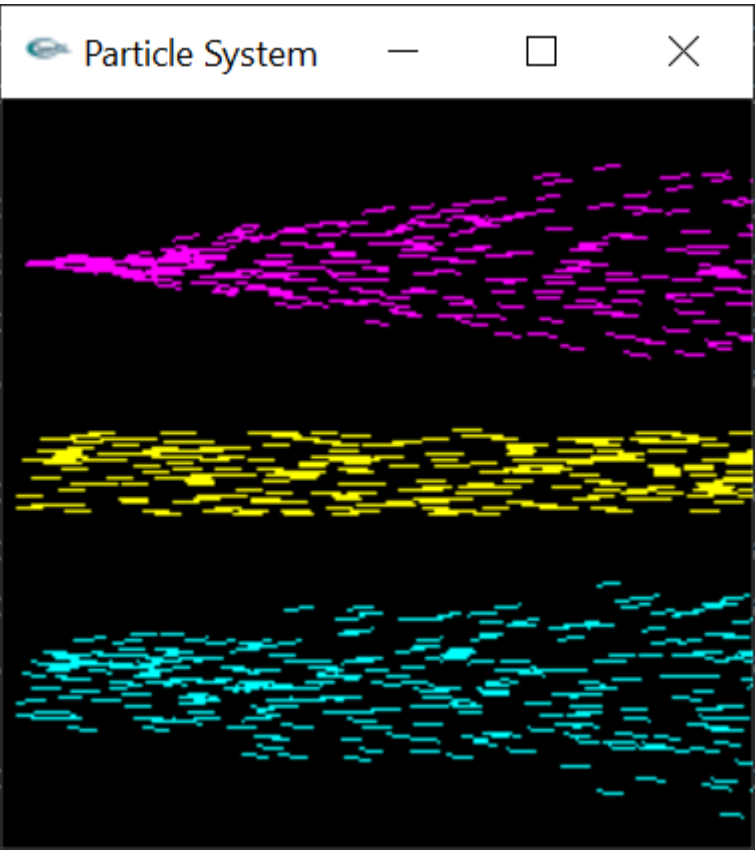
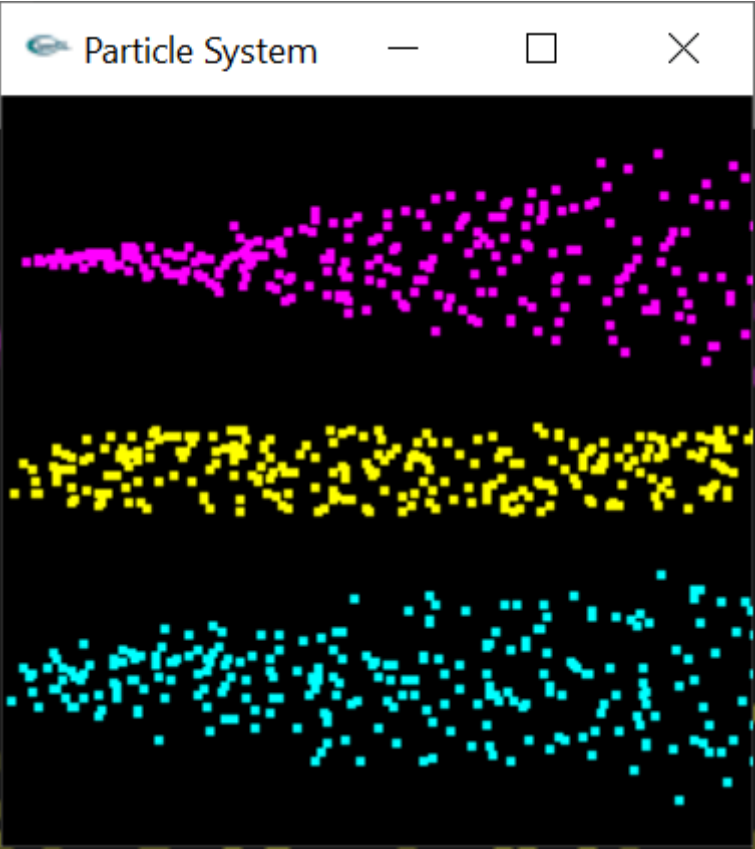
```

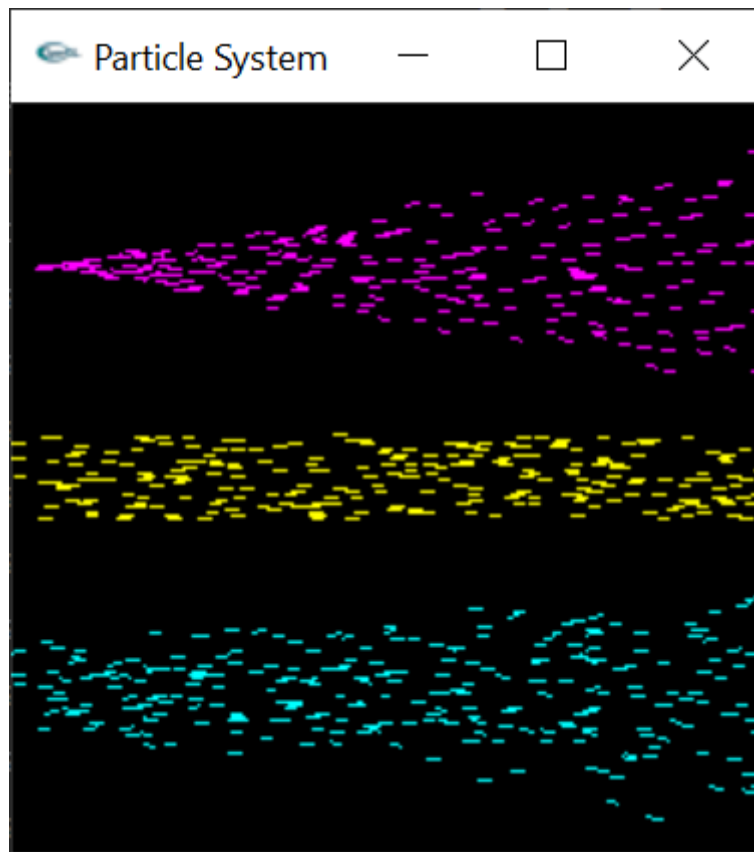
```
        glEnd();  
    }  
  
private:  
    float positionRandomness;  
    Vec3f velocity;  
    float velocityRandomness;  
};
```

2 实验结果

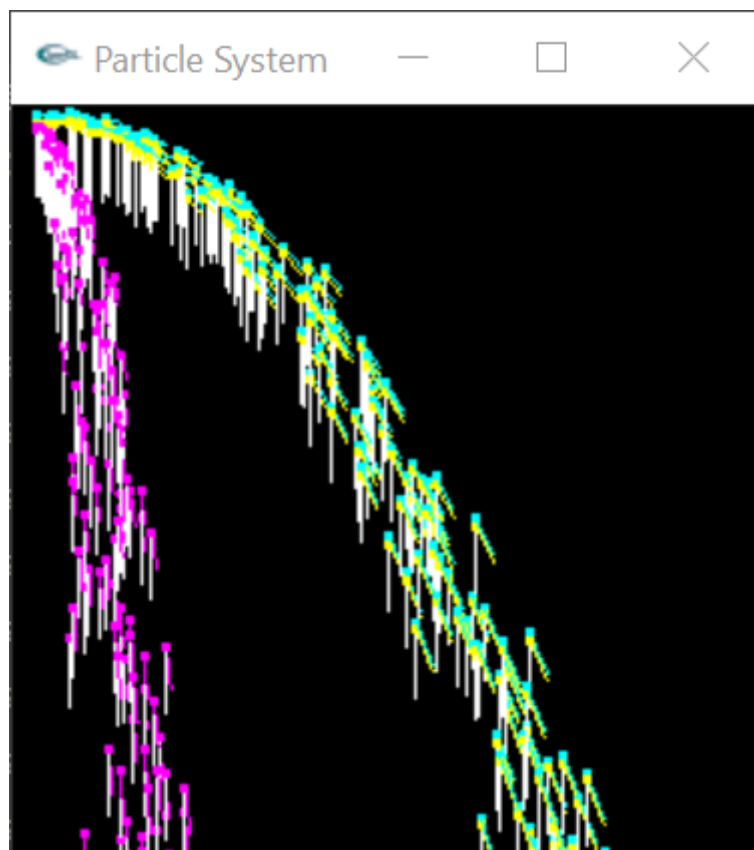
```
particle_system -input system9_01_hose.txt -refresh 0.1 -dt 0.1  
particle_system -input system9_01_hose.txt -refresh 0.05 -dt 0.05  
particle_system -input system9_01_hose.txt -refresh 0.1 -dt 0.1 -motion_blur  
particle_system -input system9_01_hose.txt -refresh 0.05 -dt 0.05 -motion_blur
```

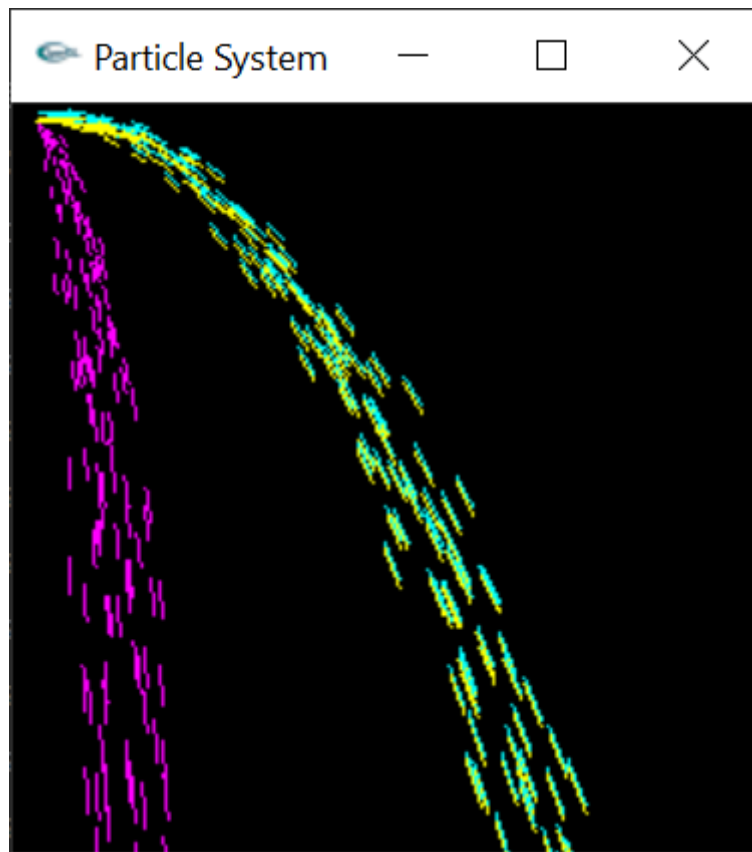




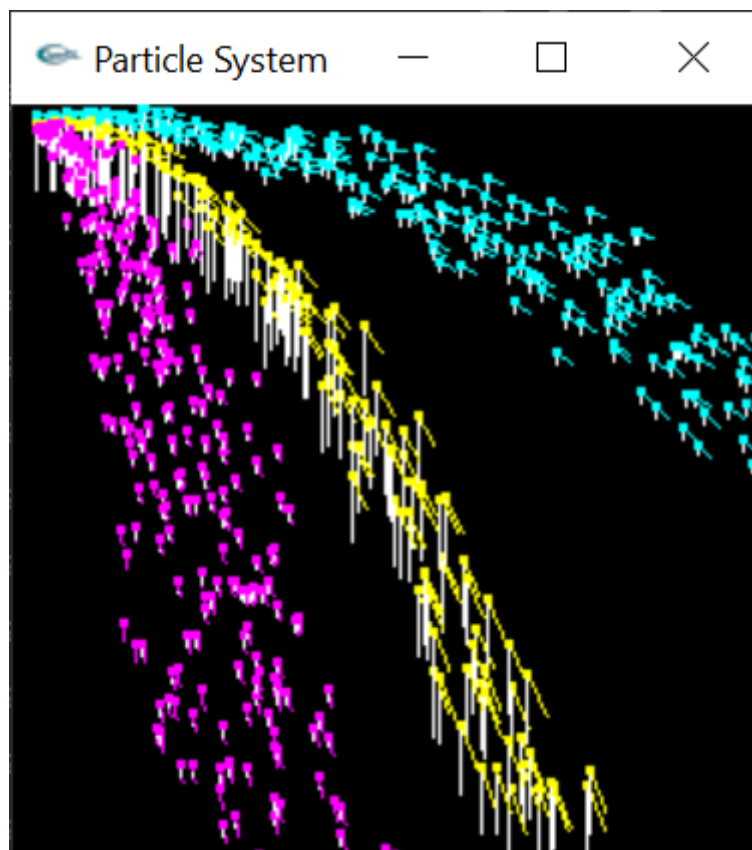


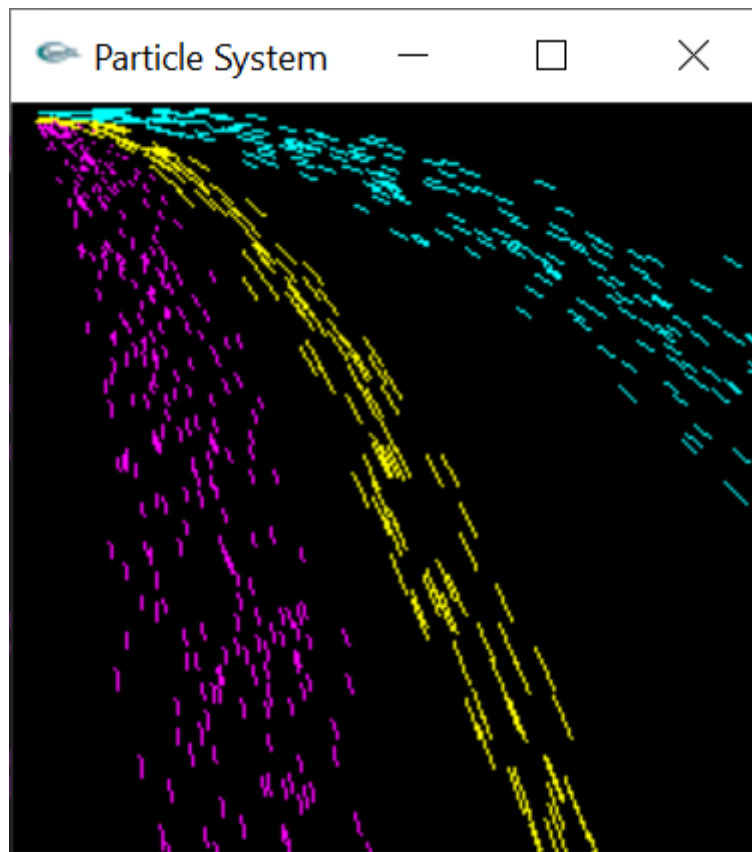
```
particle_system -input system9_02_hose_gravity.txt -refresh 0.05 -dt 0.05 -  
draw_vectors 0.1  
particle_system -input system9_02_hose_gravity.txt -refresh 0.05 -dt 0.05 -  
motion_blur
```



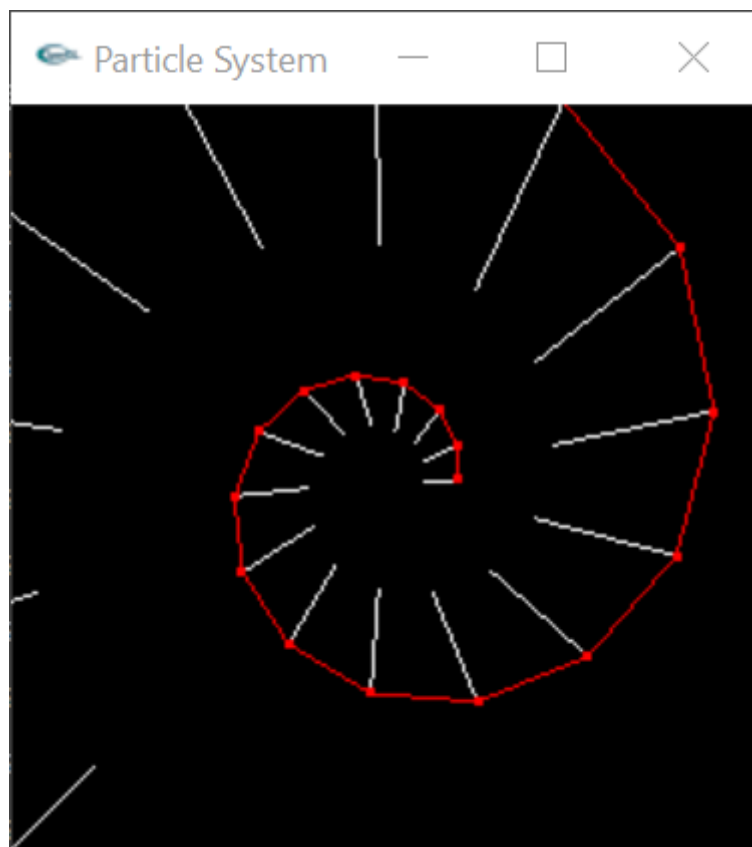


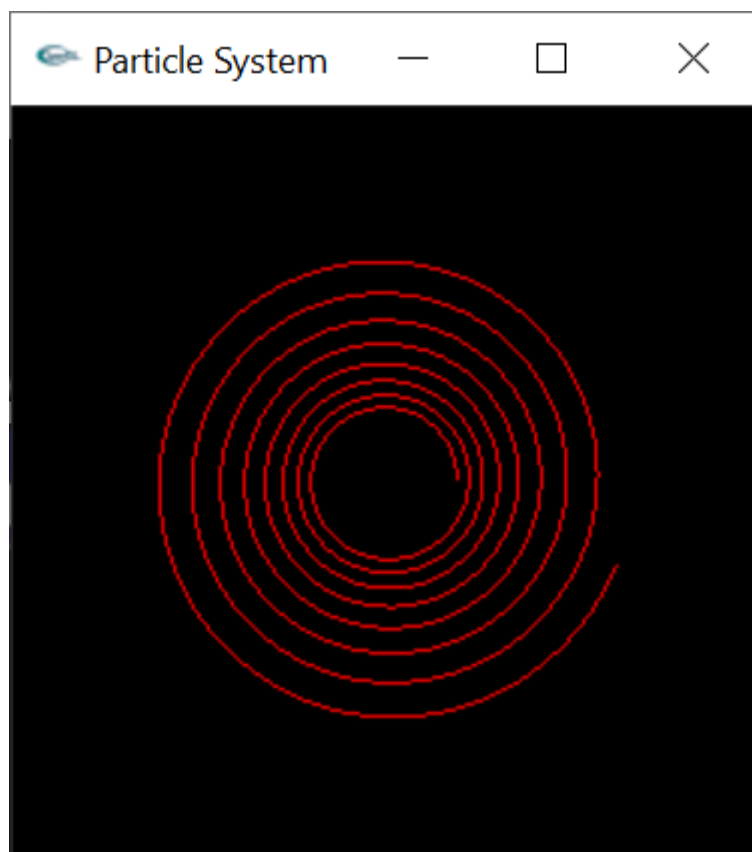
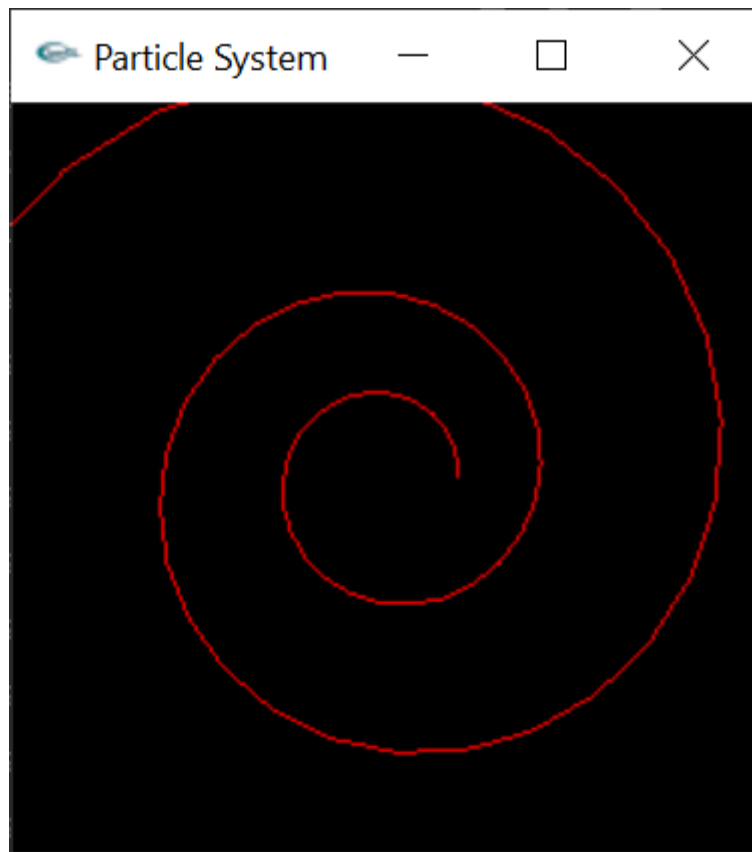
```
particle_system -input system9_03_hose_force.txt -refresh 0.05 -dt 0.05 -  
draw_vectors 0.1  
particle_system -input system9_03_hose_force.txt -refresh 0.05 -dt 0.05 -  
motion_blur
```



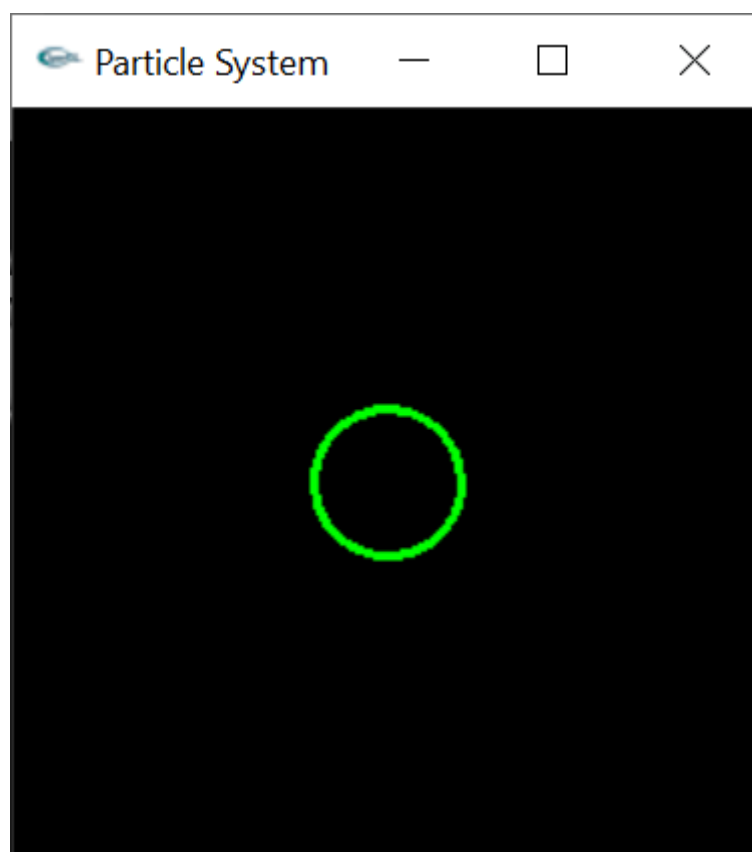
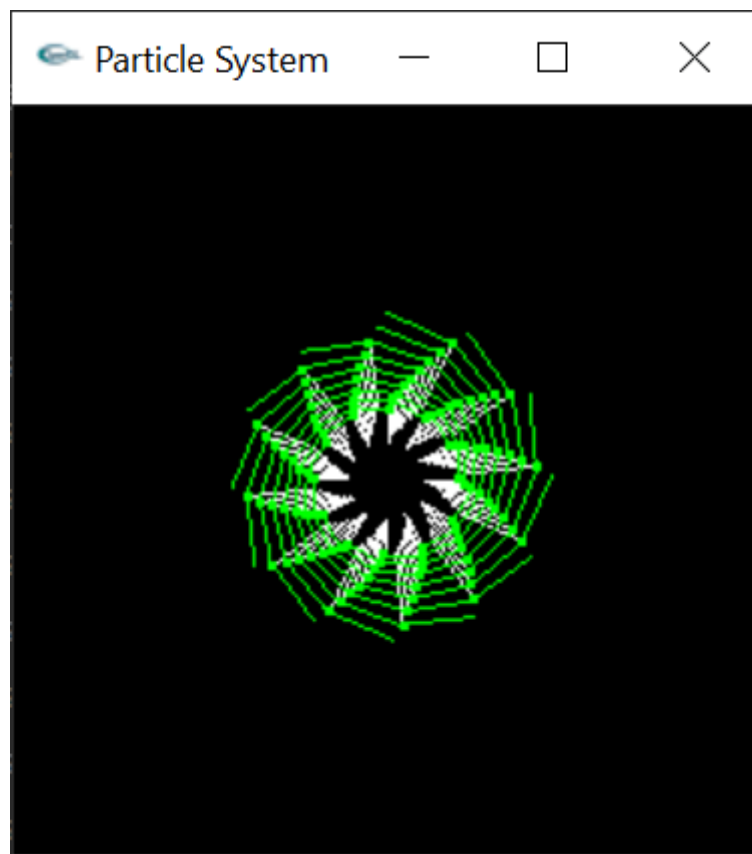


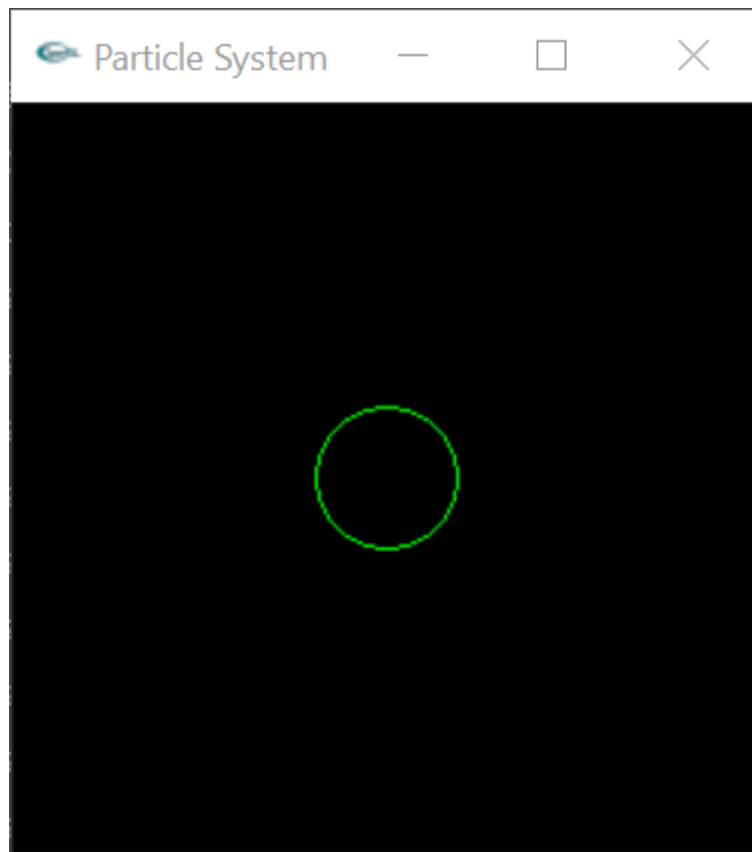
```
particle_system -input system9_04_circle_euler.txt -refresh 0.1 -dt 0.1 -  
integrator_color -draw_vectors 0.02  
particle_system -input system9_04_circle_euler.txt -refresh 0.05 -dt 0.05 -  
integrator_color -motion_blur  
particle_system -input system9_04_circle_euler.txt -refresh 0.01 -dt 0.01 -  
integrator_color -motion_blur
```



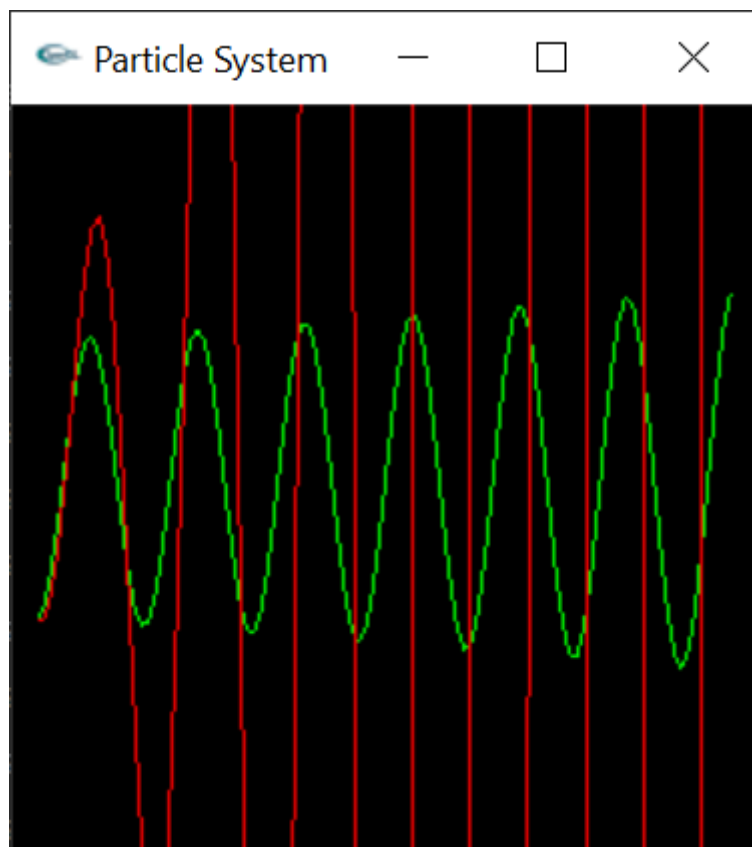


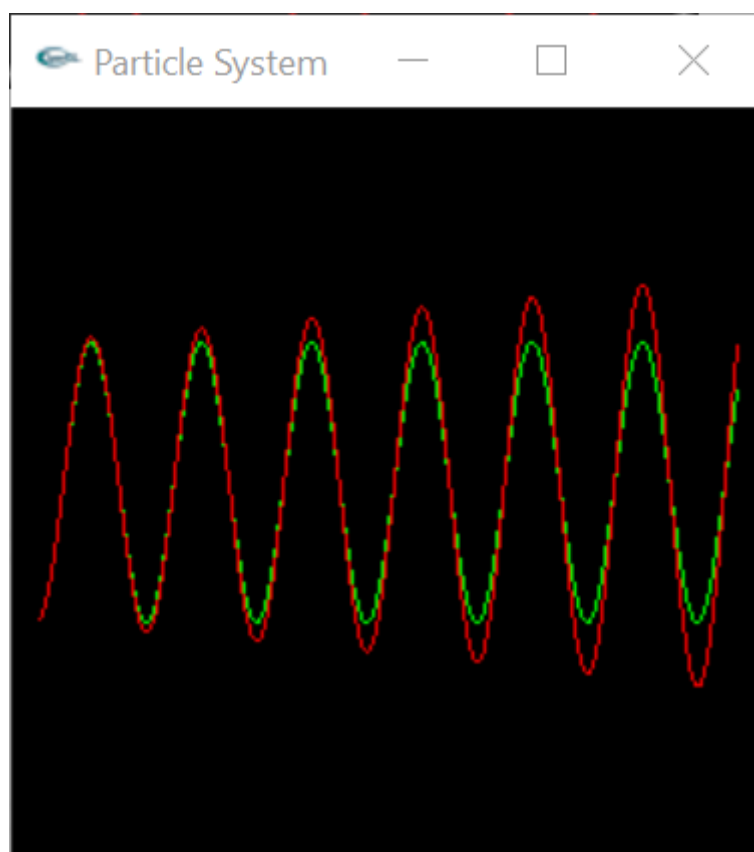
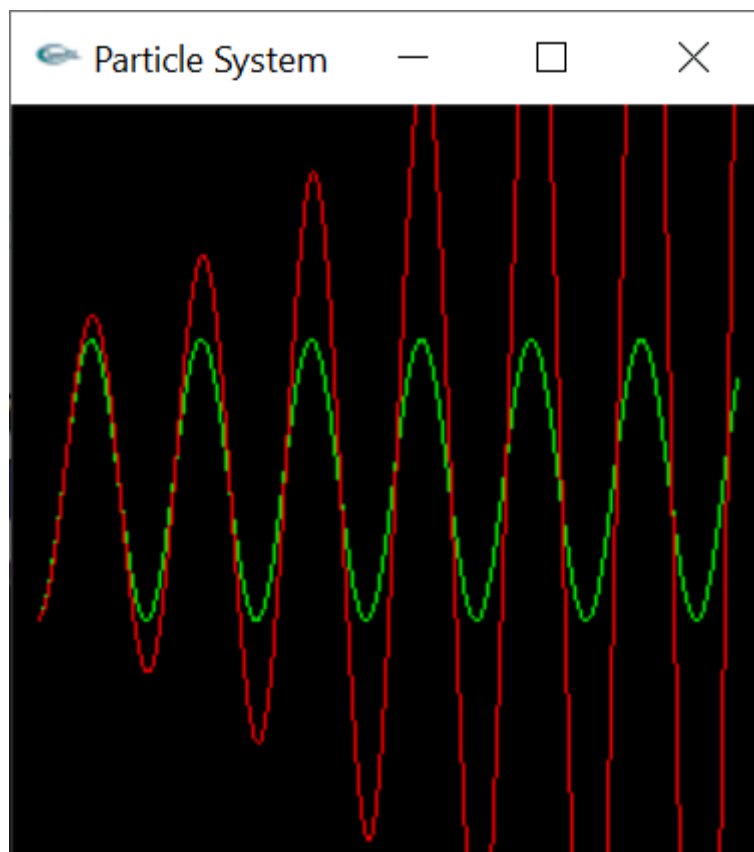
```
particle_system -input system9_05_circle_midpoint.txt -refresh 0.1 -dt 0.1 -  
integrator_color -draw_vectors 0.02  
particle_system -input system9_05_circle_midpoint.txt -refresh 0.05 -dt 0.05 -  
integrator_color -motion_blur  
particle_system -input system9_05_circle_midpoint.txt -refresh 0.01 -dt 0.01 -  
integrator_color -motion_blur
```





```
particle_system -input system9_07_wave.txt -refresh 0.01 -dt 0.2 -  
integrator_color -motion_blur  
particle_system -input system9_07_wave.txt -refresh 0.01 -dt 0.05 -  
integrator_color -motion_blur  
particle_system -input system9_07_wave.txt -refresh 0.01 -dt 0.01 -  
integrator_color -motion_blur
```





```
particle_system -input system9_08_fire.txt -refresh 0.05 -dt 0.05 -motion_blur
```

