Rutherford Scattering

PHYS 305 Final Project

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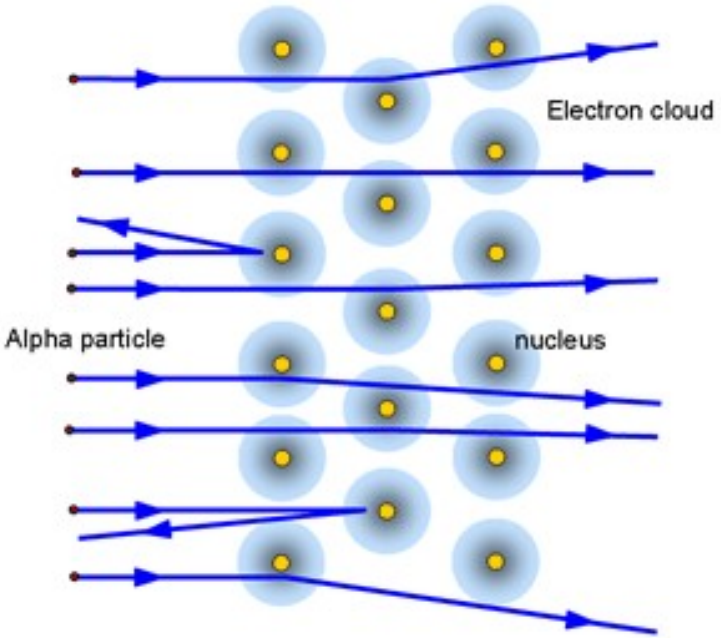
- Kernel Description
- Status

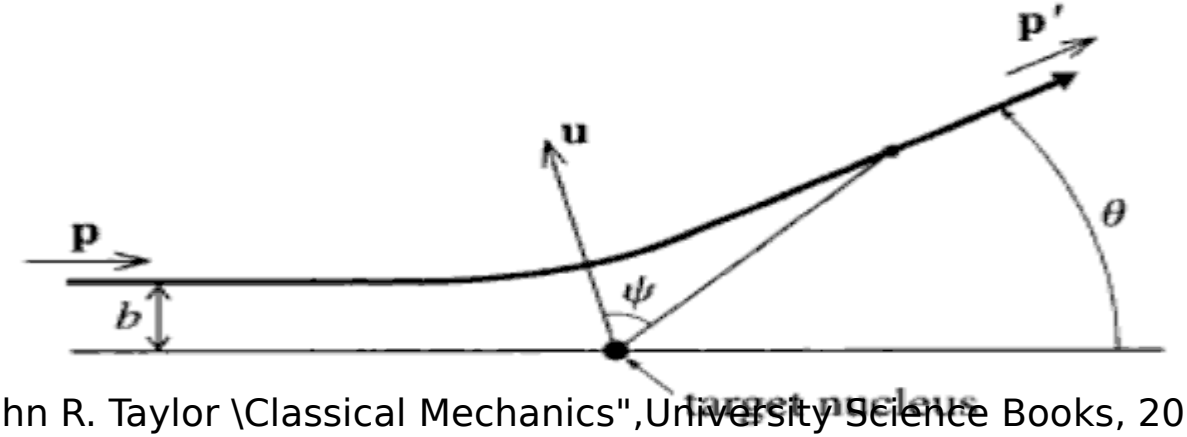
Introduction

- Most famous collision experiment
- Thin Gold (Au) sheet & alpha particle
- Create atom model
- Trajectory of alpha particle
- Number of scattering particles per area
- Different materials



[Source:http://tap.iop.org/atoms/rutherford/index.html]

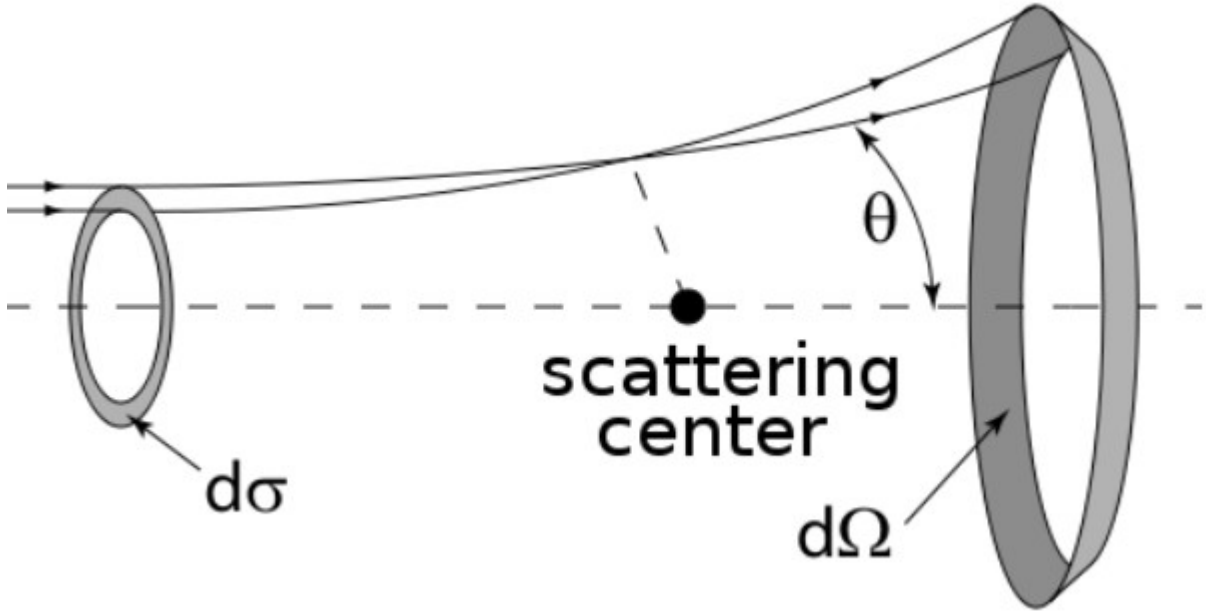
Theory



[source:John R. Taylor \Classical Mechanics",University Science Books, 2005, page 557]

$$b = \frac{(kqQ)}{mv^2}\cot(theta/2)$$

b(impact parameter)
k(Coulomb constant)
m(mass of projectile)
q(charge of projectile)
Q(charge of target)
theta(scattering angle)



[source:John R. Taylor \Classical Mechanics",University Science Books, 2005, page 557]

$$\frac{d\sigma}{d\Omega} = \left(\frac{kqQ}{4E\sin^2(\theta/2)} \right)^2$$

$\frac{d\sigma}{d\Omega}$:differential scattering cross section

Trajectory of alpha particle by using Euler method

$$x(i+1)=x(i)+v_x(i)\times dt+\frac{1}{2}a_x(i)\times dt^2$$

$$y(i+1)=y(i)+v_y(i)\times dt+\frac{1}{2}a_y(i)\times dt^2$$

$$v_x(i+1)=v_x+\frac{1}{2}(a_x(i+1)+a_x(i))\times dt$$

$$v_y(i+1)=v_y+\frac{1}{2}(a_y(i+1)+a_y(i))\times dt$$

$$a_x=\frac{(kq_1q_2)}{m}\frac{(x(i))}{(x^2+y^2)^{3/2}}$$

$$a_y=\frac{(kq_1q_2)}{m}\frac{(y(i))}{(x^2+y^2)^{3/2}}$$

[source:www.drake.edu/artsci/physics/RutherfordScattering.pdf]

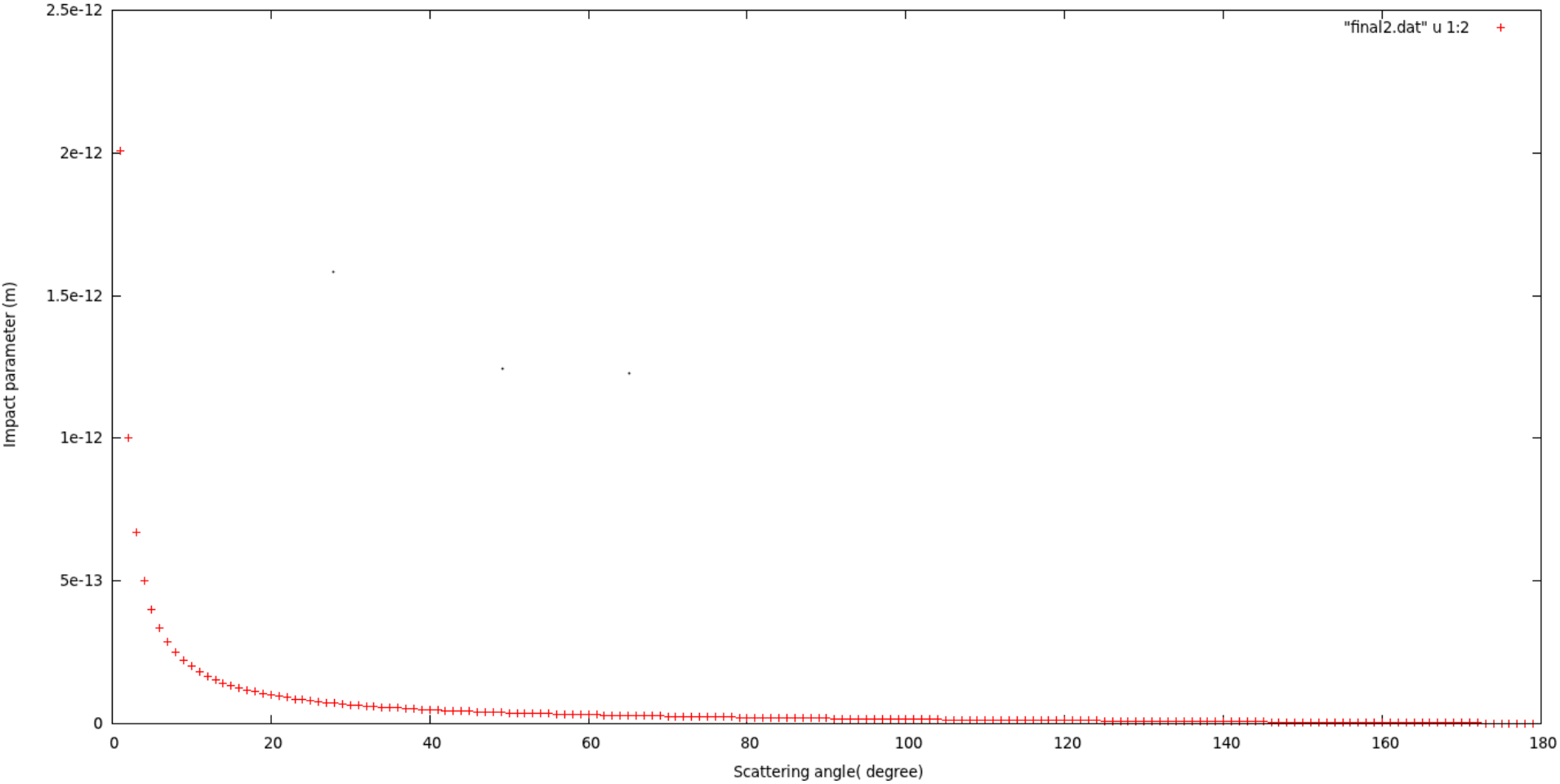
Kernel Description

```
main(){
    double Radius_gold, radius, Alpha_x, Alpha_y, Target,k,c,q,Q,m,b,v,x,y,z;
    double R,theta,phi,angle;

    k=8.988*pow(10.0,9);
    q=2.0*1.602*pow(10.0,-19);
    Q=79.0*1.602*pow(10.0,-19);
    m=6.645*pow(10.0,-27);
    Radius_gold=1.441*pow(10.0,-8);
    v=1.77*pow(10.0,7);
    c= k*Q*q/m/pow(v,2);
    R=1000.0;


for (int i=0; i<= 1000000; i++){
    x=(double (rand())/RAND_MAX-0.5)*20.0;
    y=(double (rand())/RAND_MAX-0.5)*20.0;
    theta= atan(y/x);
    b= pow( pow(x,2)+pow(y,2),0.5);

    if (b > 0.1){
        z=pow(pow(1000.0,2)-pow(b,2),0.5);
        fout<< x<<"   "<<y<<"   "<<z<<endl;
    }
    else if (b <= 0.1){
        phi=acos(b/0.1)*2.0;
        x=R*sin(M_PI-phi)*cos(theta);
        y=R*sin(M_PI-phi)*sin(theta);
        z=R*cos(M_PI-phi);
```

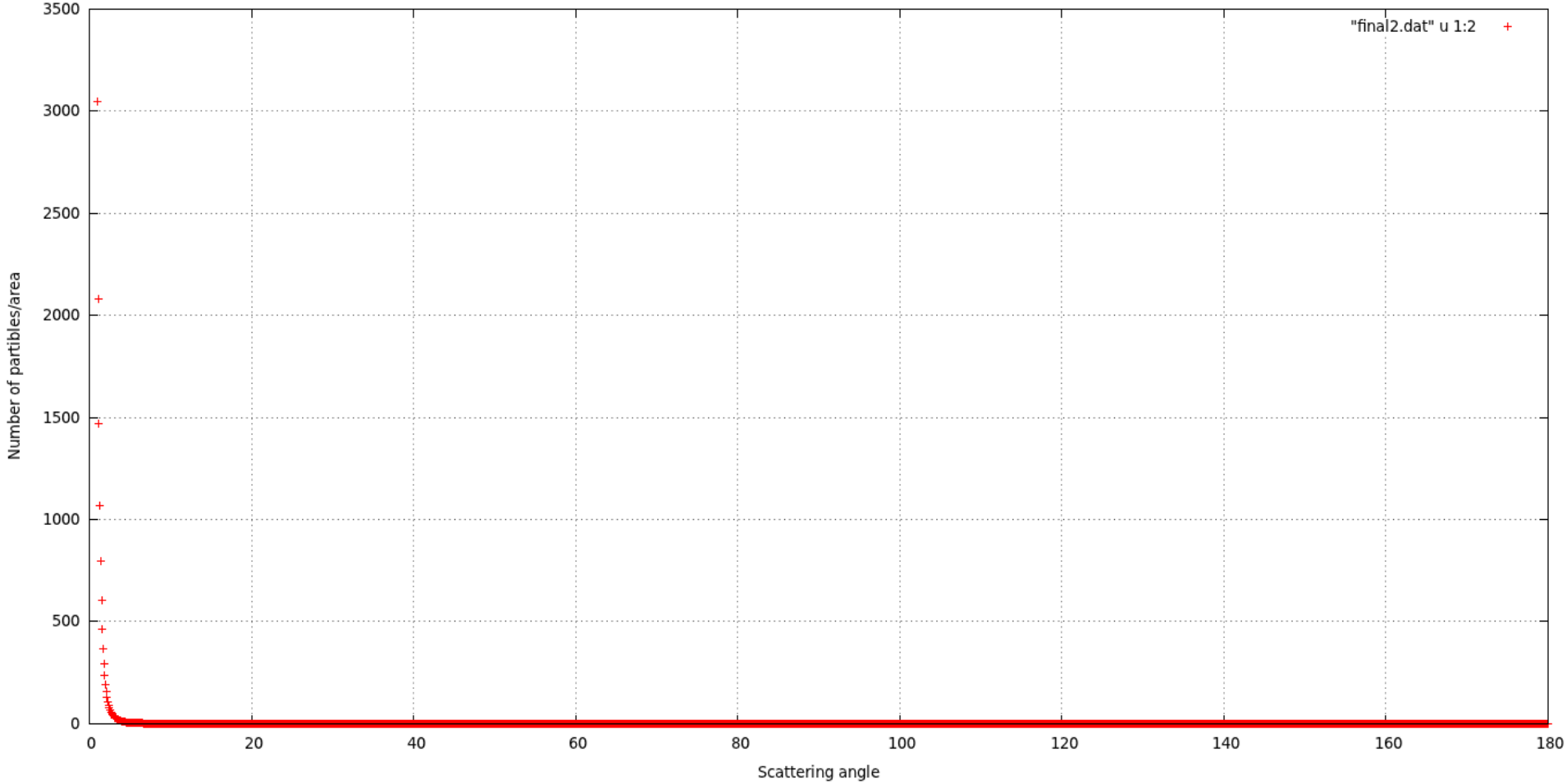
Trajectory of particle

```
while(x0 <=3.00*pow(10.0,-13)){

r0=pow(pow(x0,2)+pow(y0,2),0.5);
ax0=k*q1*q2*x0/(m*pow(r0,3));
ay0=k*q1*q2*y0/(m*pow(r0,3));

x=x0+vx0*dt+ax*pow(dt,2)/2.0;
y=y0+vy0*dt+ay*pow(dt,2)/2.0;

r=pow(pow(x,2)+pow(y,2),0.5);
ax=k*q1*q2*x/(m*pow(r,3));
ay=k*q1*q2*y/(m*pow(r,3));

vx=vx0+(ax+ax0)*dt/2.0;
vy=vy0+(ay+ay0)*dt/2.0;

outfile<<x<<"    "<<y<<endl;

x0=x;
vx0=vx;
y0=y;
vy0=vy;
```

Impact parameter as a function of an angle



The number of scattered particles per Area as a function of an angle



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Status

- Impact parameter as a function of an angle
- The number of scattered particles as a function of an angle
- Trajectory of particle (..ing)