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## 4.1

clear

a=0;b=50;h=0.1;n=(b-a)/h;

x(1)=0;y(1)=1;t(1)=0;

vx(1)=sqrt(4\*pi^2/y(1));vy(1)=0;

for k=1:1:n

r=abs(x(k)+i\*y(k));

vx(k+1)=vx(k)-4\*pi^2\*x(k)\*h/r^3;

vy(k+1)=vy(k)-4\*pi^2\*y(k)\*h/r^3;

x(k+1)=x(k)+vx(k+1)\*h;

y(k+1)=y(k)+vy(k+1)\*h;

t(k+1)=t(k)+h;

end

plot(x,y,'b')

axis equal

xlabel('x(AU)')

ylabel('y(AU)')

title('Earth orbiting the sun')



clear

a=0;b=20;h=0.01;n=(b-a)/h;

x(1)=0;y(1)=1;t(1)=0;

vx(1)=4;vy(1)=0;

for k=1:1:n

r=abs(x(k)+i\*y(k));

vx(k+1)=vx(k)-4\*pi^2\*x(k)\*h/r^3;

vy(k+1)=vy(k)-4\*pi^2\*y(k)\*h/r^3;

x(k+1)=x(k)+vx(k+1)\*h;

y(k+1)=y(k)+vy(k+1)\*h;

t(k+1)=t(k)+h;

end

plot(x,y,'b')

axis equal

xlabel('x(AU)')

ylabel('y(AU)')

title('Earth orbiting the sun')

legend('v\\_0=4','Location','Best')



## 4.2

clear

a=0;b=10;h=0.001;n=(b-a)/h;

x(1)=0;y(1)=1;t(1)=0;

vx(1)=sqrt(4\*pi^2/y(1));vy(1)=0;

for k=1:1:n

r=abs(x(k)+i\*y(k));

vx(k+1)=vx(k)-4\*pi^2\*x(k)\*h/r^3;

vy(k+1)=vy(k)-4\*pi^2\*y(k)\*h/r^3;

x(k+1)=x(k)+vx(k)\*h;

y(k+1)=y(k)+vy(k)\*h;

t(k+1)=t(k)+h;

end

plot(x,y,'b')

axis equal

xlabel('x(AU)')

ylabel('y(AU)')

title('Earth orbiting the sun')



## 4.3

%欧拉克拉默算法

clear

a=0;b=10;h=0.001;n=(b-a)/h;

x(1)=1;y(1)=0;t(1)=0;

e=0.017;

vx(1)=0;vy(1)=2\*pi\*sqrt((1+e)/x(1)\*(1+1/333000));

for k=1:1:n

r=abs(x(k)+i\*y(k));

vx(k+1)=vx(k)-4\*pi^2\*x(k)\*h/r^3;

vy(k+1)=vy(k)-4\*pi^2\*y(k)\*h/r^3;

x(k+1)=x(k)+vx(k+1)\*h;

y(k+1)=y(k)+vy(k+1)\*h;

t(k+1)=t(k)+h;

end

plot(x,y,'b')

axis equal

xlabel('x(AU)')

ylabel('y(AU)')

title('Earth orbiting the sun')



## 4.4

clear all

x(1)=0.59;

y(1)=0;

vx(1)=0;

vy(1)=3.6518135\*pi;

dt=0.001;

for i=1:76/dt

r(i)=sqrt(x(i)^2+y(i)^2);

vx(i+1)=vx(i)-4\*pi\*pi\*x(i)/(r(i)^3)\*dt;

vy(i+1)=vy(i)-4\*pi\*pi\*y(i)/(r(i)^3)\*dt;

x(i+1)=x(i)+vx(i+1)\*dt;

y(i+1)=y(i)+vy(i+1)\*dt;

end

plot(x,y)

grid on;

axis equal

xlabel('x(AU)')

ylabel('y(AU)')

title('Halley comet orbiting the Sun')



## 4.5

a=0;b=1;h=0.0001;n=(b-a)/h;

x(1)=0;y(1)=1;t(1)=0;

vx(1)=sqrt(4\*pi^2/y(1));vy(1)=0;

for k=1:1:n

r=abs(x(k)+i\*y(k));

vx(k+1)=vx(k)-4\*pi^2\*x(k)\*h/r^3;

vy(k+1)=vy(k)-4\*pi^2\*y(k)\*h/r^3;

x(k+1)=x(k)+vx(k+1)\*h;

y(k+1)=y(k)+vy(k+1)\*h;

t(k+1)=t(k)+h;

Ek\_m(k)=0.5\*(vx(k)^2+vy(k)^2);

Ep\_m(k)=-4\*pi^2/r;

L\_m(k)=r\*sqrt(vx(k)^2+vy(k)^2);

end

hold on

plot(t(1:length(t)-1),Ek\_m,'b')

plot(t(1:length(t)-1),Ep\_m,'k')

plot(t(1:length(t)-1),L\_m,'r')

hold off

xlabel('t')

ylabel('各物理量')

legend('动能','势能','角动量','Location','Best')

box on



clear

a=0;b=3;h=0.0001;n=(b-a)/h;

x(1)=0;y(1)=1;t(1)=0;

vx(1)=5;vy(1)=0;

for k=1:1:n

r=abs(x(k)+i\*y(k));

vx(k+1)=vx(k)-4\*pi^2\*x(k)\*h/r^3;

vy(k+1)=vy(k)-4\*pi^2\*y(k)\*h/r^3;

x(k+1)=x(k)+vx(k+1)\*h;

y(k+1)=y(k)+vy(k+1)\*h;

t(k+1)=t(k)+h;

Ek\_m(k)=0.5\*(vx(k)^2+vy(k)^2);

Ep\_m(k)=-4\*pi^2/r;

E(k)=Ek\_m(k)+Ep\_m(k);

L\_m(k)=r\*sqrt(vx(k)^2+vy(k)^2);

end

hold on

plot(t(1:length(t)-1),Ek\_m,'b')

plot(t(1:length(t)-1),Ep\_m,'k')

plot(t(1:length(t)-1),E,'m')

plot(t(1:length(t)-1),L\_m,'r')

hold off

xlabel('t')

ylabel('各物理量')

legend('动能','势能','能量','角动量',1)

box on



## 4.6

clear all

x(1)=1;

y(1)=0;

vx(1)=0;

vy(1)=2.824\*pi;

dt=0.001;

for i=1:320/dt

r(i)=sqrt(x(i)^2+y(i)^2);

vx(i+1)=vx(i)-4\*pi\*pi\*x(i)/(r(i)^3)\*dt;

vy(i+1)=vy(i)-4\*pi\*pi\*y(i)/(r(i)^3)\*dt;

x(i+1)=x(i)+vx(i+1)\*dt;

y(i+1)=y(i)+vy(i+1)\*dt;

end

plot(x,y)

axis equal

xlabel('x(AU)')

ylabel('y(AU)')

title('Escape the Sun')



## 4.7

clear all

x1(1)=1;

y1(1)=0;

x2(1)=0;

y2(1)=0;

G=6.67\*10^(-11);

M1=6\*10^24;

M2=2\*6\*10^24;

vx1(1)=0;

vy1(1)=2\*36.2;

vx2(1)=0;

vy2(1)=-36.2;

dt=0.001;

for i=1:2/dt

r(i)=sqrt((x1(i)-x2(i))^2+(y1(i)-y2(i))^2);

vx1(i+1)=vx1(i)-G\*M2/(1.5\*10^(11))\*(x1(i)-x2(i))/(r(i)^3)\*dt;

vy1(i+1)=vy1(i)-G\*M2/(1.5\*10^(11))\*(y1(i)-y2(i))/(r(i)^3)\*dt;

x1(i+1)=x1(i)+vx1(i+1)\*dt;

y1(i+1)=y1(i)+vy1(i+1)\*dt;

vx2(i+1)=vx2(i)-G\*M1/(1.5\*10^11)\*(x2(i)-x1(i))/(r(i)^3)\*dt;

vy2(i+1)=vy2(i)-G\*M1/(1.5\*10^11)\*(y2(i)-y1(i))/(r(i)^3)\*dt;

x2(i+1)=x2(i)+vx2(i+1)\*dt;

y2(i+1)=y2(i)+vy2(i+1)\*dt;

end

hold on

box on

plot(x1,y1,'-b')

plot(x2,y2,'-r')

xlabel('x(AU)')

ylabel('y(AU)')

% axis([0,2,80,120])

title('Two Body System')



## 4.8

clear

Ms=1.989\*10^30;

M=6\*10^24;

e=0.017;

a=1;

x(1)=a\*(1+e);

y(1)=0;

vx(1)=0;

vy(1)=2\*pi\*sqrt((1-e)/x(1)\*(1+M/Ms));

dt=0.001;

T=5;

for i=1:5/dt

r(i)=sqrt(x(i)^2+y(i)^2);

vx(i+1)=vx(i)-4\*pi\*pi\*x(i)/(r(i)^3)\*dt;

vy(i+1)=vy(i)-4\*pi\*pi\*y(i)/(r(i)^3)\*dt;

x(i+1)=x(i)+vx(i+1)\*dt;

y(i+1)=y(i)+vy(i+1)\*dt;

if sqrt((x(i)-x(1))^2+(y(i)-y(1))^2)<0.005&&i>100&&i\*dt<T

T=i\*dt;

end

end

subplot(2,2,1)

hold on

box on

plot(x,y)

axis equal

xlabel('x(AU)')

ylabel('y(AU)')

title('Earth orbiting the Sun')

Earth=T^2/a^3

clear

Ms=1.989\*10^30;

M=4.9\*10^24;

e=0.007;

a=0.72;

x(1)=a\*(1+e);

y(1)=0;

vx(1)=0;

vy(1)=2\*pi\*sqrt((1-e)/x(1)\*(1+M/Ms));

dt=0.001;

T=5;

for i=1:5/dt

r(i)=sqrt(x(i)^2+y(i)^2);

vx(i+1)=vx(i)-4\*pi\*pi\*x(i)/(r(i)^3)\*dt;

vy(i+1)=vy(i)-4\*pi\*pi\*y(i)/(r(i)^3)\*dt;

x(i+1)=x(i)+vx(i+1)\*dt;

y(i+1)=y(i)+vy(i+1)\*dt;

if sqrt((x(i)-x(1))^2+(y(i)-y(1))^2)<0.001&&i>100&&i\*dt<T

T=i\*dt;

end

end

subplot(2,2,2)

hold on

box on

plot(x,y)

axis equal

xlabel('x(AU)')

ylabel('y(AU)')

title('Venus orbiting the Sun')

Venus=T^2/a^3

clear

Ms=1.989\*10^30;

M=1.9\*10^27;

e=0.048;

a=5.2;

x(1)=a\*(1+e);

y(1)=0;

vx(1)=0;

vy(1)=2\*pi\*sqrt((1-e)/x(1)\*(1+M/Ms));

dt=0.0001;

T=50;

for i=1:50/dt

r(i)=sqrt(x(i)^2+y(i)^2);

vx(i+1)=vx(i)-4\*pi\*pi\*x(i)/(r(i)^3)\*dt;

vy(i+1)=vy(i)-4\*pi\*pi\*y(i)/(r(i)^3)\*dt;

x(i+1)=x(i)+vx(i+1)\*dt;

y(i+1)=y(i)+vy(i+1)\*dt;

if sqrt((x(i)-x(1))^2+(y(i)-y(1))^2)<0.001&&i>100&&i\*dt<T

T=i\*dt;

end

end

subplot(2,2,3)

hold on

box on

plot(x,y)

axis equal

xlabel('x(AU)')

ylabel('y(AU)')

title('Jupiter orbiting the Sun')

Jupiter=T^2/a^3

clear

Ms=1.989\*10^30;

M=5.7\*10^26;

e=0.056;

a=9.54;

x(1)=a\*(1+e);

y(1)=0;

vx(1)=0;

vy(1)=2\*pi\*sqrt((1-e)/x(1)\*(1+M/Ms));

dt=0.0001;

T=100;

for i=1:100/dt

r(i)=sqrt(x(i)^2+y(i)^2);

vx(i+1)=vx(i)-4\*pi\*pi\*x(i)/(r(i)^3)\*dt;

vy(i+1)=vy(i)-4\*pi\*pi\*y(i)/(r(i)^3)\*dt;

x(i+1)=x(i)+vx(i+1)\*dt;

y(i+1)=y(i)+vy(i+1)\*dt;

if sqrt((x(i)-x(1))^2+(y(i)-y(1))^2)<0.0001&&i>100&&i\*dt<T

T=i\*dt;

end

end

subplot(2,2,4)

hold on

box on

plot(x,y)

axis equal

xlabel('x(AU)')

ylabel('y(AU)')

title('Saturn orbiting the Sun')

Saturn=T^2/a^3

Earth =

1.0020

Venus =

1.0035

Jupiter =

1.0026

Saturn =

1.0008



## 4.9

a=0;b=40;h=0.001;n=(b-a)/h;

x(1:6,1)=1;y(1:6,1)=0;t(1)=0;

e=[0.017 0.05 0.1 0.3 0.6 0.7];

vx(1:6,1)=0;vy(1:6,1)=2\*pi\*sqrt((1+e)/x(1)\*(1+1/333000));

for kk=1:1:6

for k=1:1:n

r=abs(x(kk,k)+i\*y(kk,k));

vx(kk,k+1)=vx(kk,k)-4\*pi^2\*x(kk,k)\*h/r^3.05;

vy(kk,k+1)=vy(kk,k)-4\*pi^2\*y(kk,k)\*h/r^3.05;

x(kk,k+1)=x(kk,k)+vx(kk,k+1)\*h;

y(kk,k+1)=y(kk,k)+vy(kk,k+1)\*h;end

end

subplot(2,3,1),plot(x(1,:),y(1,:))

axis equal

subplot(2,3,2),plot(x(2,:),y(2,:))

axis equal

subplot(2,3,3),plot(x(3,:),y(3,:))

axis equal

subplot(2,3,4),plot(x(4,:),y(4,:))

axis equal

subplot(2,3,5),plot(x(5,:),y(5,:))

axis equal

subplot(2,3,6),plot(x(6,:),y(6,:))

axis equal



## 4.10

p=0;q=10;h=0.001;n=(q-p)/h;

a=0.39;e=0.206;alpha=0.01;

x(1)=a\*(1+e);y(1)=0;t(1)=0;

vx(1)=0;vy(1)=2\*pi\*sqrt((1-e)/a/(1+e));

for k=1:1:n

r(k)=abs(x(k)+i\*y(k));

vx(k+1)=vx(k)-4\*pi^2\*x(k)\*h\*(1+alpha/r(k)^2)/r(k)^3;

vy(k+1)=vy(k)-4\*pi^2\*y(k)\*h\*(1+alpha/r(k)^2)/r(k)^3;

x(k+1)=x(k)+vx(k+1)\*h;

y(k+1)=y(k)+vy(k+1)\*h;

t(k+1)=t(k)+h;

end

plot(x,y,'b')

axis equal

xlabel('x(AU)')

ylabel('y(AU)')

title('Mercury orbiting the sun')

grid on



## 4.11

## 4.12

## 4.13

## 4.14

## 4.15

## 4.16

## 4.17

## 4.18

## 4.19

## 4.20