Assignment 2

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Contents

As initial condition enter 1.,0. (for $X1$, $X2$) $tmax = dpi$ (ie 2.*pi) (the matrix A should be the identity)

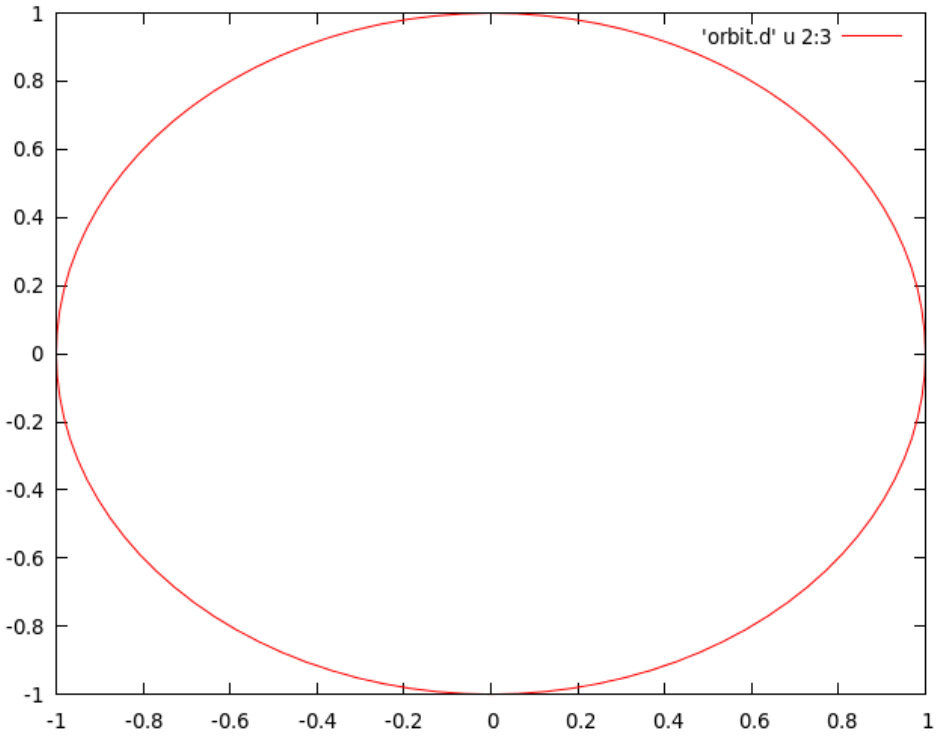
1 Main-os-flow-var CODE

```
c*****************************************************************
c
c  MAIN_OS_FLOW.f
c
c       We integrate the harmonic oscillator field with Taylor
c       from t=ti up to t=tmax
c       idir= +1 (integration forward in time); =-1 (backward)
c       np= number of intermediate points (apart from the initial one)
c           that we want to write on the file orbit.d. If np=1
c           only the initial and final points are written
c
c  input: xi,ti,tmax,idir,np
c*****************************************************************
        implicit real*8 (a-h,o-z)
        parameter (n=6)
        dimension xi(n),x(n)
        open(10,file='orbit.d',status='unknown')
        write(*,*) 'Initial conditions x(1),x(2),x(3),x(4),x(5),x(6)'
        read(*,*) (xi(i),i=1,n)
c here we have to compute de variable h
        write(*,*) 'ti,tmax,np (number of points)'
        read(*,*)ti,tmax,np
c particular example integration up to t=pi
c        pi=4.d0*datan(1.d0)
c        tmax=pi/2.d0
        if (tmax.ge.ti)then
c         'idir (=1 forward in time, =-1 backward)'
            idir=1
        else
            idir=-1
```

```
        endif
        do i=1,n
         x(i)=xi(i)
        enddo
        ham=(x(1)*x(1)+x(2)*x(2))/2.d0

         write(*,*)ti,'   initial t, initial cond:'
         write(*,*)(x(i),i=1,n)
c REMARK: xinctime positive
       xinctime=dabs(tmax-ti)/np
         write (10,*)ti,(x(ii),ii=1,n)
       do 20 i=1,np
         call flow(ti,n,x,idir,xinctime)
         ham_new=(x(1)*x(1)+x(2)*x(2))/2.d0
         dif=dabs(ham-ham_new)
         if (dif.gt.1.D-11)then
   write(*,*)'problem in first integral'
   stop

 endif
         write (10,*)ti,(x(ii),ii=1,n)
 20    continue
       detm=dabs(x(3)*x(6)-x(4)*x(5))
       difdetm=detm-1.d0
       if (dabs(difdetm).lt.1.D-11)then
           write(*,*)'determinant is Zero'
   stop

       endif
       write(*,*)ti,'  final t,  final point:'
       write(*,*)(x(i),i=1,n)
        end


       subroutine flow(t,n,x,idir,xinctemps)
       IMPLICIT REAL*8 (A-H,O-Z)
       dimension x(n)
```

```
       tmax=t+idir*xinctemps
c
c parameters for the integration
c
        hab=0.1e-16
        hre=0.1e-16
        pabs=dlog10(hab)
        prel=dlog10(hre)
c Option of control of step
        istep=1
        ht=0.d0
c
 1        CALL taylor_f77_eq_os_var_(t,x,idir,istep,pabs,prel,
     &  tmax,ht,iordre,ifl)
c        write(10,100) t,(x(i),i=1,n)
        if (idir.eq.1.and.t.lt.tmax)go to 1
        if (idir.eq.-1.and.t.gt.tmax)go to 1
c check t=tmax
        if (dabs(t-tmax).le.1.d-13)return
        write(*,*)'problems in taylor'
        stop
c 100     format(f15.8,2f22.15)
        return
        end
```

2 Periodic orbit plot



3 Main-os-flow2-var CODE, using 'CALL DET'

```
c*****************************************************************
c
c  MAIN_OS_FLOW.f
c
c       We integrate the harmonic oscillator field with Taylor
c       from t=ti up to t=tmax
c       idir= +1 (integration forward in time); =-1 (backward)
c       np= number of intermediate points (apart from the initial one)
c           that we want to write on the file orbit.d. If np=1
c           only the initial and final points are written
c
c  input: xi,ti,tmax,idir,np
```

```
c*****************************************************************
        implicit real*8 (a-h,o-z)
        parameter (n=6)
        dimension xi(n),x(n),a(2,2)
        open(10,file='orbit.d',status='unknown')
        write(*,*) 'Initial condition x(1),x(2),x(3),x(4),x(5),x(6)'
        read(*,*) (xi(i),i=1,n)
        write(*,*) 'ti,tmax,np (number of points)'
        read(*,*)ti,tmax,np
c particular example integration up to t=pi
c        pi=4.d0*datan(1.d0)
c        tmax=pi/2.d0
        if (tmax.ge.ti)then
c         'idir (=1 forward in time, =-1 backward)'
           idir=1
        else
           idir=-1
        endif
        do i=1,n
         x(i)=xi(i)
        enddo
         write(*,*)ti,'   initial t, initial cond:'
         write(*,*)(x(i),i=1,n)
c REMARK: xinctime positive
       xinctime=dabs(tmax-ti)/np
         write (10,*)ti,(x(ii),ii=1,n)
       do 20 i=1,np
         call flow(ti,n,x,idir,xinctime)
         write (10,*)ti,(x(ii),ii=1,n)
 20    continue

        a(1,1)=x(3)
        a(1,2)=x(4)
        a(2,1)=x(5)
        a(2,2)=x(6)
        CALL DET(a,DETA,2)

         difdetm=DETA-1.d0
```

```
       if (dabs(difdetm).lt.1.D-11)then
           write(*,*)'determinant is Zero'
   stop
end if


       write(*,*)ti,'  final t,  final point:'
       write(*,*)(x(i),i=1,n)
        end
       write(*,*)ti,'  final t,  final point:'
       write(*,*)(x(i),i=1,n)
        end


       subroutine flow(t,n,x,idir,xinctemps)
       IMPLICIT REAL*8 (A-H,O-Z)
       dimension x(n)
       tmax=t+idir*xinctemps
c
c parameters for the integration
c
        hab=0.1e-16
        hre=0.1e-16
        pabs=dlog10(hab)
        prel=dlog10(hre)
c Option of control of step
        istep=1
        ht=0.d0
c
 1        CALL taylor_f77_eq_os_(t,x,idir,istep,pabs,prel,
     &  tmax,ht,iordre,ifl)
c        write(10,100) t,(x(i),i=1,n)
        if (idir.eq.1.and.t.lt.tmax)go to 1
        if (idir.eq.-1.and.t.gt.tmax)go to 1
c check t=tmax
        if (dabs(t-tmax).le.1.d-13)return
        write(*,*)'problems in taylor'
        stop
```

```
c 100     format(f15.8,2f22.15)
        return
        end
```

4 Assignment part 2 Main-lorenz-flow CODE

eq_lorenz.eq

```
syma=10.;
rho=28.;
beta=8./3.;
diff(x,t)=syma*(y-x);
diff(y,t)=rho*x-y-x*z;
diff(z,t)=x*y-beta*z;
```

```
c*****************************************************************
c
c  MAIN_LORENZ_FLOW.f
c
c       We integrate the harmonic oscillator field with Taylor
c       from t=ti up to t=tmax
c       idir= +1 (integration forward in time); =-1 (backward)
c       np= number of intermediate points (apart from the initial one)
c           that we want to write on the file orbit.d. If np=1
c           only the initial and final points are written
c
c  input: xi,ti,tmax,idir,np
c*****************************************************************
        implicit real*8 (a-h,o-z)
        parameter (n=3)
        dimension xi(n),x(n)
        open(10,file='orbit.d',status='unknown')
        write(*,*) 'Initial condition x(1),x(2)'
        read(*,*) (xi(i),i=1,n)
        write(*,*) 'ti,tmax,np (number of points)'
        read(*,*)ti,tmax,np
```

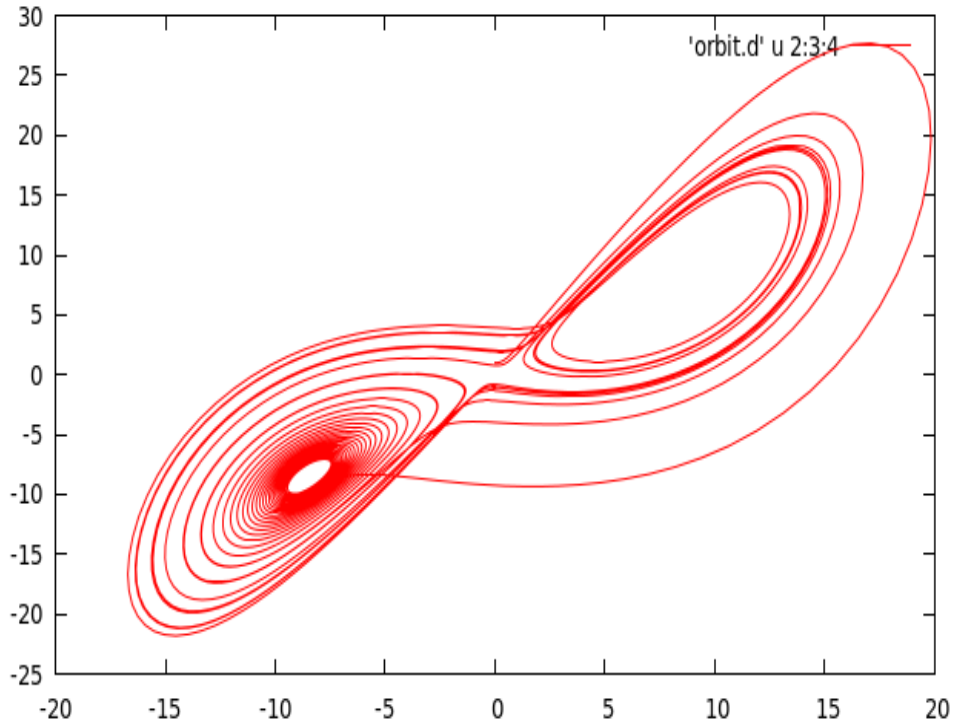
```
c particular example integration up to t=pi
c        pi=4.d0*datan(1.d0)
c        tmax=pi/2.d0
        if (tmax.ge.ti)then
c         'idir (=1 forward in time, =-1 backward)'
            idir=1
        else
            idir=-1
        endif
        do i=1,n
         x(i)=xi(i)
        enddo
         write(*,*)ti,'   initial t, initial cond:'
         write(*,*)(x(i),i=1,n)
c REMARK: xinctime positive
       xinctime=dabs(tmax-ti)/np
         write (10,*)ti,(x(ii),ii=1,n)
       do 20 i=1,np
         call flow(ti,n,x,idir,xinctime)
         write (10,*)ti,(x(ii),ii=1,n)

 20    continue
       write(*,*)ti,'  final t,  final point:'
       write(*,*)(x(i),i=1,n)
        end


       subroutine flow(t,n,x,idir,xinctemps)
       IMPLICIT REAL*8 (A-H,O-Z)
       dimension x(n)
       tmax=t+idir*xinctemps
c
c parameters for the integration
c
        hab=0.1e-16
        hre=0.1e-16
        pabs=dlog10(hab)
        prel=dlog10(hre)
```

```
c Option of control of step
        istep=1
        ht=0.d0
c
 1        CALL taylor_f77_eq_lorenz_(t,x,idir,istep,pabs,prel,
     &  tmax,ht,iordre,ifl)
c         write(10,100) t,(x(i),i=1,n)
        if (idir.eq.1.and.t.lt.tmax)go to 1
        if (idir.eq.-1.and.t.gt.tmax)go to 1
c check t=tmax
        if (dabs(t-tmax).le.1.d-13)return
        write(*,*)'problems in taylor'
        stop
c 100     format(f15.8,2f22.15)
        return
        end
```

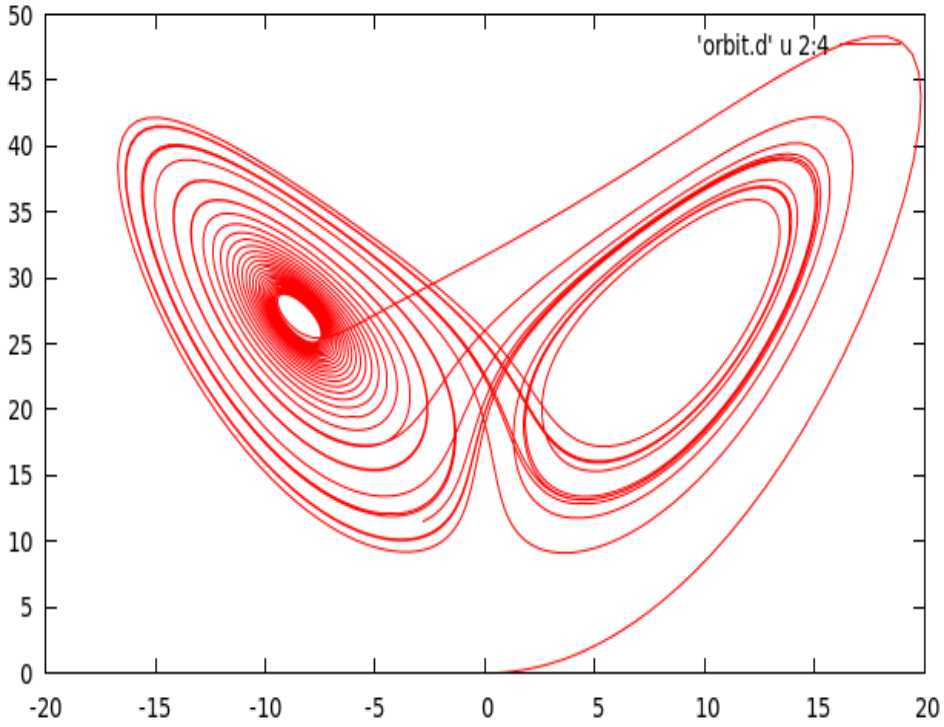
5 Lorenz Tests

Entering the intial conditons 0,10, for ti=0, tmax=30 and np=400

5.1 Plot 1: (x,y,z)



5.2 Plot 2: (x,z)



5.3 Plot 3: (t,y)