

USE FOR CLASS

```
common param,a,b,phi,i  
window,1,xsize=400,y size=300,xpos=10,ypos=10  
window,2,xsize=650,y size=300,xpos=440,ypos=10  
.r Macintosh HD:Users:Shared:UCSD Teaching:Physics 171/271:subs
```

;ILLUSTRATION OF CHOICE OF PHI AFTER DERIVATION OF STABILITY EQUATIONS

```
i=0. ; unstable set  
a=0.4  
b=0.7  
phi=0.3
```

```
i=0. ; stable set  
a=0.4  
b=0.7  
phi=0.4
```

```
ic=fx_root([-2.,2.,0.],'root') & print,ic  
z=fltarr(2) & y=fltarr(2)  
z(0)=ic(0) & z(1)=(1./b)*z(0)+a/b  
xyouts,z(0),z(1),'+',alignment=0.5,color=0  
print,(1.-z(0)^2)/b  
y(0)=z(0)+0.2  
y(1)=z(1)  
x=0. & dydx=fn(x,y)  
h=0.005  
n=25000L  
v=6.0*findgen(1000)/999.-3.0 & w=6.0*findgen(1000)/999.-3.0  
wset,2 & plot,h*findgen(1.1*n),replicate(z(0),1.1*n),xtitle="time",charsize=2,background='ffffff'xl,color=0,yrange=[-3.,3.],ystyle=1./nodata,/device  
oplot,h*findgen(1.1*n),replicate(z(0),0.1*n),color='ff0000'xl,thick=2 & oplot,h*findgen(1.1*n),replicate(z(1),0.1*n),color='00ff00'xl,thick=2  
wset,1 & plot,v,v-v^3/3.+i,background='ffffff'xl,color=0,xrange=[-3,3],yrange=[-3,3],xtitle="fast",ytitle="slow",charsize=2,xstyle=1,ystyle=1./nodata,/device  
oplot,v,v-v^3/3.+i,color='0000ff'xl,thick=2  
oplot,[-3,3],[0,0],color='0000ff'xl & oplot,[0,0],[-3,3],color='0000ff'xl  
oplot,v,v/b+a/b,color='0000ff'xl,thick=2  
v=fltarr(n) & w=fltarr(n) & wset=1  
for k=0L,n-1L do begin & y=rk4(y,dydx,x,h,'fn') & v(k)=y(0) & w(k)=y(1) & xyouts,y(0),y(1),',',alignment=0.5,color='00ff00'xl & endfor  
wset,2  
plot,h*findgen(1.1*n),[replicate(z(0),0.1*n),v],xtitle="time",charsize=2,background='ffffff'xl,color=0,yrange=[-3.,3.],ystyle=1./nodata  
oplot,h*findgen(1.1*n),[replicate(z(0),0.1*n),v],color='ff0000'xl,thick=2 & oplot,h*findgen(1.1*n),[replicate(z(1),0.1*n),w],color='00ff00'xl,thick=2
```

;ILLUSTRATION OF DISRUPTION OF STABILITY BY INCREASING I

i=0. ; stable set
a=0.7
b=0.6
phi=0.1

i=0.5; - Change I, 0.3 gives one spike

```
ic=fx_root([-2.,2.,0.],'root') & print,ic
z=fltarr(2) & y=fltarr(2)
z(0)=ic(0) & z(1)=(1./b)*z(0)+a/b
xyouts,z(0),z(1),'+',alignment=0.5,color=0
print,(1.-z(0)^2)/b
y(0)=z(0)+0.2
y(1)=z(1)
x=0. & dydx=fn(x,y)
h=0.005
n=10000L
v=6.0*findgen(1000)/999.-3.0 & w=6.0*findgen(1000)/999.-3.0
wset,2 & plot,h*findgen(1.1*n),replicate(z(0),1.1*n),xtitle="time",charsize=2,background='ffffff'xl,color=0,yrange=[-3.,3.],ystyle=1,/nodata,/device
oplot,h*findgen(1.1*n),replicate(z(0),0.1*n),color='ff0000'xl,thick=2 & oplot,h*findgen(1.1*n),replicate(z(1),0.1*n),color='00ff00'xl,thick=2
wset,1 & plot,v,v-v^3/3.+i,background='ffffff'xl,color=0,xrange=[-3,3],yrange=[-3,3],xtitle="fast",ytitle="slow",charsize=2,xstyle=1,ystyle=1,/nodata,/device
oplot,v,v-v^3/3.+i,color='0000ff'xl,thick=2
oplot,[-3,3],[0,0],color='0000ff'xl & oplot,[0,0],[-3,3],color='0000ff'xl
oplot,v,v/b+a/b,color='0000ff'xl,thick=2
v=fltarr(n) & w=fltarr(n) & wset=1
for k=0L,n-1L do begin & y=rk4(y,dydx,x,h,'fn') & v(k)=y(0) & w(k)=y(1) & xyouts,y(0),y(1),'',alignment=0.5,color='00ff00'xl & endfor
wset,2
plot,h*findgen(1.1*n),[replicate(z(0),0.1*n),v],xtitle="time",charsize=2,background='ffffff'xl,color=0,yrange=[-3.,3.],ystyle=1,/nodata
oplot,h*findgen(1.1*n),[replicate(z(0),0.1*n),v],color='ff0000'xl,thick=2 & oplot,h*findgen(1.1*n),[replicate(z(1),0.1*n),w],color='00ff00'xl,thick=2
```

;ANODE BREAK

i=-0.3 ; set for 0 for stable state

a=0.7

b=0.6

phi=0.15 ; if you increase this number you loose anode break

ic=fx_root([-2.,2.,0.],'root') & print,ic

z=fltarr(2) & y=fltarr(2)

z(0)=ic(0) & z(1)=(1./b)*z(0)+a/b

y(0)=z(0)

y(1)=z(1)

i=0 ; anode break

x=0. & dydx=fn(x,y)

h=0.005

n=10000L

v=6.0*findgen(1000)/999.-3.0 & w=6.0*findgen(1000)/999.-3.0

wset,2 & plot,h*findgen(1.1*n),replicate(z(0),1.1*n),xtitle="time",charsize=2,background='ffffff'xl,color=0,yrange=[-3.,3.],ystyle=1,/nodata,/device

oplot,h*findgen(1.1*n),replicate(z(0),0.1*n),color='ff0000'xl,thick=2 & oplot,h*findgen(1.1*n),replicate(z(1),0.1*n),color='00ff00'xl,thick=2

wset,1 & plot,v,v-v^3/3.+i,background='ffffff'xl,color=0,xrange=[-3,3],yrange=[-3,3],xtitle="fast",ytitle="slow",charsize=2,xstyle=1,ystyle=1,/nodata,/device

oplot,v,v-v^3/3.+i,color='0000ff'xl,thick=2

oplot,[-3,3],[0,0],color='0000ff'xl & oplot,[0,0],[-3,3],color='0000ff'xl

oplot,v,v/b+a/b,color='0000ff'xl,thick=2

xyouts,z(0),z(1),'+',alignment=0.5,color=0

v=fltarr(n) & w=fltarr(n) & wset=1

for k=0L,n-1L do begin & y=rk4(y,dydx,x,h,'fn') & v(k)=y(0) & w(k)=y(1) & xyouts,y(0),y(1),'',alignment=0.5,color='00ff00'xl & endfor

wset,2

plot,h*findgen(1.1*n),[replicate(z(0),0.1*n),v],xtitle="time",charsize=2,background='ffffff'xl,color=0,yrange=[-3.,3.],ystyle=1,/nodata

oplot,h*findgen(1.1*n),[replicate(z(0),0.1*n),v],color='ff0000'xl,thick=2 & oplot,h*findgen(1.1*n),[replicate(z(1),0.1*n),w],color='00ff00'xl,thick=2

```
function fn,x,y
common param,a,b,phi,i
return,[y(0)-y(0)^3/3.0-y(1)+i,phi*(y(0)+a-b*y(1))]
end
```

```
function root,v
common param,a,b,phi,i
return,(v-v^3/3.0+i)-(1./b)*(v+a)
end
```