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%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%% fitzhugh function %%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%
function dydt = fitzhugh(t,y,a,b,c,I)

% voltage variable
v = y(1);

% refractory variable
w = y(2);

% define the 2d system
dv = -v^3 + (1+a)*v^2 -a*v -w + I;
dw = b*v-c*w;
dydt = [dv;dw];

%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%% runfitzhugh script %%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%
% a = 0.1; periodic
% a = 0.2; subthreshold
% a = 0.3; single spike
a = 0.3;
b = 0.01;
c = 0.01;

% input current
I=0.1;

vinit = 0.2; winit =0;T=400; deltaT = 0.05;

%set error bounds for integration
options=odeset('RelTol',10^(-10),'AbsTol',[10^(-10)*ones(1,2)]);

% use ode45 to solve the odes
[t,result] = ode15s(@(t,var) ...
    fitzhugh(t,var,a,b,c,I),[0:deltaT:T-deltaT],[vinit winit],op

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v = result(:,1);
w = result(:,2);

% refractory var as a function of time
figure(1);
set(gca,'FontSize',18);
hold on; box on;
plot(t,w,'Color',[0 0 1]);
xlabel('t');ylabel('w')

% voltage as a function of time
figure(2);
set(gca,'FontSize',18);
hold on; box on;
plot(t,v,'Color',[0 0 1]);
xlabel('t');ylabel('v')

% phase space
figure(3);
set(gca,'FontSize',18);
plot(v,w);

% draw nulclines
hold on;
vval = [-2:0.01:2];

wl1 = -vval.^3 + (1+a)*vval.^2 -a*vval +I;
wl2 = b/c*vval;

plot(vval,wl1,'r');
plot(vval,wl2,'m');

axis([-0.4 1.2 -0.1 0.4])
xlabel('v');ylabel('w')

```