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%Explanation of base program

%The program splits a single junciton up into xmax discrete sections.  Each
%section has a supercurrent density, and a phase difference that is
%contributed to by the field (PhaseF), and an arbitrary phase set at x=1
%called Phase1.  For each value of field and Phase1 the supercurrent at
%each point is calculated and the net supercurrent (sum along the junction)
%is calcualted to find the supercurrent carried at that phase and that
%field.  To find the maximum supercurrent for a given field, the max of
%that vector is taken, and can be plotted against the magnetic field.  This
%is the exact measurment of the critical current vs field that we do in the
%lab.

%% Clearing memory and input screen.
clear;
clc;
close all;
%% Defining the Parameters of the Simulaiton

    %Dividing the junction up into discrete sections
    xmax=301;
    x(1,:)=(1:xmax);

    %Defining Super Current parameters
    SCurrentMag =1;
    SCurrentNoiseMag =.01;


%Setting up Loop steps and ranges

    %Phase Loop parameters
    p=1;
    pmax=301;
    Phase1Min=-0*pi;
    Phase1Max=2.0*pi;

    %Flux Loop Parameters
    f=1;
    fmax=501;
    FluxinJuncMin=-3;
    FluxinJuncMax=3;

%Calculating Parameters from Initial Conditions

    SCurrentDensity=(SCurrentMag*ones(1,xmax)+SCurrentNoiseMag*(2*rand(1,xmax)-1))/xmax;

%Pre Allocating memory to the arrays to decrease runtime
    Phase1=zeros(1,pmax);
    FluxinJunc=zeros(1,fmax);
    IndexMax=zeros(1,fmax);
    Phase1MaxSC=zeros(1,fmax);
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    SCurrent=zeros(xmax,pmax,fmax);
    SCurrentNet=zeros(1,pmax);
    MaxSCurrentNet=zeros(1,fmax);

%% Loops for running the simulation Meat of the Simulation


%Field Contribution to the Phase
%Define the loop step size, then run the for loop
FluxinJuncSS=(FluxinJuncMax-FluxinJuncMin)/(fmax-1);
for f=1:fmax

    FluxinJunc(f)=FluxinJuncMin+(f-1)*FluxinJuncSS;
    PhaseF=2*pi*FluxinJunc(f)*x./xmax;


%Phase1 Loop of externally set phase at edge of JJ
    %Define the loop step size, then run the for loop
    Phase1SS=(Phase1Max-Phase1Min)/(pmax-1);

    for p=1:pmax
        Phase1(p)=Phase1Min+(p-1)*Phase1SS;

        PhaseDrop=Phase1(p)+PhaseF;

        SCurrent=SCurrentDensity.*sin(PhaseDrop);
        SCurrentNet(p)=sum(SCurrent);
    end

    [MaxSCurrentNet(f),IndexMax(f)]=max(SCurrentNet);
    Phase1MaxSC(f)=Phase1(IndexMax(f));

end

figure
subplot(2,1,1); plot(FluxinJunc,MaxSCurrentNet,'.')
ylabel('Critical Current');

subplot(2,1,2); plot(FluxinJunc,Phase1MaxSC/pi,'.')
xlabel('Flux');ylabel('Phase1 of Ic/pi');
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