CDM inducing regeneration of truncated Airy pulses in fiber-optics link
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NUMERICAL CODES FOR THE SIMULATIONS OF THE MANUSCRIPT

1. ***First model of Fig. 1 :*** *Fixed chirp and alternation of GVD only (results of Fig. 4)*

```
clc;
clear all;
T0=50; %timewidth
s2=-1; %starting with an anomalous GVD
A=1; %normalized power
L=4.1; %dimensionless length of the fiber/distance of propagation
b=0; %nonlinearity set zero for linear systems (b=N^2)
C=-0.5; %initial chirp
N=2000; %Number of time step
dt=T0/(N); %time step
t=(-N/2:(N/2)-1)*dt; %timewidth grid
w=(2*pi/(T0))*(-N/2:N/2-1); %frequency grid
a=0.05; %truncation coefficient
u=A*exp(a*t).*airy(t).*exp(-0.5i.*C.*t.^2); %definition of the Airy pulse
u0=u; %input pulse
dz=dt ; %we choose equal step for the space and time
tabz=[]; %initializing the table of the propagation distance parameter
tabu=[]; % initializing the table of the pulse amplitude
JJ=1; %parameter of incrementation
z0=0; %initializing the propagation distance parameter
for n=1:21  %start of the ring for the pulse propagation in the fiber links

    for z=z0:dz:z0+L-dz %propagation within n-th piece of fiber
       um(1,JJ)=max(abs(u).^2); %recording the JJ-th max value of the pulse
                                 %intensity
       tabu=[tabu;abs(u).^2]; %recording the current value of pulse intensity
       u=exp(b*dz*i*abs(u).*abs(u)).*u; %nonlinear part of the SSFM[1]
       c=fftshift(fft(u)); %Fast Fourier Transform (FFT)
       c=exp(dz*s2*i*(w.^2)/2).*c; %dispersive part of the SSFM
       u=ifft(fftshift(c)); %inverse of the FFT = temporal profile
       tabz=[tabz;z]; %  recording the current propagation distance
       fprintf('%05.1f %% complete\n', z0*100/(L*N)); %displaying the running
                                                      %percentage of the simulation
       JJ=JJ+1; %incrementation
    end
       z0=z+dz; %incrementation of the propagation distance
    if n==5 %recording the amplitude at the fifth round
       uf=u;
    end
  s2=-s2; %alternation of the GVD
end
figure (1); %hold on of the first figure drawing the 3D-contour plot
 pcolor(t,tabz,tabu) ;shading interp;
 xlabel('\tau');
 ylabel('\xi');
figure(2); %hold on of the second figure drawing the 2D-plot of max(u) versus \xi
 plot(tabz,um);
 xlabel('\xi');
 ylabel('max\midU\mid^2');
```

2. ***Second model of Fig. 2 :*** *Fixed GVD and alternation of chirp only (results of Fig. 5)*

The same comments as in the case above except for the definition of the chirp

```
clc;
clear all;
T0=50;
s2=1;
A=1;
L=4.1;
```

[1] SSFM : Split-Step Fourier Method

```
b=0;
C=-0.5; %this value will change within the ring below for propagation
N=2000;
dt=T0/(N) ;
t=(-N/2:(N/2)-1)*dt;
w=(2*pi/(T0))*(-N/2:N/2-1);
a=0.05;
u=A*exp(a*t).*airy(t).*exp(-0.5i.*C.*t.^2);
u0=u;
dz=dt;
tabz=[];
tabu=[];
JJ=1;
z0=0;
for n=1:21
    for z=z0:dz:z0+L-dz
       um(1,JJ)=max(abs(u).^2);
       tabu=[tabu;abs(u).^2];
       u=exp(b*dz*i*abs(u).*abs(u)).*u;
       c=fftshift(fft(u));
       c=exp(dz*s2*i*(w.^2)/2).*c;
       u=ifft(fftshift(c));
       tabz=[tabz;z];
       fprintf('%05.1f %% complete\n', z0*100/(L*N));
       JJ=JJ+1;
    end
    z0=z+dz;
    if n==5
       uf=u;
    end
    C=-C; %alternation of the initial chirp value
    u=u.*exp(-0.5i.*C.*t.^2);
end
figure(1)
 pcolor(t,tabz,tabu);shading interp;
 xlabel('\tau');
 ylabel('\xi');
figure(2);
 plot(tabz,um);
 xlabel('\xi');
 ylabel('max\midU\mid^2');
```

3. *Third model of Fig. 3 : Alternation of both the GVD and the chirp (results of Fig. 6)*

The same comments as in the case above

```
clc;
clear all;
T0=50;
s2=-1;
A=1;
L=4.1;
b=0;
C=-0.5;
N=2000;
dt=T0/(N) ;
t=(-N/2:(N/2)-1)*dt;
w=(2*pi/(T0))*(-N/2:N/2-1);
a=0.05;
u=A*exp(a*t).*airy(t).*exp(-0.5i.*C.*t.^2);
u0=u;
dz=dt ;
tabz=[];
tabu=[];
JJ=1;
z0=0;
```

```
for n=1:21
    for z=z0:dz:z0+L-dz
       um(1,JJ)=max(abs(u).^2);
       tabu=[tabu;abs(u).^2];
       u=exp(b*dz*i*abs(u).*abs(u)).*u;
       c=fftshift(fft(u));
       c=exp(dz*s2*i*(w.^2)/2).*c;
       u=ifft(fftshift(c));
       tabz=[tabz;z];
       fprintf('%05.1f %% complete\n', z0*100/(L*N));
       JJ=JJ+1;
    end
    z0=z+dz;
    if n==5
       uf=u;
    end
    s2=-s2; %alternation of GVD
    C=-C; %alternation of the initial chirp
    u=u.*exp(-0.5i.*C.*t.^2);
end
figure(1)
 pcolor(t,tabz,tabu) ;shading interp;
 xlabel('\tau');
 ylabel('\xi');
figure(2);
 plot(tabz,um);
 xlabel('\xi')  ;
 ylabel('max\midU\mid^2');
```

4. *Effect of the initial chirp* (results of Fig. 7)

Using the first code, we just change the value of the chirp.

5. *Effect of the temporal gap τ_B on the regeneration of SFEAP in the linear system* (results of Figs. 8 and 9)

Using the first code, we introduce the parameter τ_B for SFEAPs

```
clc;
clear all;
T0=50;
tb=1 ; %temporal gap; other values 2.5 ;5 ;7.5
s2=-1;
A=1;
L=4.1;
b=0;
C=-0.5;
N=2000;
dt=T0/(N) ;
t=(-N/2:(N/2)-1)*dt;
w=(2*pi/(T0))*(-N/2:N/2-1);
a=0.05;
u=A.*(exp(a.*(tb+t)).*airy(tb+t)+exp(a.*(tb-t)).*airy(tb-t)).*exp(-0.5i*C.*t.^2);
%superposition of the two airy pulses separated by tb=1

u0=u;
dz=dt;
tabz=[];
tabu=[];
M=L/10;JJ=1;
z0=0;
for n=1:21

    for z=z0:dz:z0+L-dz
       um(1,JJ)=max(abs(u).^2);
       tabu=[tabu;abs(u).^2];
```

```
        u=exp(b*dz*i*abs(u).*abs(u)).*u;
        c=fftshift(fft(u));
        c=exp(dz*s2*i*(w.^2)/2).*c;
        u=ifft(fftshift(c));
        tabz=[tabz;z];
        JJ=JJ+1;
        fprintf('%05.1f %% complete\n', z0*100/(L*N));
    end
    z0=z+dz;
    if n==5
        uf=u;
    end
   s2=-s2;
end
figure(1)
 pcolor(t,tabz,tabu) ;shading interp;
 xlabel('\tau');
 ylabel('\xi');
figure(2);
 plot(tabz,um);
 xlabel('\xi')  ;
 ylabel('max\midU\mid^2');
```

6. ***Effect of the nonlinearity on the regeneration of a chirped FEAP*** *(results of Fig. 10)*

Using the first code, we set the nonlinearity nonzero and its value varies

```
clc;
clear all;
T0=50;
s2=-1;
A=1;
L=4.1;
C=-1;
b=1; %the nonlinearity is nonzero and varies as 4; 9; 16;
N=2000;
dt=T0/(N) ;
t=(-N/2:(N/2)-1)*dt;
w=(2*pi/(T0))*(-N/2:N/2-1);
a=0.05;
u=A.*exp(a.*t).*airy(t).*exp(-0.5i*C.*t.^2);
u0=u;
dz=dt;
tabz=[];
tabu=[];
JJ=1;
z0=0;
for n=1:21

    for z=z0:dz:z0+L-dz
        um(1,JJ)=max(abs(u).^2);
        tabu=[tabu;abs(u).^2];
        u=exp(b*dz*i*abs(u).*abs(u)).*u;
        c=fftshift(fft(u));
        c=exp(dz*s2*i*(w.^2)/2).*c;
        u=ifft(fftshift(c));
        tabz=[tabz;z];
        JJ=JJ+1;
        fprintf('%05.1f %% complete\n', z0*100/(L*N));
    end
    z0=z+dz;
    if n==5
        uf=u;
    end
   s2=-s2;
end
```

```
 figure(1)
 pcolor(t,tabz,tabu) ;shading interp;
 xlabel('\tau');
 ylabel('\xi');
figure(2);
 plot(tabz,um);
 xlabel('\xi')  ;
 ylabel('max\midU\mid^2');
```

7. ***Effect of the nonlinearity on the regeneration of strongly chirped SFEAP*** *(results of Fig. 11)*
   Using the fifth code, we set the nonlinearity nonzero and its value varies

```
clc;
clear all;
T0=50;
tb=1;
s2=-1;
A=1;
L=4.1;
C=-0.5;
b=1; %the nonlinearity is nonzero and varies as 4; 9; 16;
N=2000;
dt=T0/(N) ;
t=(-N/2:(N/2)-1)*dt;
w=(2*pi/(T0))*(-N/2:N/2-1);
a=0.05;
u=A.*(exp(a.*(tb+t)).*airy(tb+t)+exp(a.*(tb-t)).*airy(tb-t)).*exp(-0.5i*C.*t.^2);
%superposition of the two airy pulses separated by tb=2.5
u0=u;
dz=dt;
tabz=[];
tabu=[];
JJ=1;
z0=0;
for n=1:21

    for z=z0:dz:z0+L-dz
       um(1,JJ)=max(abs(u).^2);
       tabu=[tabu;abs(u).^2];
       u=exp(b*dz*i*abs(u).*abs(u)).*u;
       c=fftshift(fft(u));
       c=exp(dz*s2*i*(w.^2)/2).*c;
       u=ifft(fftshift(c));
       tabz=[tabz;z];
       JJ=JJ+1;
       fprintf('%05.1f %% complete\n', z0*100/(L*N));
    end
    z0=z+dz;
    if n==5
       uf=u;
    end
  s2=-s2;
end
figure(1)
 pcolor(t,tabz,tabu) ;shading interp;
 xlabel('\tau');
 ylabel('\xi');
figure(2);
 plot(tabz,um);
 xlabel('\xi')  ;
 ylabel('max\midU\mid^2');
```