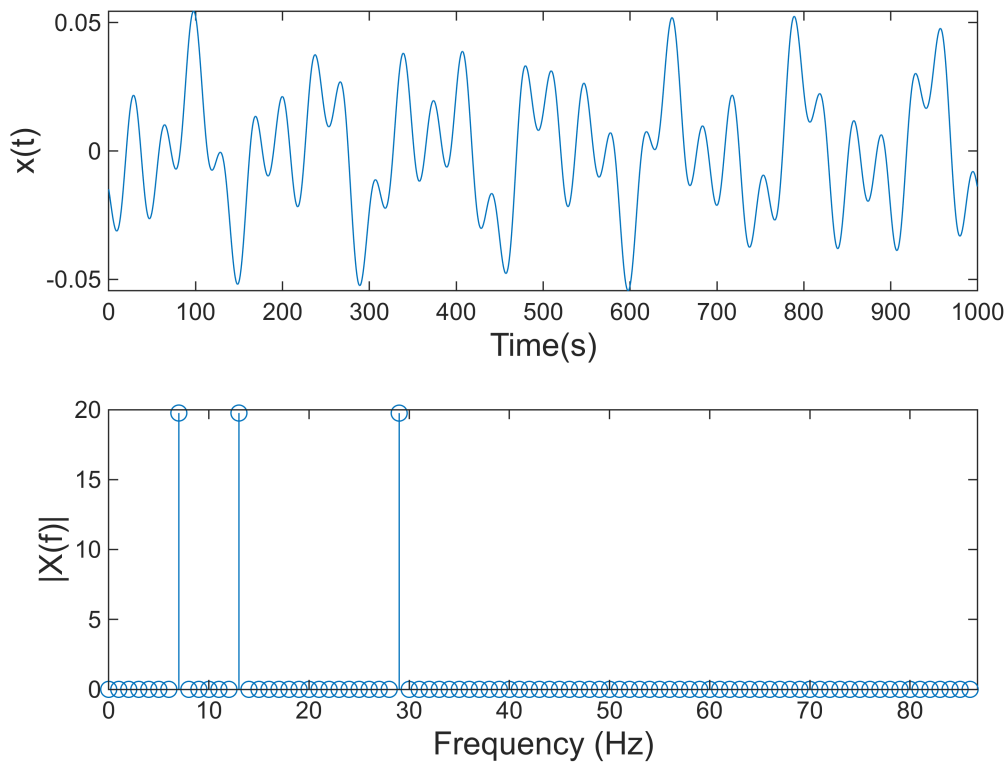


Preparation

```
%ms=reshape(distSig3,2048,600);
load 'multisine_7_13_29'
Trials = 600;
ms = repmat(distSig3_1p,Trials,1);
ms(end+1)= ms(1);
ms = diff(ms);
ms = ms - mean(ms);
ms=reshape(ms,2048,Trials);

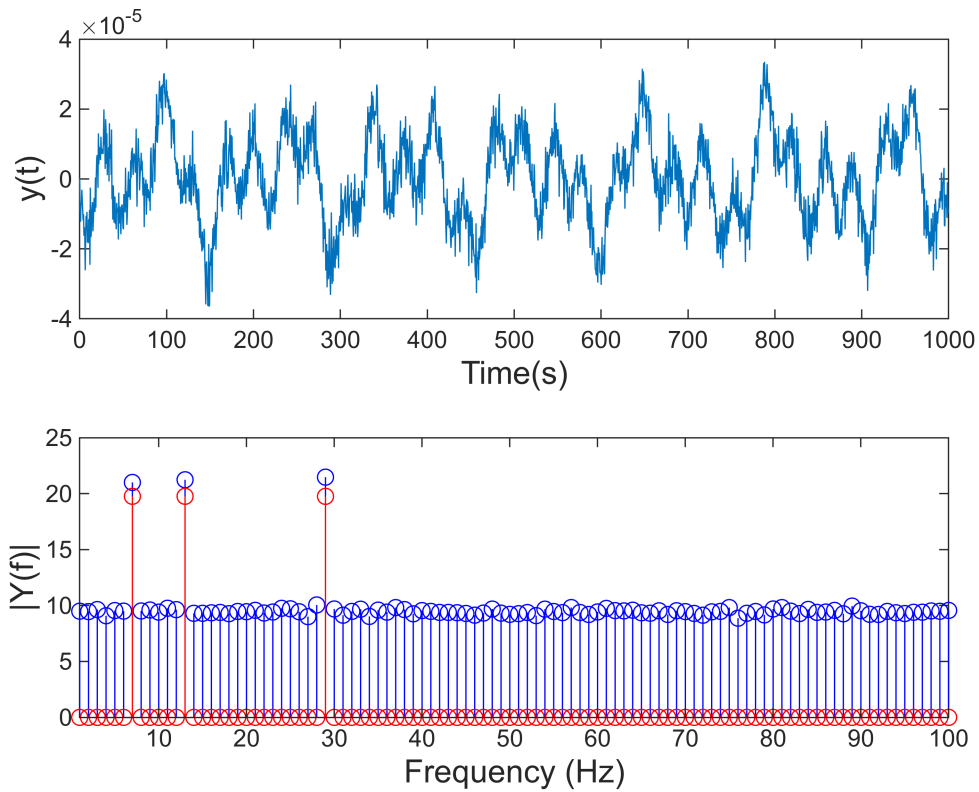
ms=ms*50;
tv = (0:1/2048:1-1/2048)*1000;
fe = [8 14 30];
N=2048;
MS = fft(ms,N);
f = [0:1/N:1-1/N]*N;
figure
subplot(211)
plot(tv, mean(ms,2));
xlabel('Time(s)', 'FontSize',12)
ylabel('x(t)', 'FontSize',12)
%f = [0:1/(N):1-1/(N)]*N;
subplot(212)
stem (f, mean(abs(MS),2));
xlabel('Frequency (Hz)', 'FontSize',12)
ylabel('|X(f)|', 'FontSize',12)
xlim([1 100])
```



add background noise to the input

```
ms_noise = awgn(ms, -20, 'measured', 'db');
MS_noise = fft(ms_noise, N);

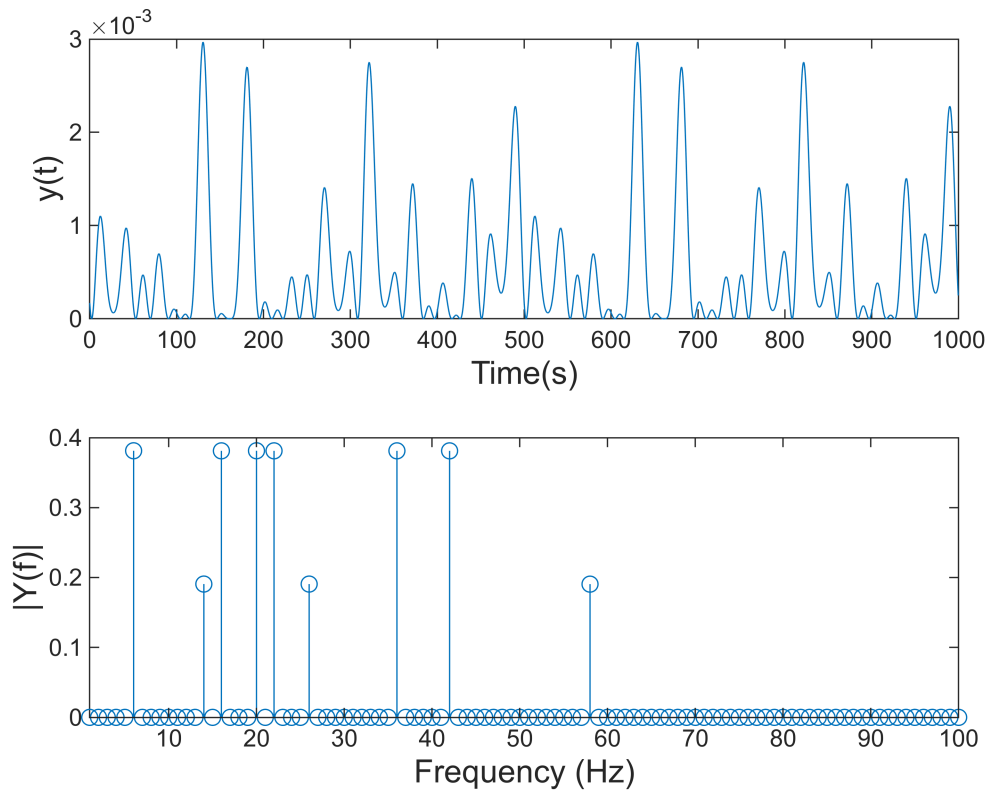
%MS_noise(fe, :) = MS(fe, :);
ms_noise = ifft(MS_noise ./ N, N);
figure
subplot(211)
%stem(f, mean(abs(D2_delay_noise), 2));
plot(tv, mean(ms_noise, 2));
xlabel('Time(s)', 'FontSize', 12)
ylabel('y(t)', 'FontSize', 12)
%xlim([1 100])
%f = [0:1/(N):1-1/(N)] * N;
subplot(212)
stem(f, mean(abs(MS_noise), 2), 'b-');
hold on
stem(f, mean(abs(MS), 2), 'r-');
xlabel('Frequency (Hz)', 'FontSize', 12)
ylabel('|Y(f)|', 'FontSize', 12)
xlim([1 100])
```



2 order+time delay

```
tau = 67;
ms_delay = circshift(ms,tau);
d2_delay = ms_delay.^2;
%d2_delay = ms_noise.^2;
D2_delay = fft(d2_delay,N);
f2=[6 14 16 20 22 26 36 42 58];
%D2_delay(f2+1,:) = D2_delay(f2+1,:)./abs(D2_delay(f2+1,:));
d2_delay = ifft(D2_delay,N);

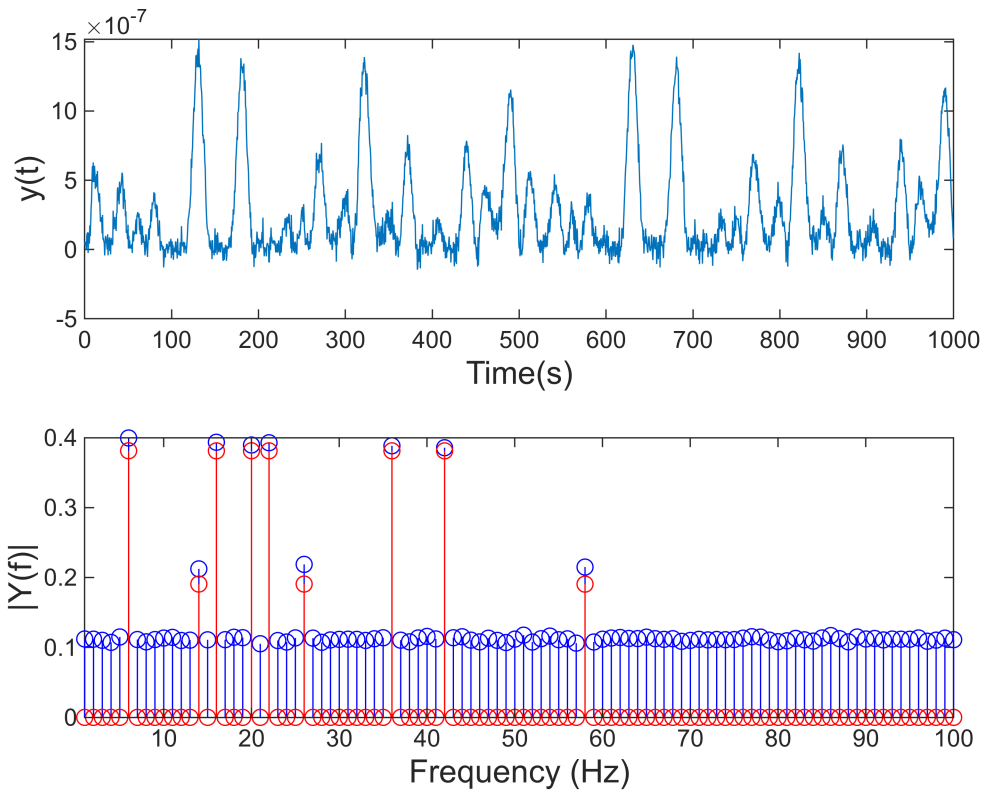
figure
subplot(211)
plot(tv, mean(d2_delay,2));
xlabel('Time(s)','FontSize',12)
ylabel('y(t)','FontSize',12)
%f = [0:1/(N):1-1/(N)]*N;
subplot(212)
stem(f, mean(abs(D2_delay),2));
xlabel('Frequency (Hz)','FontSize',12)
ylabel('|Y(f)|','FontSize',12)
xlim([1 100])
```



add background noise to the output

```
d2_delay_noise = awgn(d2_delay, -10, 'measured', 'db');
D2_delay_noise = fft(d2_delay_noise, N);

%D2_delay_noise(f2+1,:) = D2_delay(f2+1,:);
d2_delay_noise = ifft(D2_delay_noise./N, N);
figure
subplot(211)
%stem(f, mean(abs(D2_delay_noise), 2));
plot(tv, mean(d2_delay_noise, 2));
xlabel('Time(s)', 'FontSize', 12)
ylabel('y(t)', 'FontSize', 12)
%xlim([1 100])
%f = [0:1/(N):1-1/(N)]*N;
subplot(212)
stem(f, mean(abs(D2_delay_noise), 2), 'b-');
hold on
stem(f, mean(abs(D2_delay), 2), 'r-');
xlabel('Frequency (Hz)', 'FontSize', 12)
ylabel('|Y(f)|', 'FontSize', 12)
xlim([1 100])
```



n:m phase coupling

```
[NMPC_1, NMPC_p_1]= MNPC_p_EEG (MS_noise,D2_delay_noise,7,90);
[NMPC_2, NMPC_p_2]= MNPC_p_EEG (MS_noise,D2_delay_noise,13,90);
[NMPC_3, NMPC_p_3]= MNPC_p_EEG (MS_noise,D2_delay_noise,29,90);
```

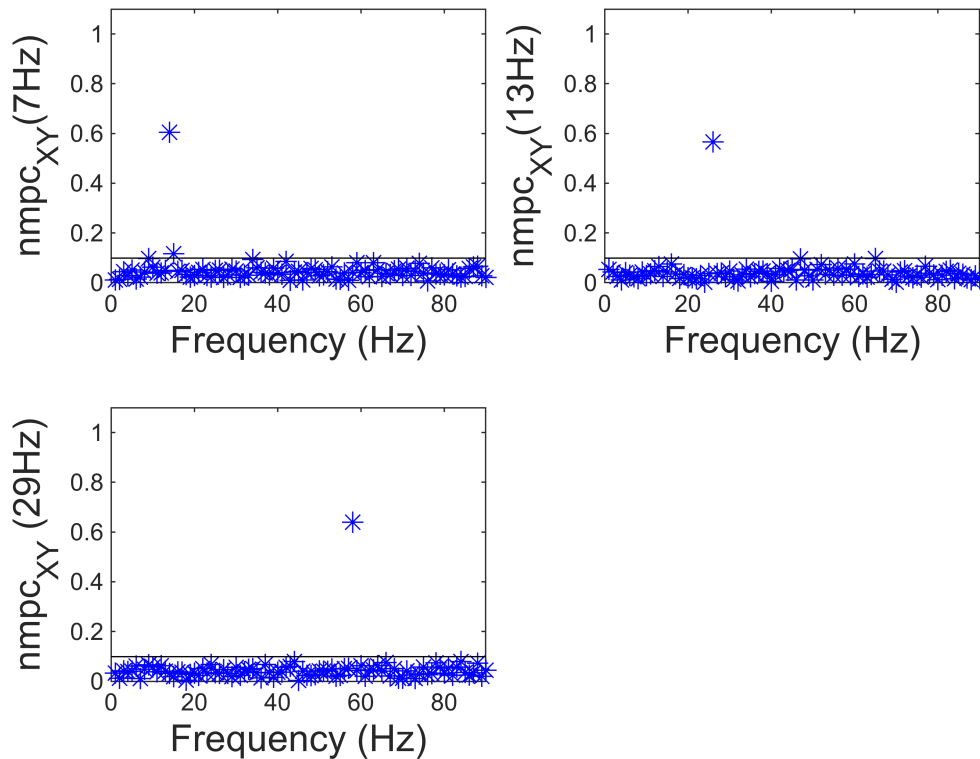
```
figure
subplot(221)
l(1)=plot(f(2:91),NMPC_1,'b*','MarkerSize',8);
hold on
plot(f(1:91),1.4*sqrt(3/Trials)*ones(91,1),'k-');
xlim([0 90]);
ylim([0 1.1]);
xlabel('Frequency (Hz)','FontSize',14);
ylabel('nmpc_{XY}(7Hz)','FontSize',14);
```

```
subplot(222)
l(1)=plot(f(2:91),NMPC_2,'b*','MarkerSize',8);
hold on
plot(f(1:91),1.4*sqrt(3/Trials)*ones(91,1),'k-');
xlim([0 90]);
ylim([0 1.1]);
xlabel('Frequency (Hz)','FontSize',14);
ylabel('nmpc_{XY}(13Hz)','FontSize',14);
```

```

subplot(223)
l(1)=plot(f(2:91),NMPC_3,'b*','MarkerSize',8);
hold on
plot(f(1:91),1.4*sqrt(3/Trials)*ones(91,1),'k-');
xlim([0 90]);
ylim([0 1.1]);
xlabel('Frequency (Hz)','FontSize',14);
ylabel('nmpc_{XY} (29Hz)','FontSize',14);

```

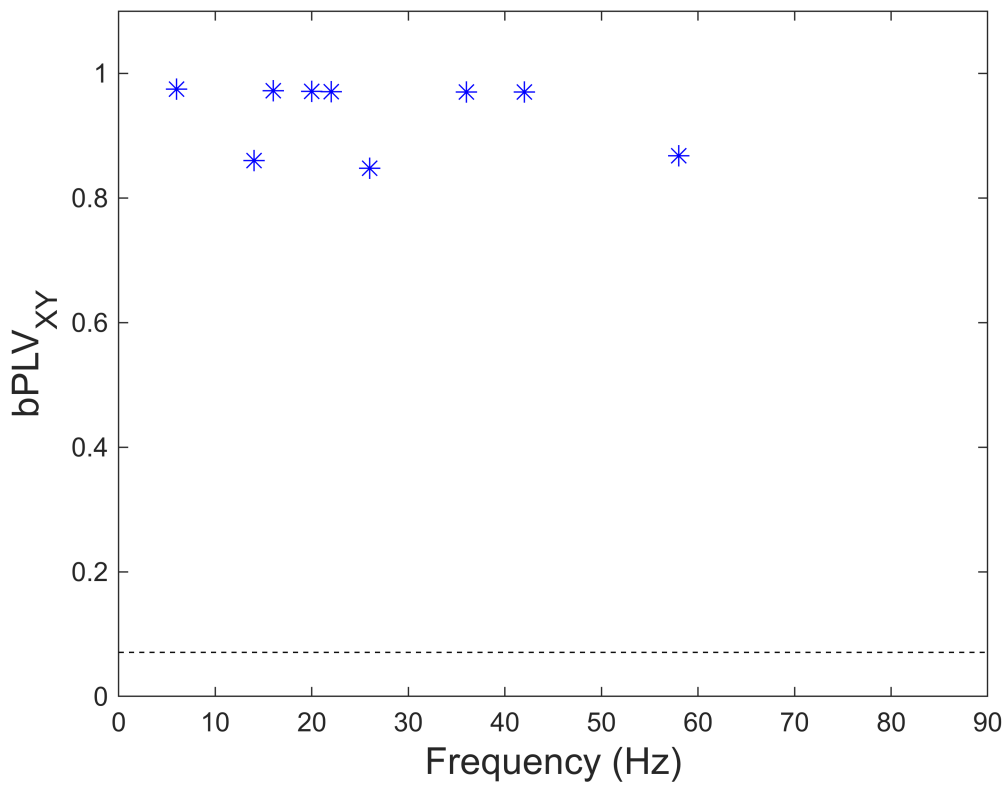


phase bicoherence/MSPC second order

```

[C_2,C_p_2,Ang_2,TimeD_2,f_sigma_2]=MSPC_2(MS,D2_delay_noise,fe);
figure
%subplot(224)
l(1)=plot(f_sigma_2-1,C_2,'b*','MarkerSize',8);
hold on
plot(f(1:101),sqrt(3/Trials)*ones(101,1),'k--')
hold on
%stem(fe-1, 1.5*ones(3,1),'r-');
xlim([0 90]);
ylim([0 1.1]);
xlabel('Frequency (Hz)','FontSize',14);
ylabel('bPLV_{XY}','FontSize',14);

```



NMC map

```

min_freq = 1;
max_freq = 100;
[NCMC_C, NCMC_C_p] = MNPC (MS_noise,D2_delay_noise,min_freq,max_freq);
%[NCMC_C, NCMC_C_p] = MNPC (MS_noise,D2_delay,min_freq,max_freq);

CL = sqrt(1 - (0.05/10000)^(1/(Trials-1))); % Bonferroni correction

SC = NCMC_C>CL;
NCMC = NCMC_C.*SC;

figure
imagesc(NCMC);
xlabel ('Output');
ylabel ('Input');
set(gca, 'YDir', 'normal')
title('NMC')

```

