

Contents

- Figures
- Error Analysis

```
clear; clc;
k0 = 0.5; kf = 1.5;
kplot = k0:(kf-k0)/499:kf;
count = 1;
initial_guesses = zeros(1,length(kplot));
omega_xie = zeros(1,length(kplot));
omega_xie_rescaled = zeros(1,length(kplot));

sigma = 0.5;
mu = 100;
exactReal = mu*kplot+1; % other solution: mu*kplot-1
exactImag = -sigma*kplot;

for k=kplot
    init_guess = Vlasov_1D_linearized_Steve_v4(k, sigma, 0); %\tilde{\Omega}+i\gamma
    initial_guesses(count) = init_guess+mu*k; %\Omega+i\gamma

    xi = (init_guess+mu*k)/k;
    xi_scaled = init_guess/(sigma*k);

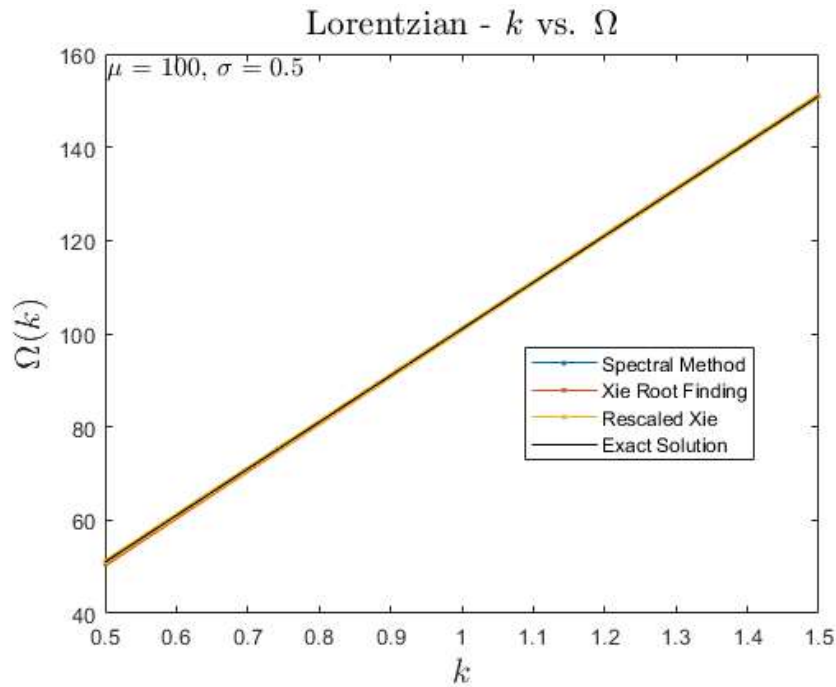
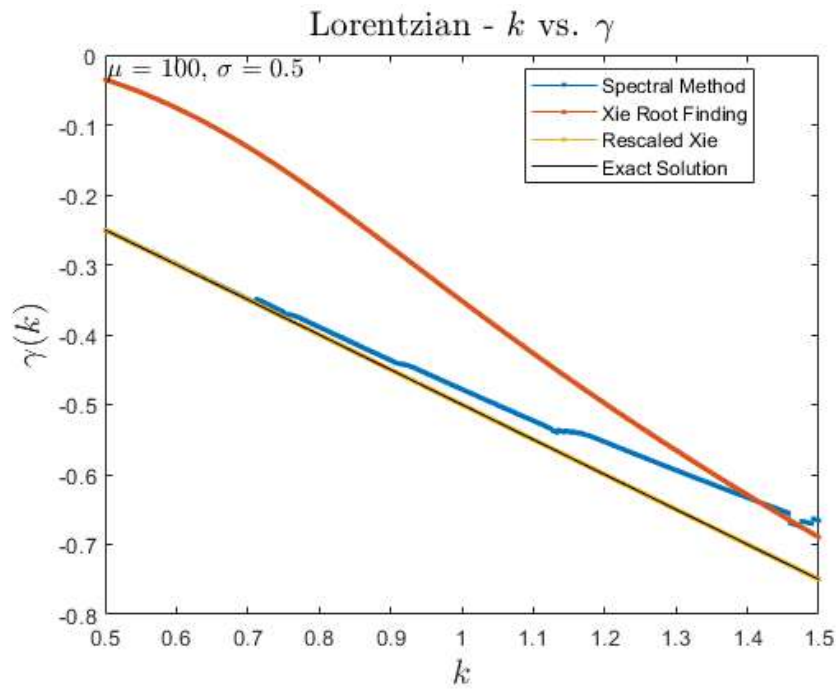
    omega_xie(count) = Lorentzian_Disp_Using_Xie(k, sigma, mu, xi)*k; %\omega=xi*k
    omega_xie_rescaled(count) = Lorentzian_Disp_Using_Xie(k*sigma, 1, 0, xi_scaled)*sigma*k + mu*k; %\omega=xi*\sigma*k+mu*k
    count = count+1;
end
```

Figures

```
close all
txt = ['$\mu$ = ',num2str(mu),' ', '$\sigma$ = ', num2str(sigma)];

figure
plot(kplot, imag(initial_guesses),'.-'); hold on
plot(kplot, imag(omega_xie),'.-');
plot(kplot, imag(omega_xie_rescaled),'.-');
plot(kplot, exactImag,'k');
title('Lorentzian - $k$ vs. $\gamma$', 'Interpreter', 'latex', 'FontSize', 16)
xlabel('$k$', 'Interpreter', 'latex', 'FontSize', 16)
ylabel('$\gamma(k)$', 'Interpreter', 'latex', 'FontSize', 16)
legend('Spectral Method', 'Xie Root Finding', 'Rescaled Xie', 'Exact Solution', 'location', 'Best')
xL=xlim; yL=ylim;
text(xL(1)+(kplot(2)-kplot(1)),yL(2),txt, 'HorizontalAlignment', 'left', 'VerticalAlignment', 'top', 'Interpreter', 'latex', 'FontSize', 12)

figure
plot(kplot, real(initial_guesses),'.-'); hold on
plot(kplot, real(omega_xie),'.-');
plot(kplot, real(omega_xie_rescaled),'.-');
plot(kplot, exactReal, 'k')
title('Lorentzian - $k$ vs. $\Omega$', 'Interpreter', 'latex', 'FontSize', 16)
xlabel('$k$', 'Interpreter', 'latex', 'FontSize', 16)
ylabel('$\Omega(k)$', 'Interpreter', 'latex', 'FontSize', 16)
legend('Spectral Method', 'Xie Root Finding', 'Rescaled Xie', 'Exact Solution', 'Location', 'Best')
xL=xlim; yL=ylim;
text(xL(1)+(kplot(2)-kplot(1)),yL(2),txt, 'HorizontalAlignment', 'left', 'VerticalAlignment', 'top', 'Interpreter', 'latex', 'FontSize', 12)
```



Error Analysis

L2 error = $\sum (y_{\text{exact}} - y_{\text{sample}})^2$

```
% real part: Omega = mu*k+1
L2err.spectral(1) = sum( (exactReal-(real(initial_guesses))).^2 );
L2err.xie(1) = sum( (exactReal-(real(omega_xie))).^2 );
L2err.xie_rescaled(1) = sum( (exactReal-(real(omega_xie_rescaled))).^2 );

% imaginary part: gamma = -sigma*k
L2err.spectral(2) = sum( (exactImag-(imag(initial_guesses))).^2 );
L2err.xie(2) = sum( (exactImag-(imag(omega_xie))).^2 );
L2err.xie_rescaled(2) = sum( (exactImag-(imag(omega_xie_rescaled))).^2 );

Error = struct2table(L2err)
```

Error =

1×3 table

spectral		xie		xie_rescaled	
0.058913	0.70033	13.858	12.707	2.9454e-12	1.3409e-11