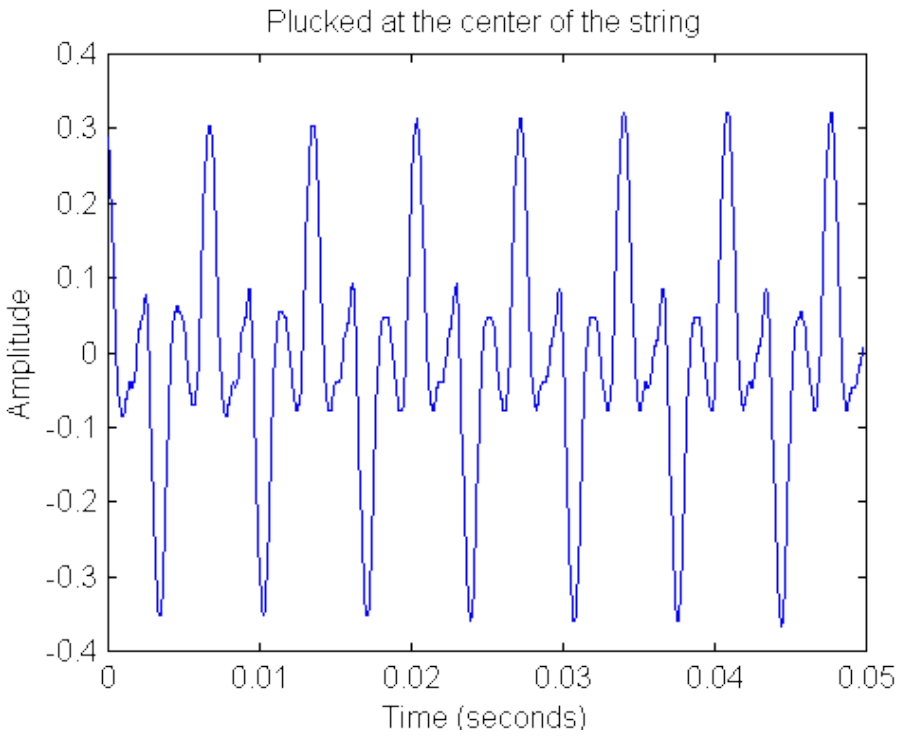
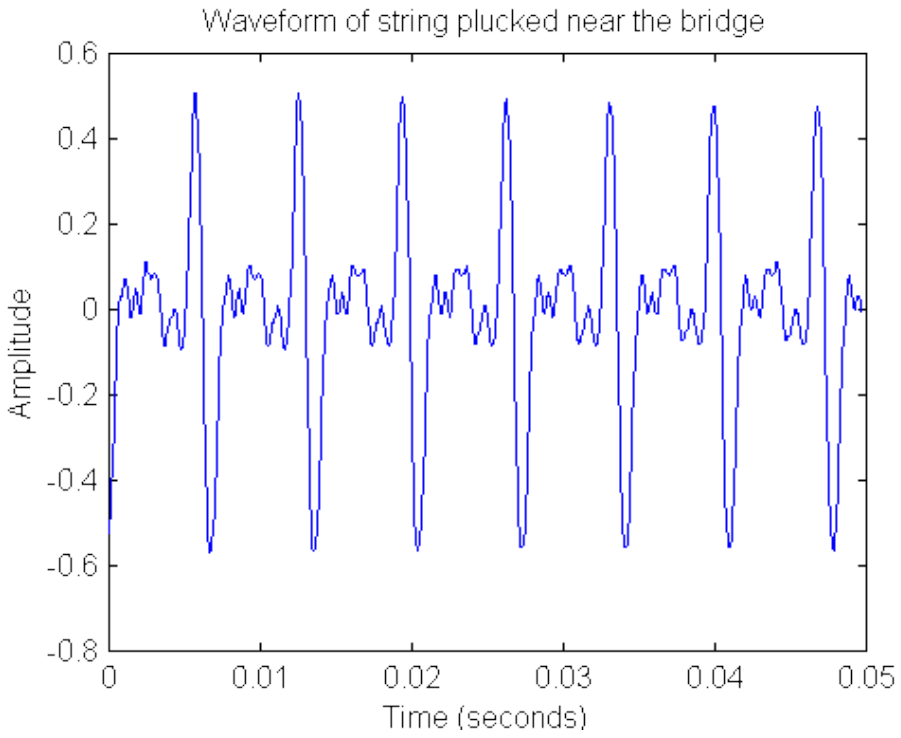
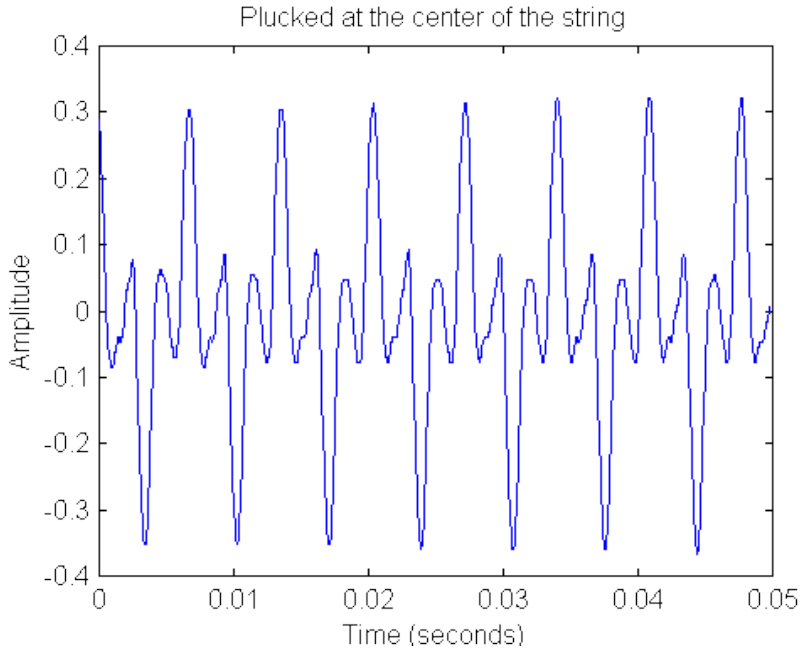
Recasting a problem in Fourier space

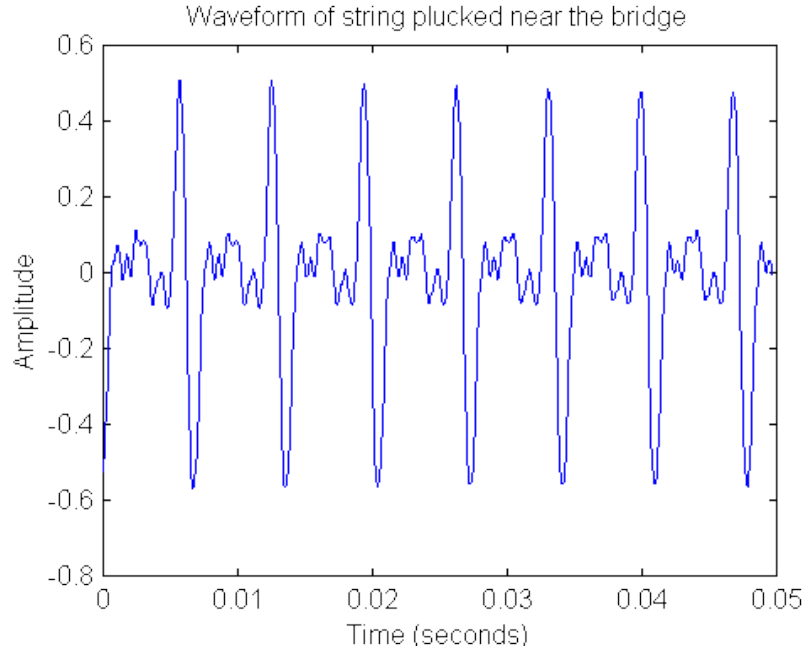
Amplitude as a function of time for plucked guitar:

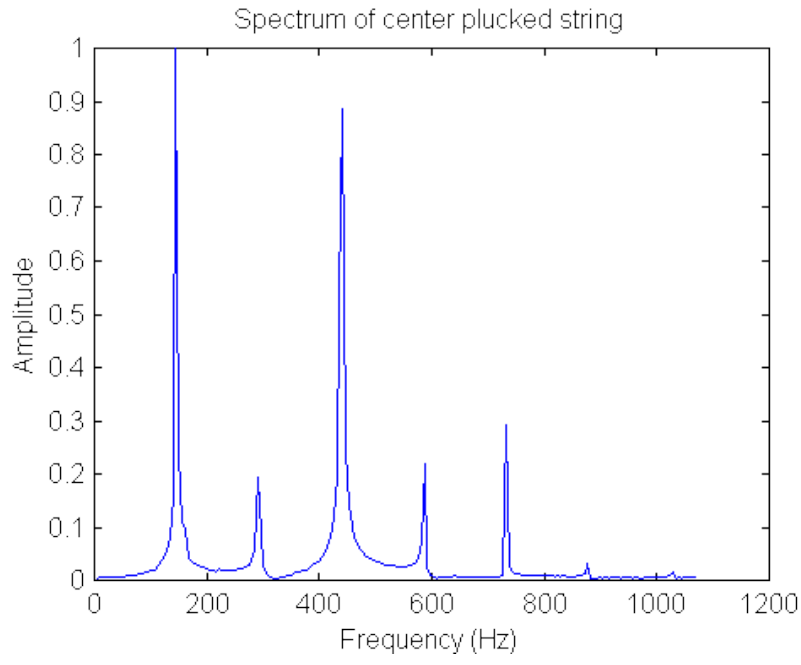


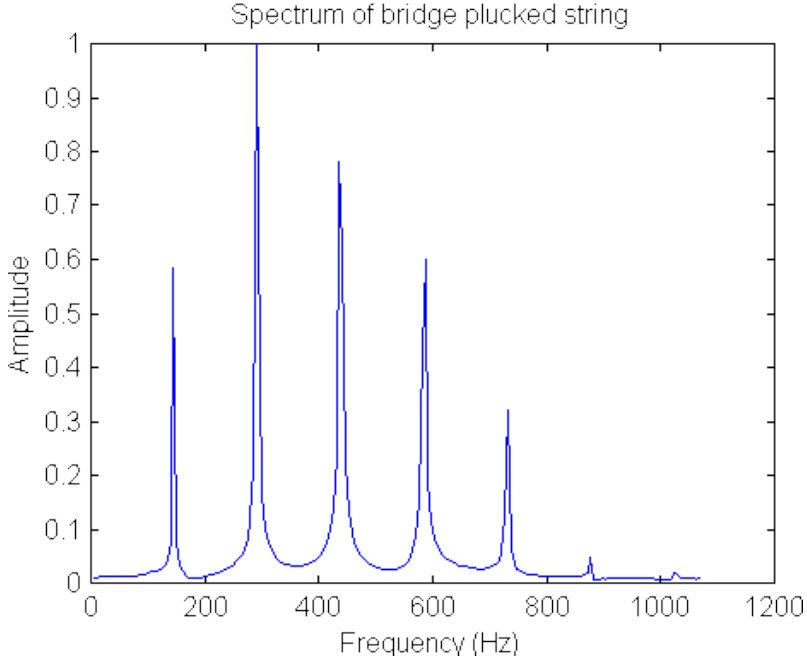


Same information is contained in amplitude of *frequencies*


Plucked at the center of the string
Amplitude
Time (seconds)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
0
0.01
0.02
0.03
0.04
0.05


Waveform of string plucked near the bridge
Amplitude
Time (seconds)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
0.01
0.02
0.03
0.04
0.05


Spectrum of center plucked string
Amplitude
Frequency (Hz)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
200
400
600
800
1000
1200


Spectrum of bridge plucked string
Amplitude
Frequency (Hz)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
200
400
600
800
1000
1200

Energy by adding up frequencies/wavelengths

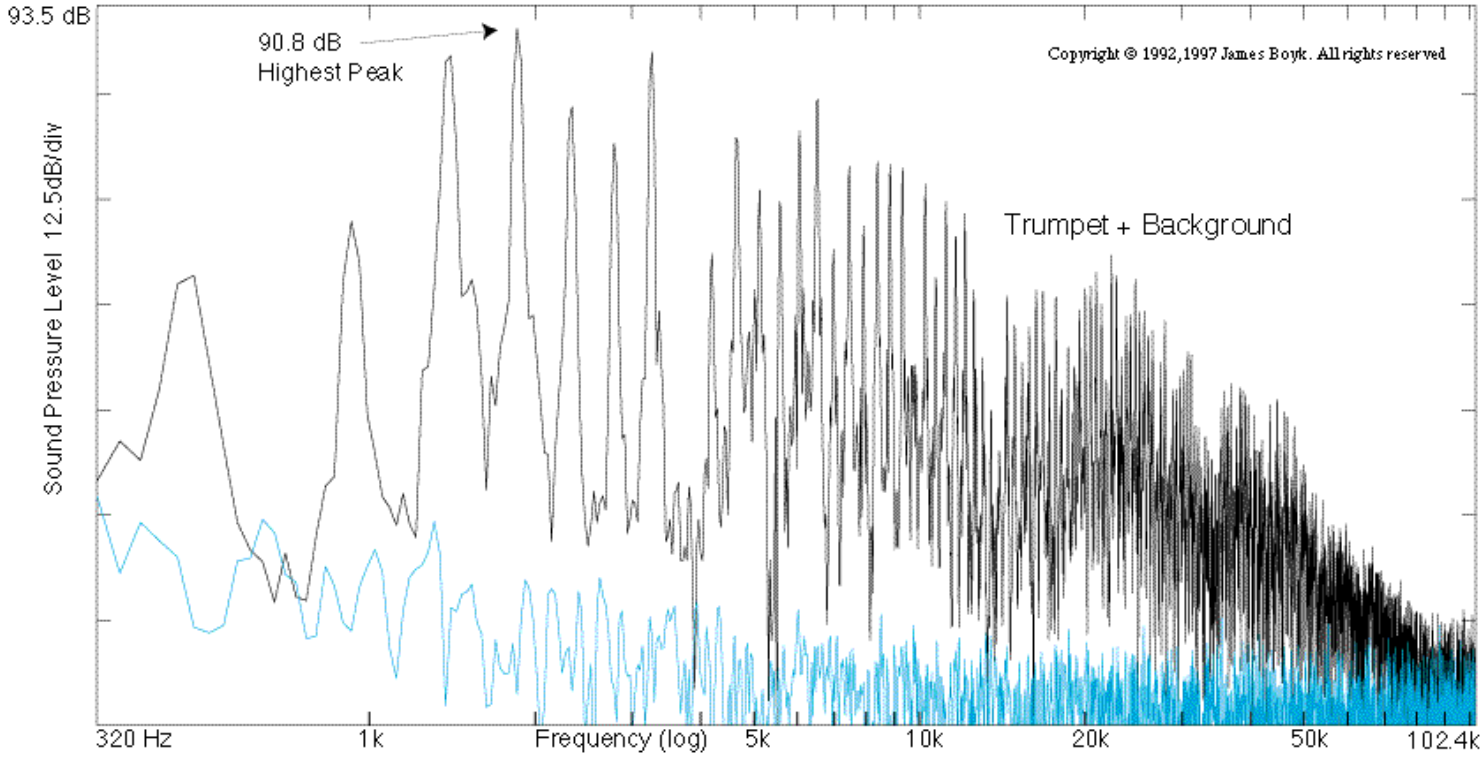
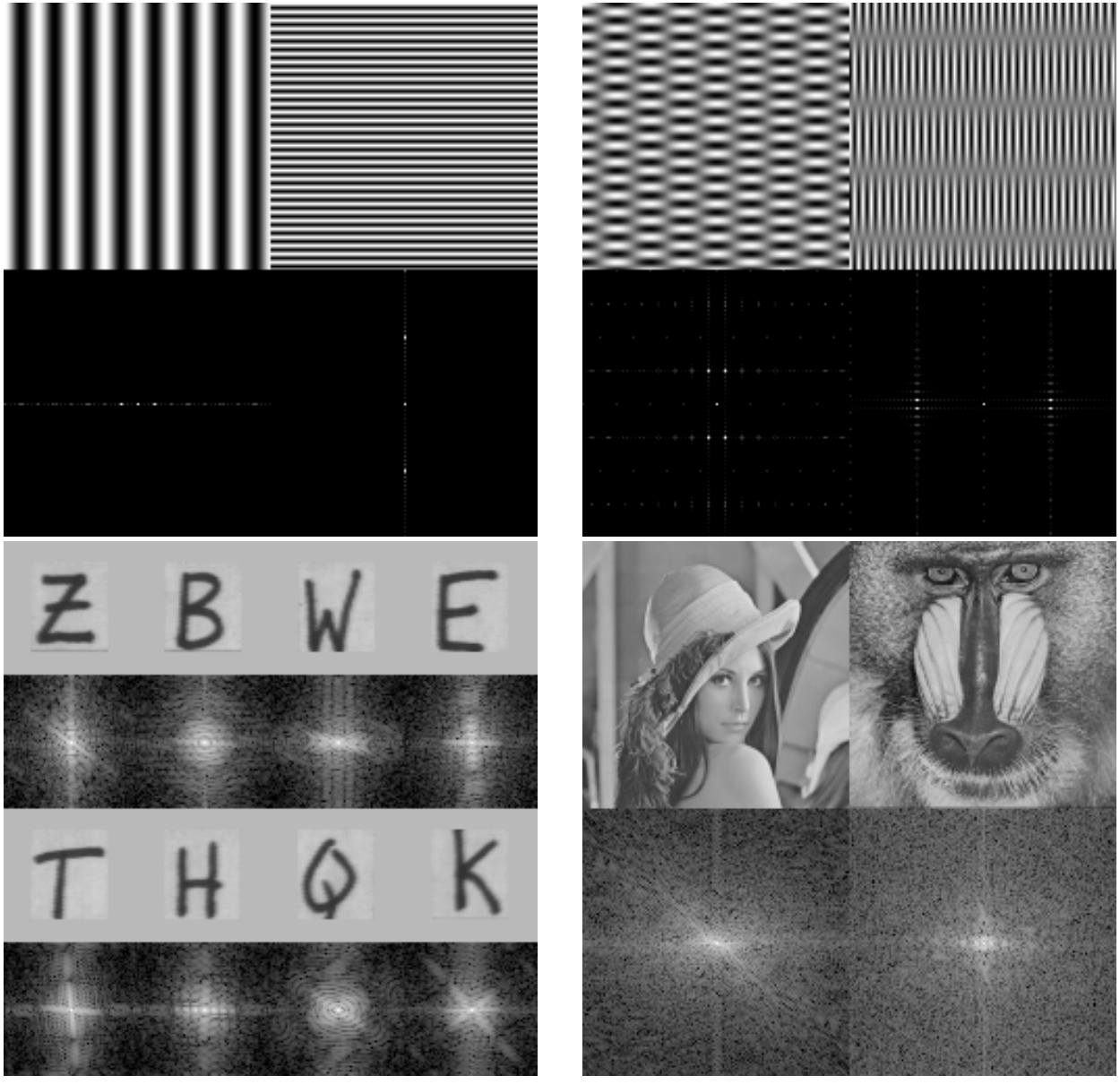


Figure 1(a) (Amplitude *vs.* frequency). **Trumpet with Harmon mute**; 95.5 dB at Aco 7016 microphone 4 feet away. Microphone aimed at bell, which was angled down about 20 degrees. Upper Trace: Trumpet + Background, corrected to 70 kHz (see text). Lower trace: Background alone.

- Describe energy by where particle is and how fast it is moving *or* by adding up energy in each wavelength given the distribution of wavelengths

2D Fourier transforms of images

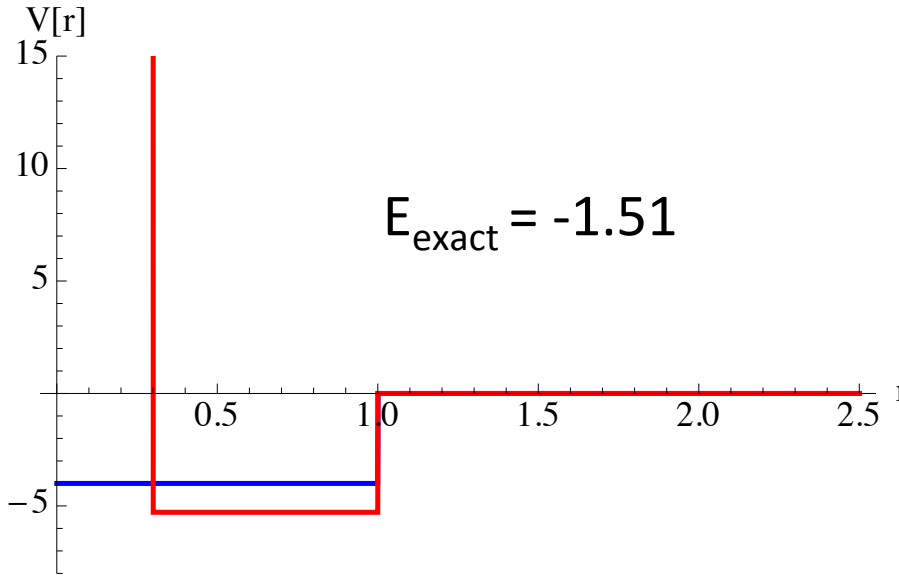


Expanding wave functions in an HO basis

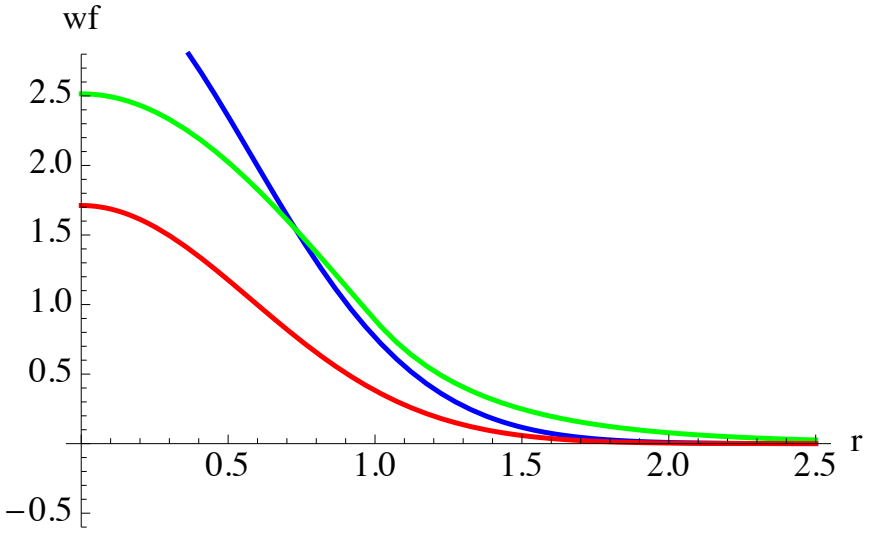
- Single-particle radial wf $\psi(r)$
- Expand in harmonic oscillator wfs:

$$\psi_{N_{\max}}(r) = \sum_{\alpha=0}^{N_{\max}} c_\alpha \phi_\alpha(r)$$

- Find c_αs by diagonalizing $\hat{H}\Psi = E\Psi$

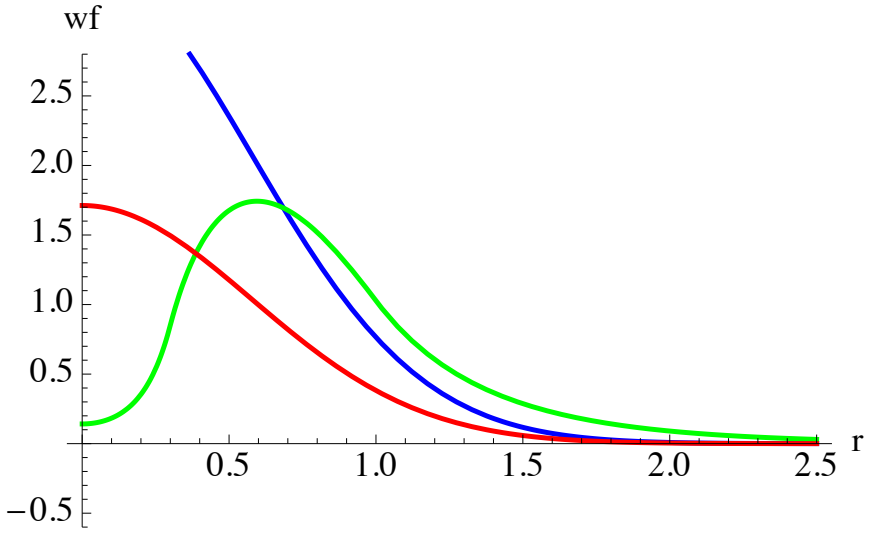


$\psi_{\text{exact}}(r)$, $\psi_0(r)$, $0.5 * \phi_0$



$N_{\max} = 0$, $E_0 = -1.30$

$\psi_{\text{exact}}(r)$, $\psi_0(r)$, $0.5 * \phi_0$



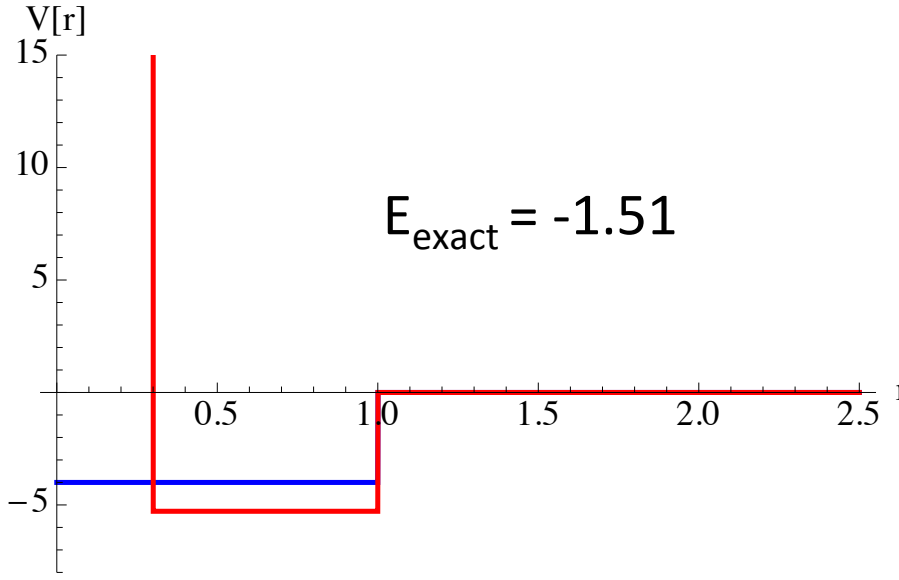
$N_{\max} = 0$, $E_0 = +5.23$

Expanding wave functions in an HO basis

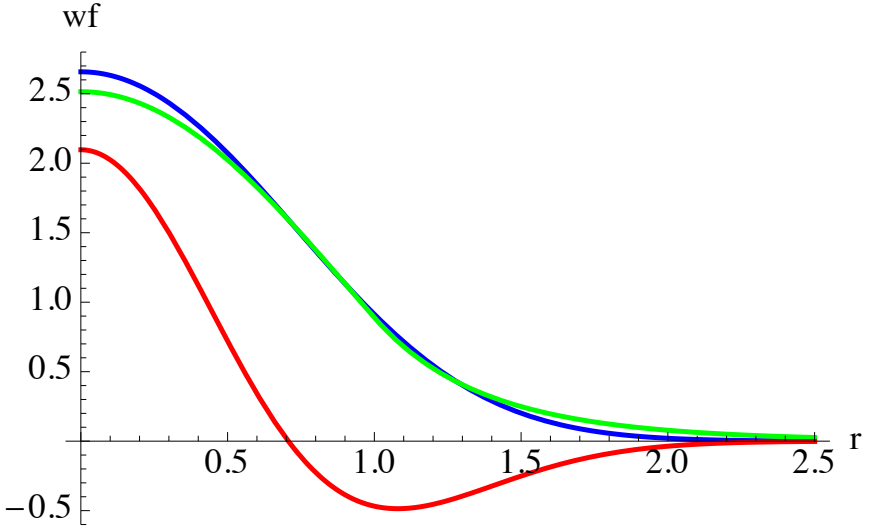
- Single-particle radial wf $\psi(r)$
- Expand in harmonic oscillator wfs:

$$\psi_{N_{\max}}(r) = \sum_{\alpha=0}^{N_{\max}} c_\alpha \phi_\alpha(r)$$

- Find c_αs by diagonalizing $\hat{H}\Psi = E\Psi$

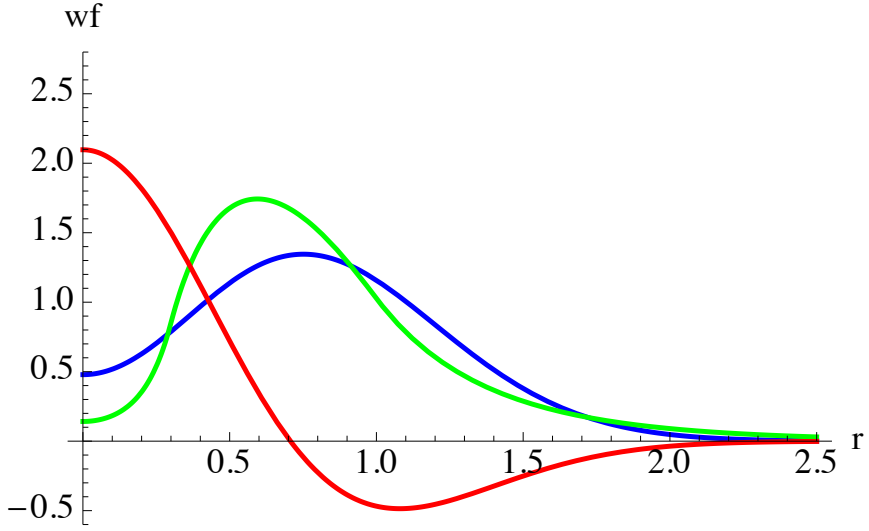


$\psi_{\text{exact}}(r)$, $\psi_2(r)$, $0.5 * \phi_2$



$N_{\max} = 2$, $E_2 = -1.46$

$\psi_{\text{exact}}(r)$, $\psi_2(r)$, $0.5 * \phi_2$



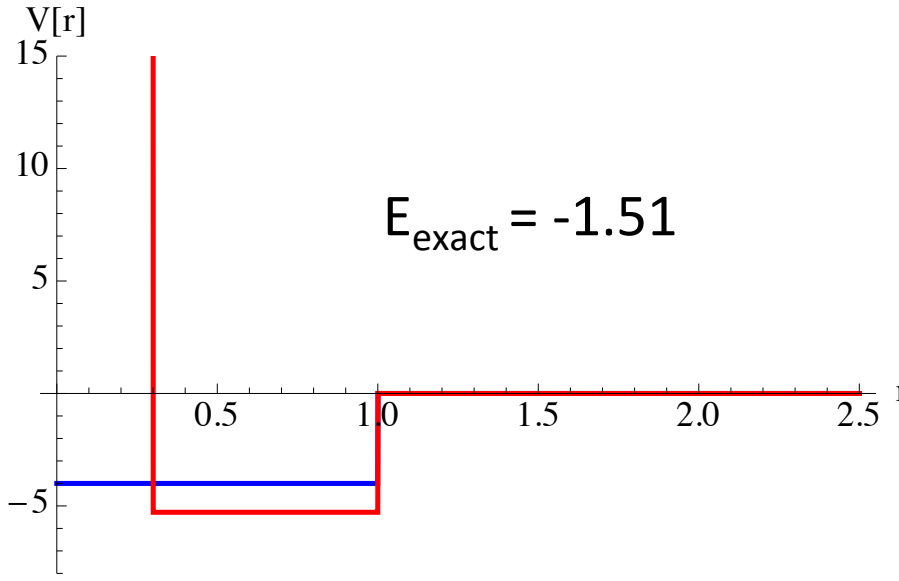
$N_{\max} = 2$, $E_2 = -0.87$

Expanding wave functions in an HO basis

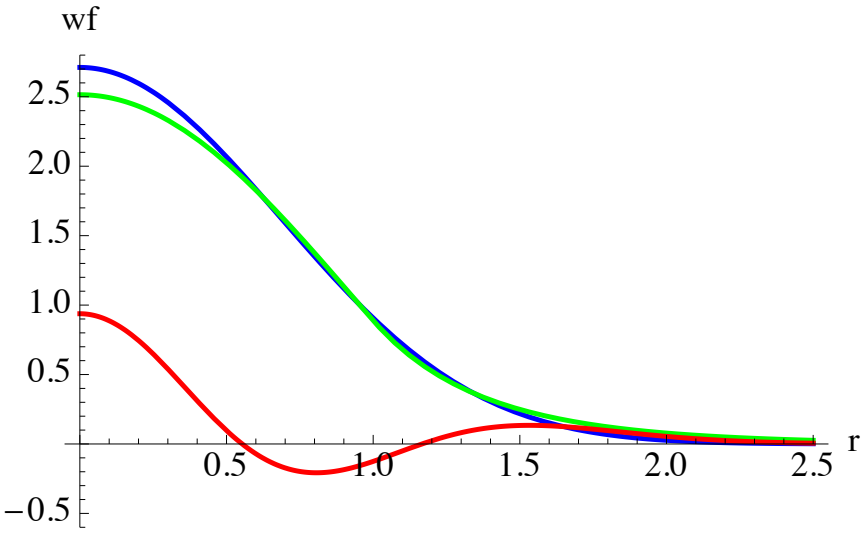
- Single-particle radial wf $\psi(r)$
- Expand in harmonic oscillator wfs:

$$\psi_{N_{\max}}(r) = \sum_{\alpha=0}^{N_{\max}} c_\alpha \phi_\alpha(r)$$

- Find c_αs by diagonalizing $\hat{H}\Psi = E\Psi$

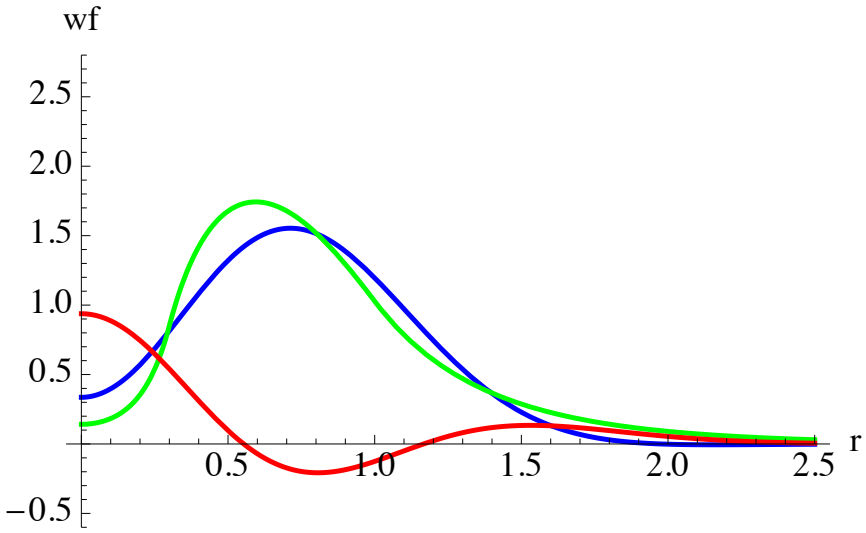


$\psi_{\text{exact}}(r)$, $\psi_4(r)$, $0.2 * \phi_4$



$N_{\max} = 4$, $E_4 = -1.46$

$\psi_{\text{exact}}(r)$, $\psi_4(r)$, $0.2 * \phi_4$



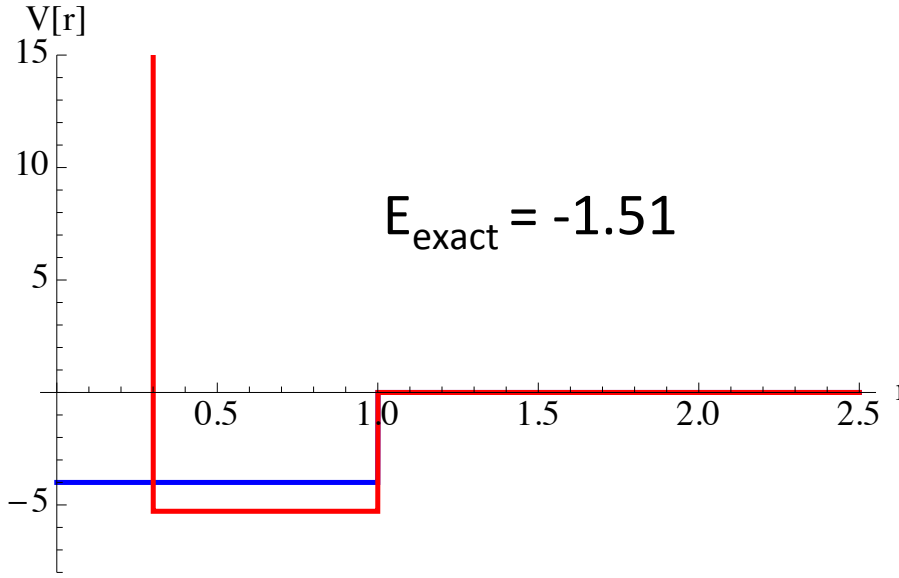
$N_{\max} = 4$, $E_4 = -1.04$

Expanding wave functions in an HO basis

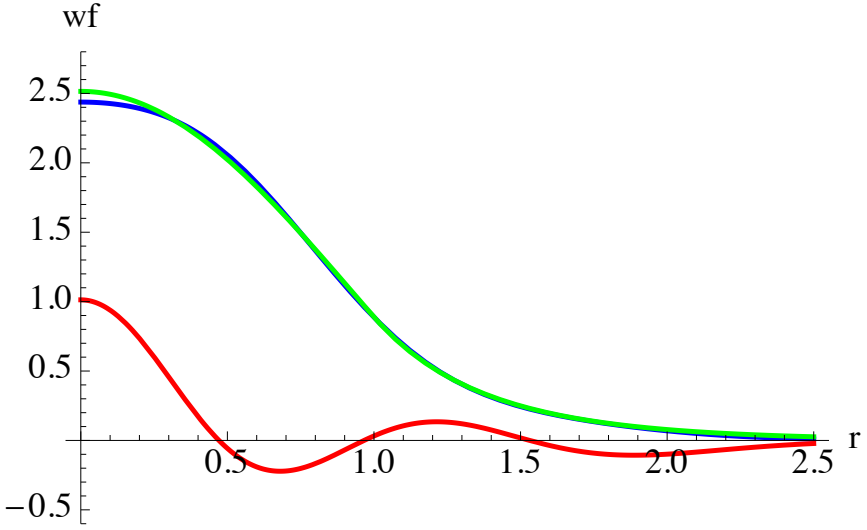
- Single-particle radial wf $\psi(r)$
- Expand in harmonic oscillator wfs:

$$\psi_{N_{\max}}(r) = \sum_{\alpha=0}^{N_{\max}} c_\alpha \phi_\alpha(r)$$

- Find c_αs by diagonalizing $\hat{H}\Psi = E\Psi$

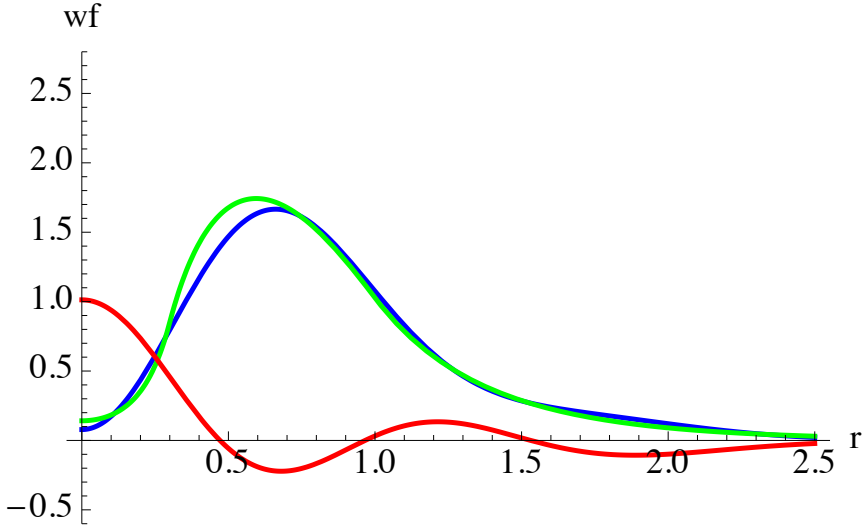


$\psi_{\text{exact}}(r)$, $\psi_6(r)$, $0.2 * \phi_6$



$N_{\max} = 6$, $E_6 = -1.50$

$\psi_{\text{exact}}(r)$, $\psi_6(r)$, $0.2 * \phi_6$



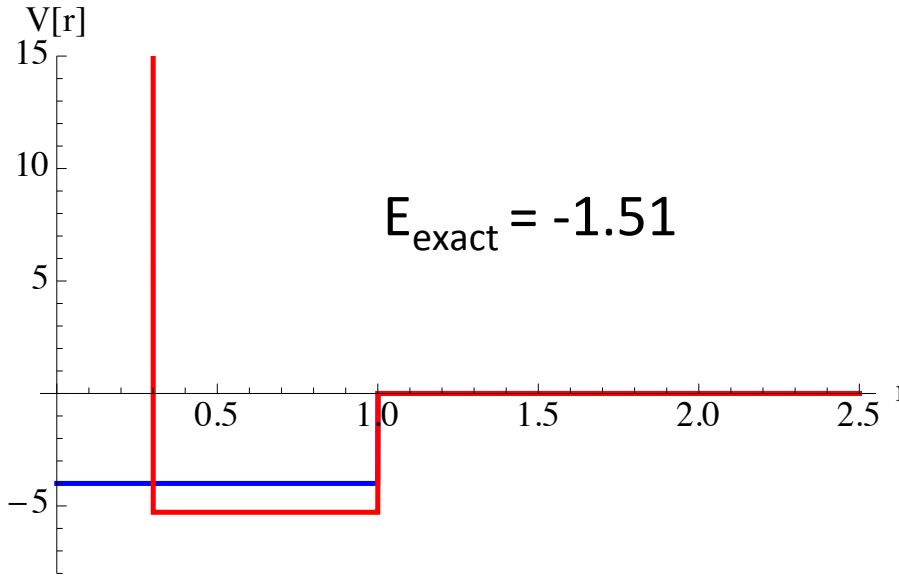
$N_{\max} = 6$, $E_6 = -1.40$

Expanding wave functions in an HO basis

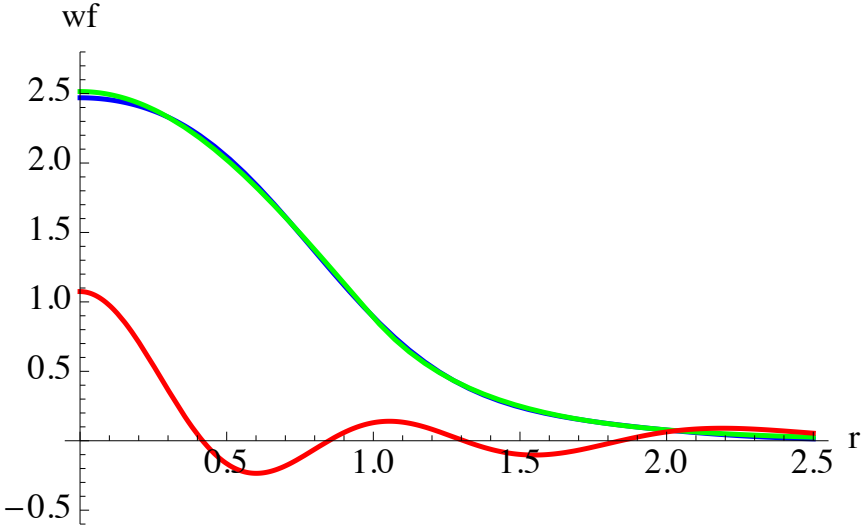
- Single-particle radial wf $\psi(r)$
- Expand in harmonic oscillator wfs:

$$\psi_{N_{\max}}(r) = \sum_{\alpha=0}^{N_{\max}} c_\alpha \phi_\alpha(r)$$

- Find c_αs by diagonalizing $\widehat{H}\Psi = E\Psi$
- Extend to many-body system

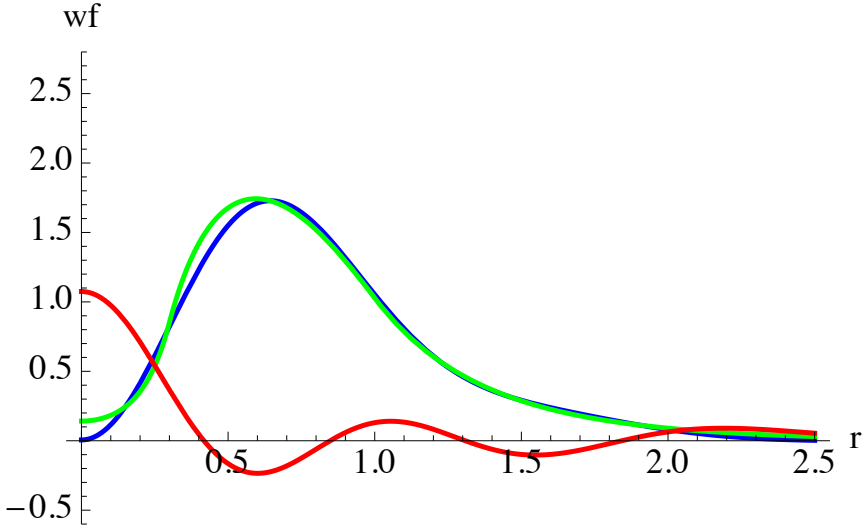


$\psi_{\text{exact}}(r)$, $\psi_8(r)$, $0.2 * \phi_8$



$N_{\max} = 8$, $E_8 = -1.50$

$\psi_{\text{exact}}(r)$, $\psi_8(r)$, $0.2 * \phi_8$



$N_{\max} = 8$, $E_8 = -1.43$