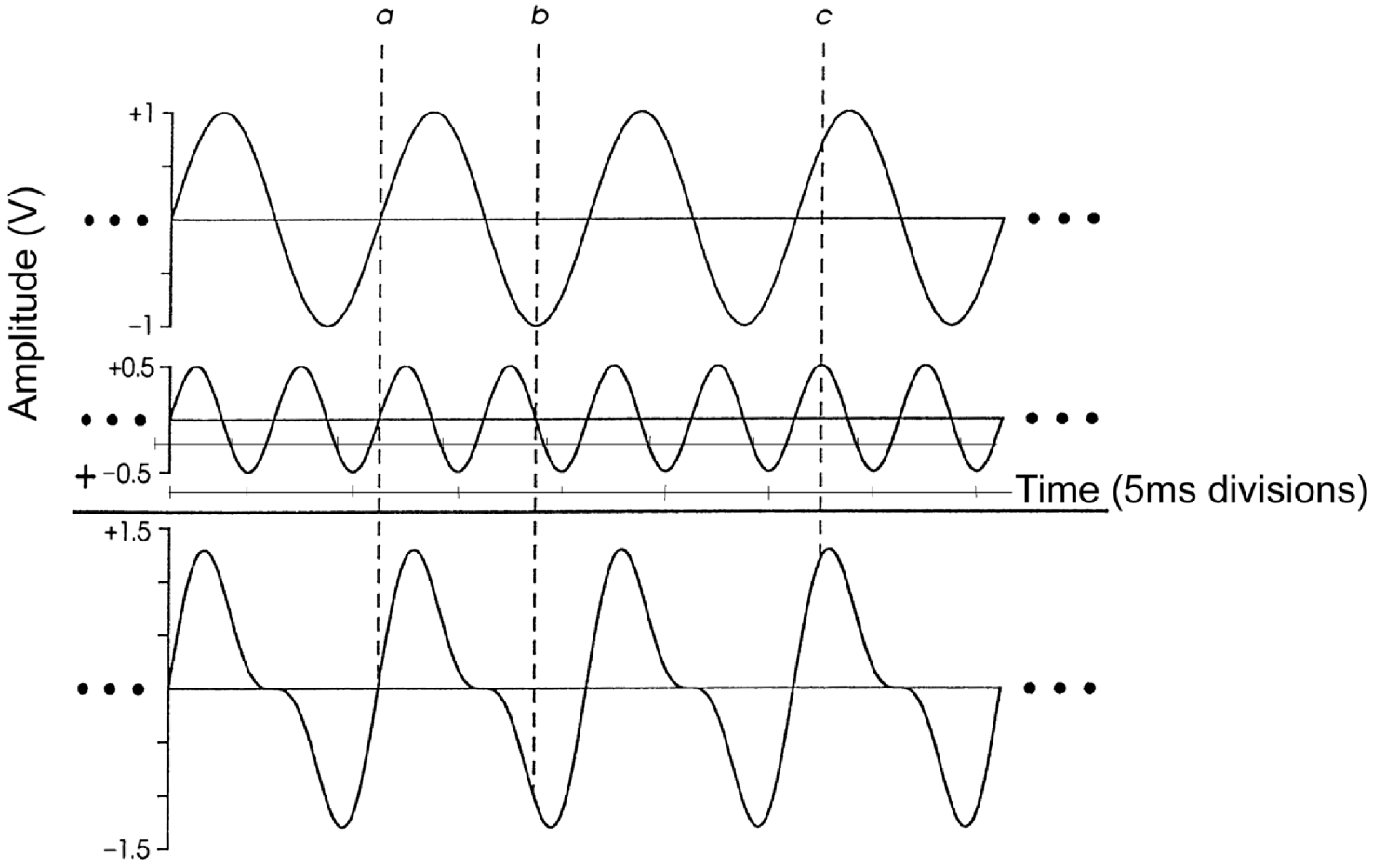
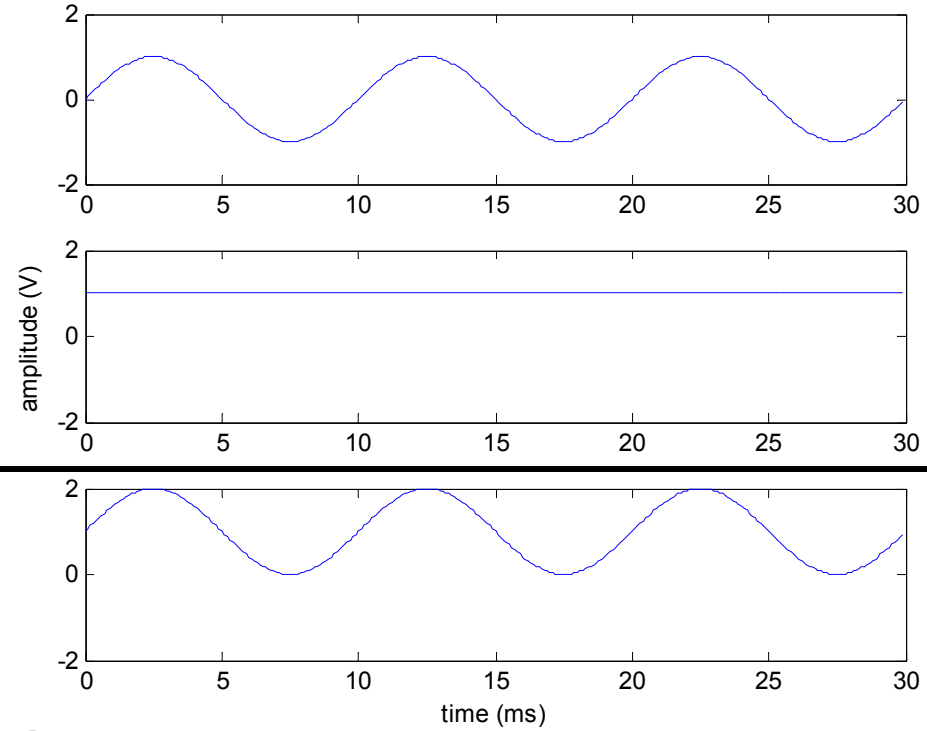
AUDL 4007
Auditory Perception

Technical preludes:
Adding up levels + SNRs

You know about adding up waves, e.g. from two loudspeakers



But how do you get the total rms from the rms values of two signals that are added?



+

rms= 0.707 V

rms= 1.0 V

rms= 1.22 V *≠ 1.707!*

Conclusion: you don't add them!
(the squaring for rms is non-linear)

Powers & intensities *do* add

power/intensity ~ voltage^2/pressure^2

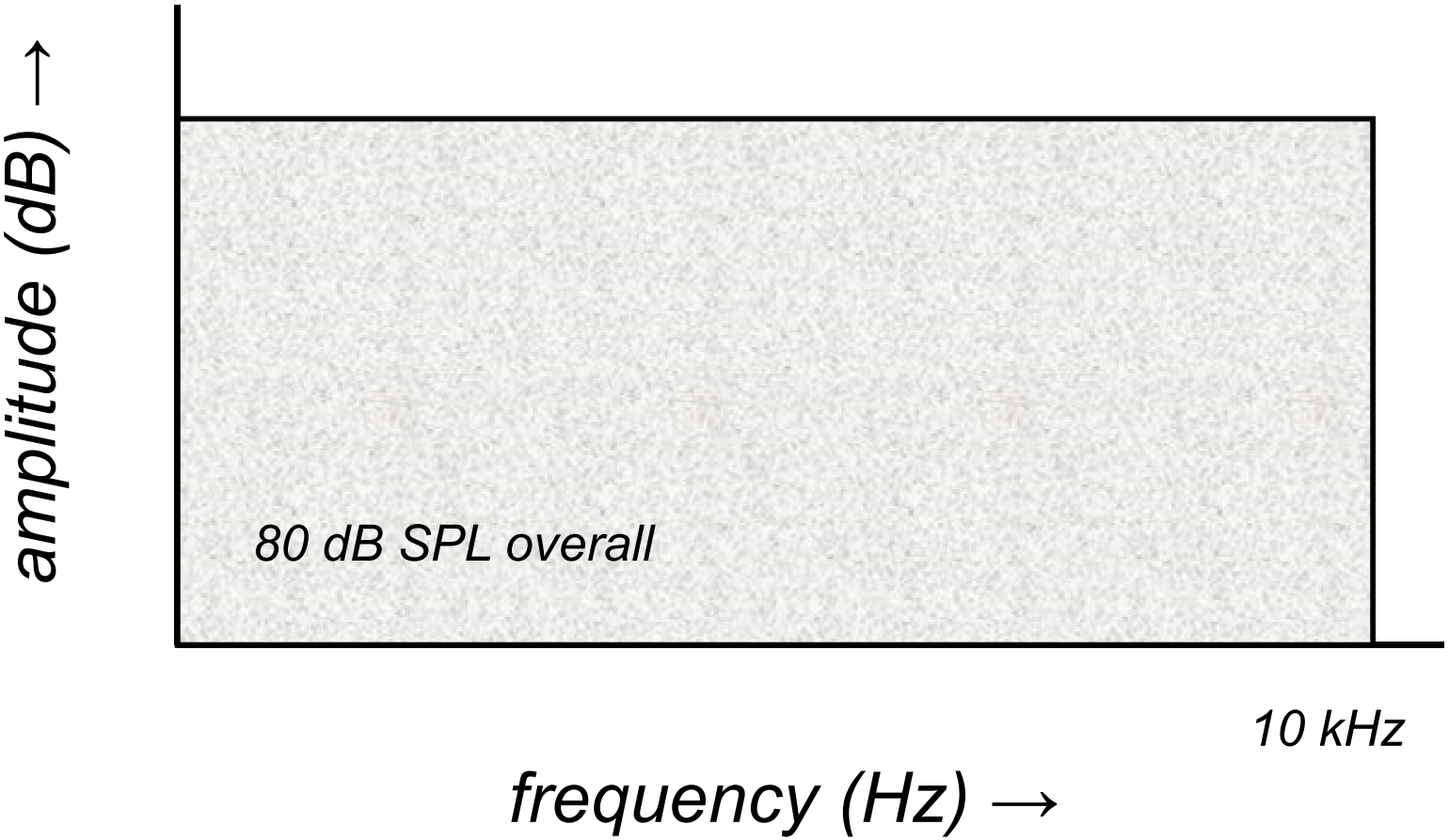
no need to worry about constant of proportionality

$$\sqrt{0.7072^2 + 1^2} = \sqrt{0.5+1.0} = \sqrt{1.5} = 1.22$$

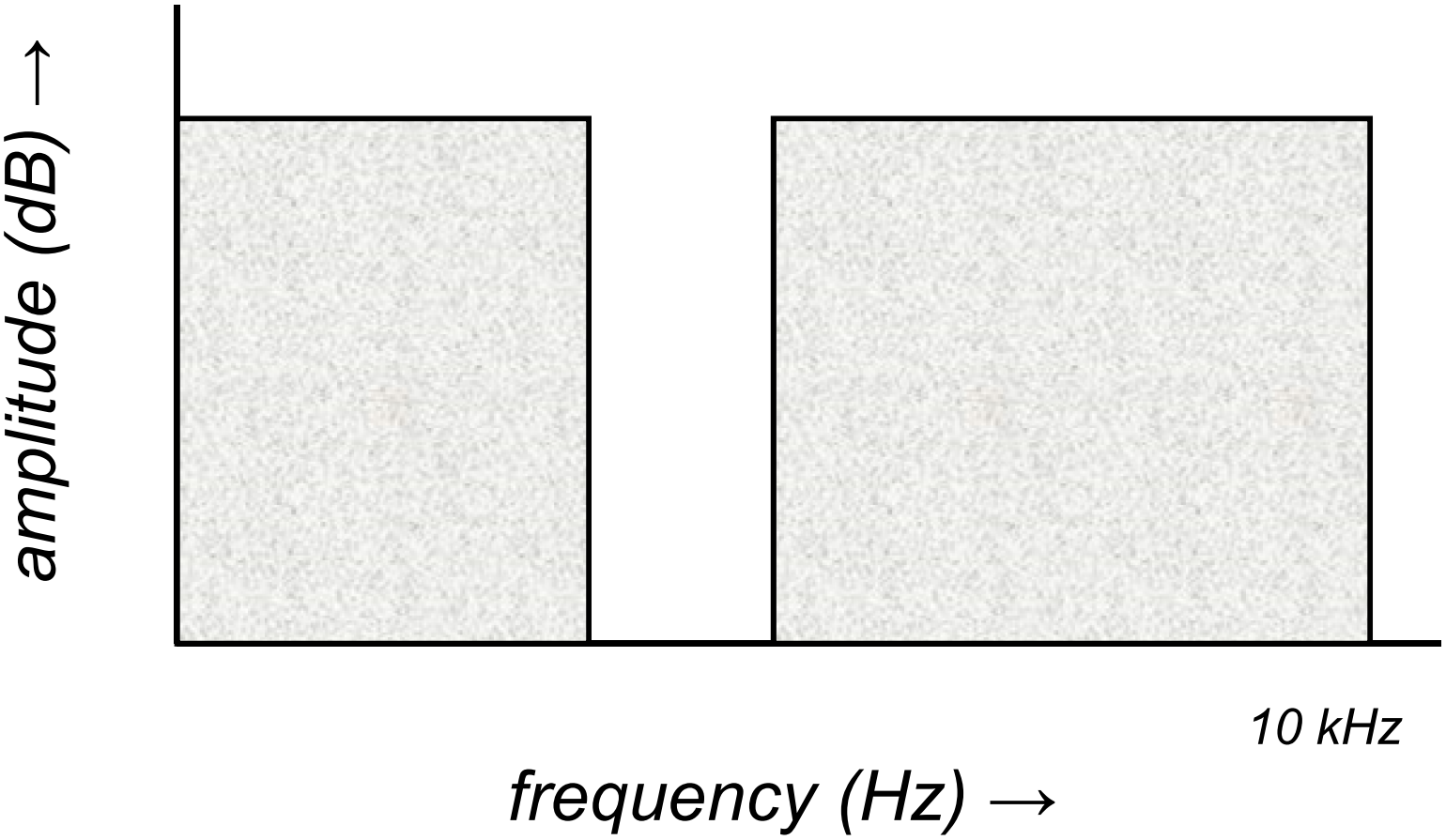
This holds true as long as the two signals *do not overlap in spectrum*

What can happen when you add a 1-V 1-kHz sine wave to another 1-V 1-kHz sinusoid?

Specifying levels for noises: signals with *continuous* spectra



Specifying levels for noises: signals with *continuous* spectra



40 dB SPL spectrum level

Specifying levels for noises signals with *continuous* spectra

- spectrum level
  - measured within a 1 Hz band
- overall level
  - summed over the whole spectrum
- converting between measures has to be done in terms of *power*, not amplitude.

Converting between measures

- Suppose the spectrum level of noise was 40 dB SPL
  - measured within a 1 Hz band
- What would be the overall level of a noise ranging from 100 - 1100 Hz?
- Convert 40 dB SPL to intensity, then add together 1000 times (multiply by 1000)
- overall = spectrum level + 10 log(BW)
  - here, 40 + 10 log(1000) = ?
- spectrum level = overall - 10 log(BW)

Signal-to-Noise Ratio (SNR)

- Literally …
  - rms level of signal/rms level of noise
- usually expressed in dB
  - $20 \log_{10}(\text{signal/noise})$
- Nothing implied about the form of the signal or noise
  - the signal is what you are interested in (*e.g.,* a tone, a band of noise, a word, a sentence)
  - the noise is everything else (*e.g.,* a tone, car noise, speech from other people)

Various SNRs for a sentence in speech-shaped noise

SNR of +40 dB? 

SNR of -40 dB? 

SNR of 0 dB? 

Intelligibility for a particular SNR depends on many factors

SNR of -10 dB for speech-shaped noise

SNR of -10 dB for a single male talker in the background