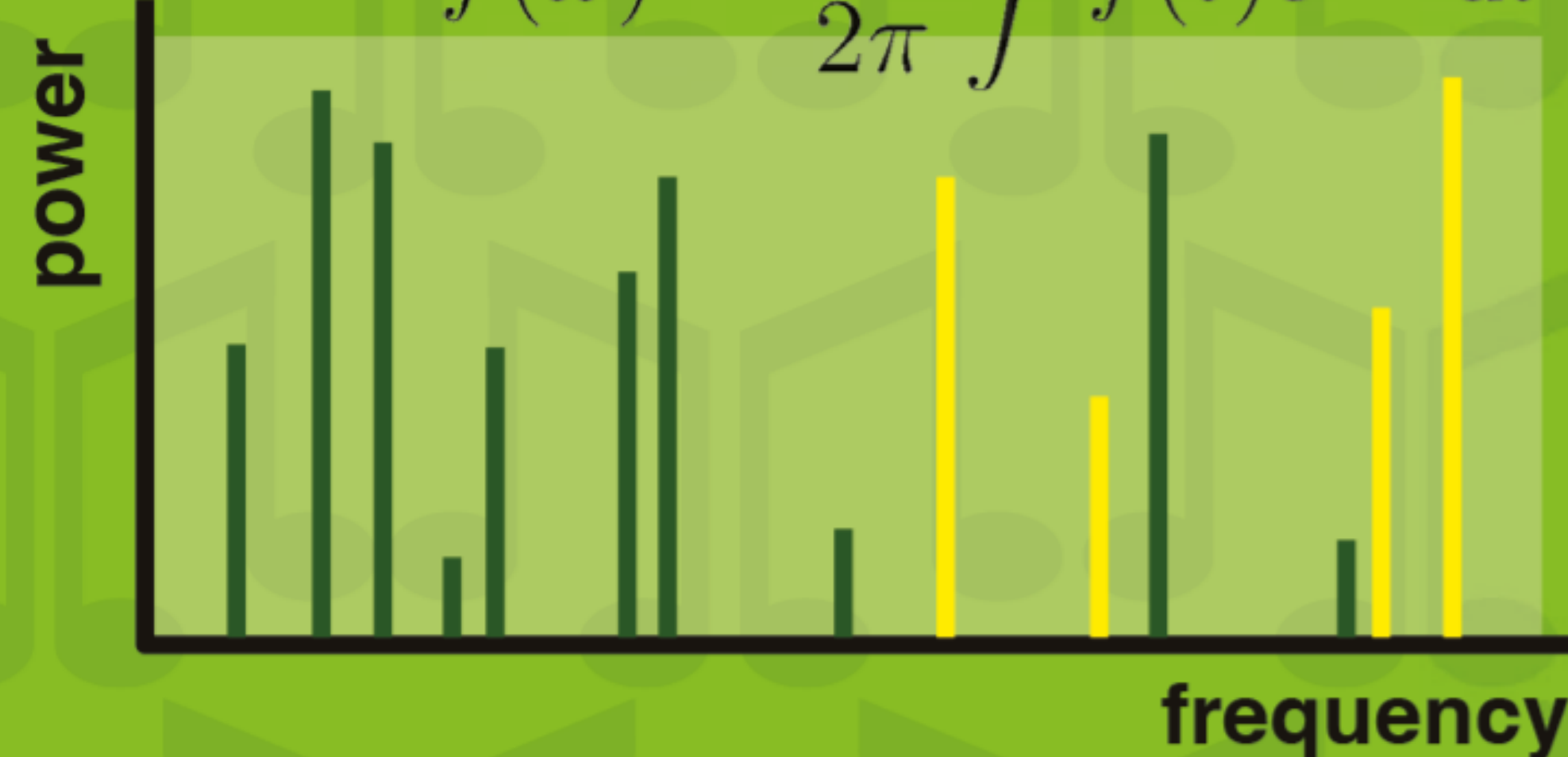
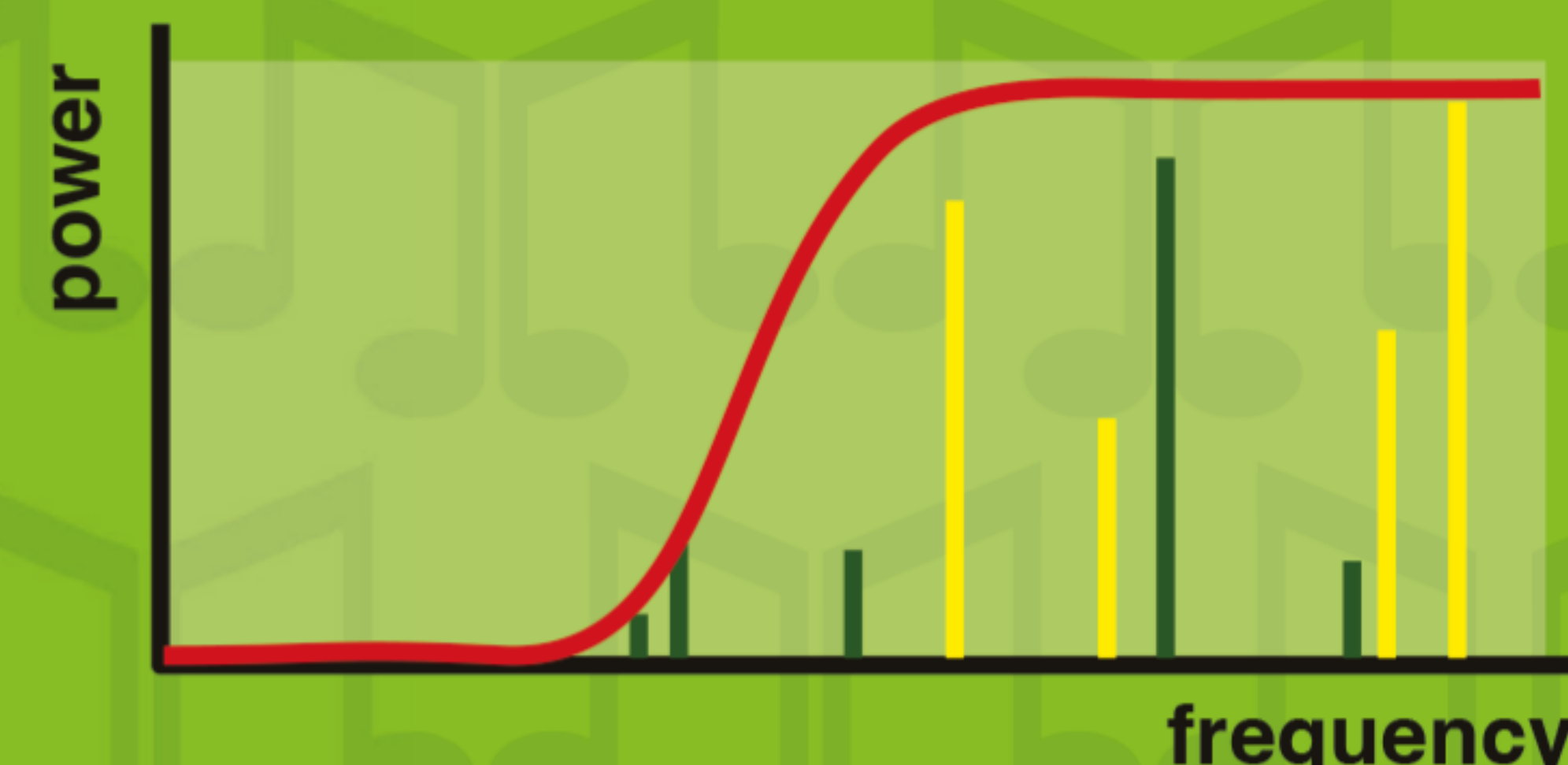
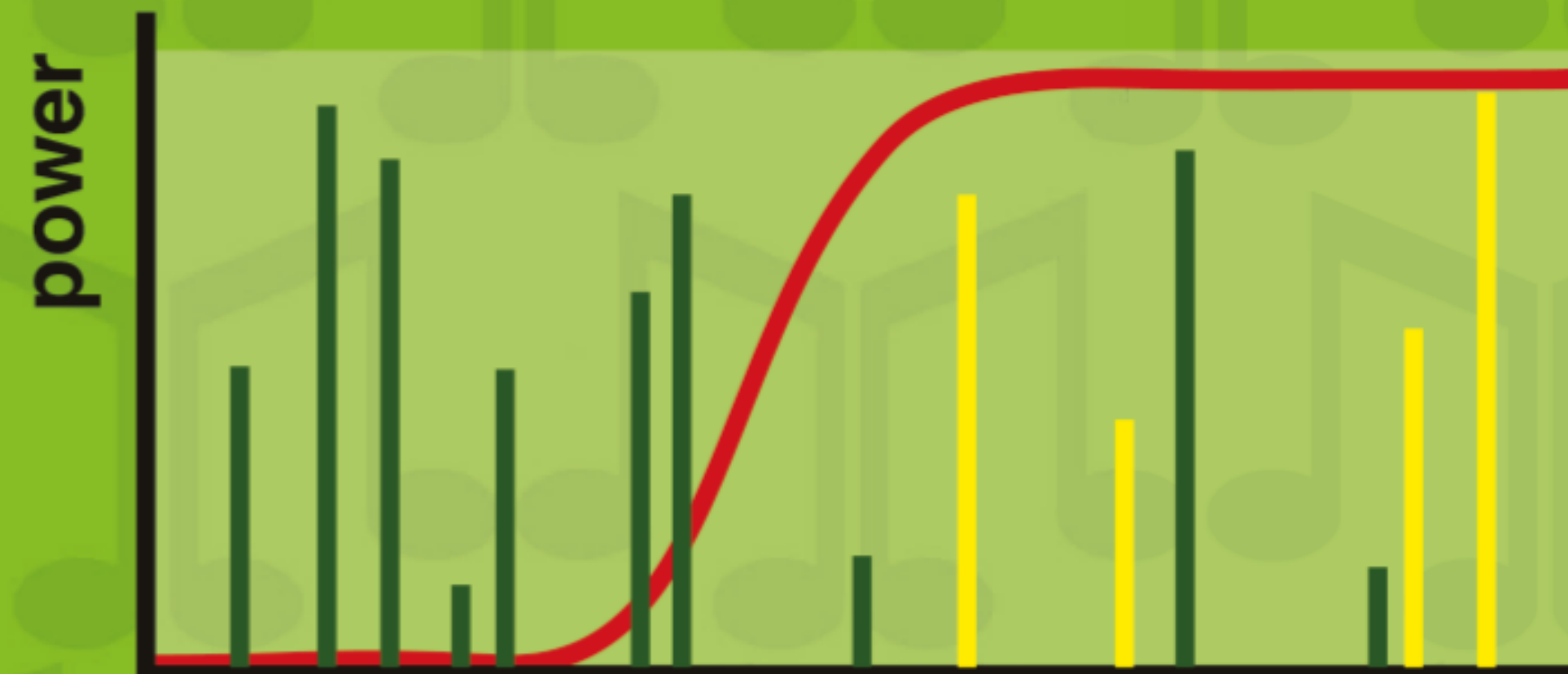


1. Fourier transform

$$f(\omega) = \frac{1}{2\pi} \int f(t)e^{i\omega t} dt$$

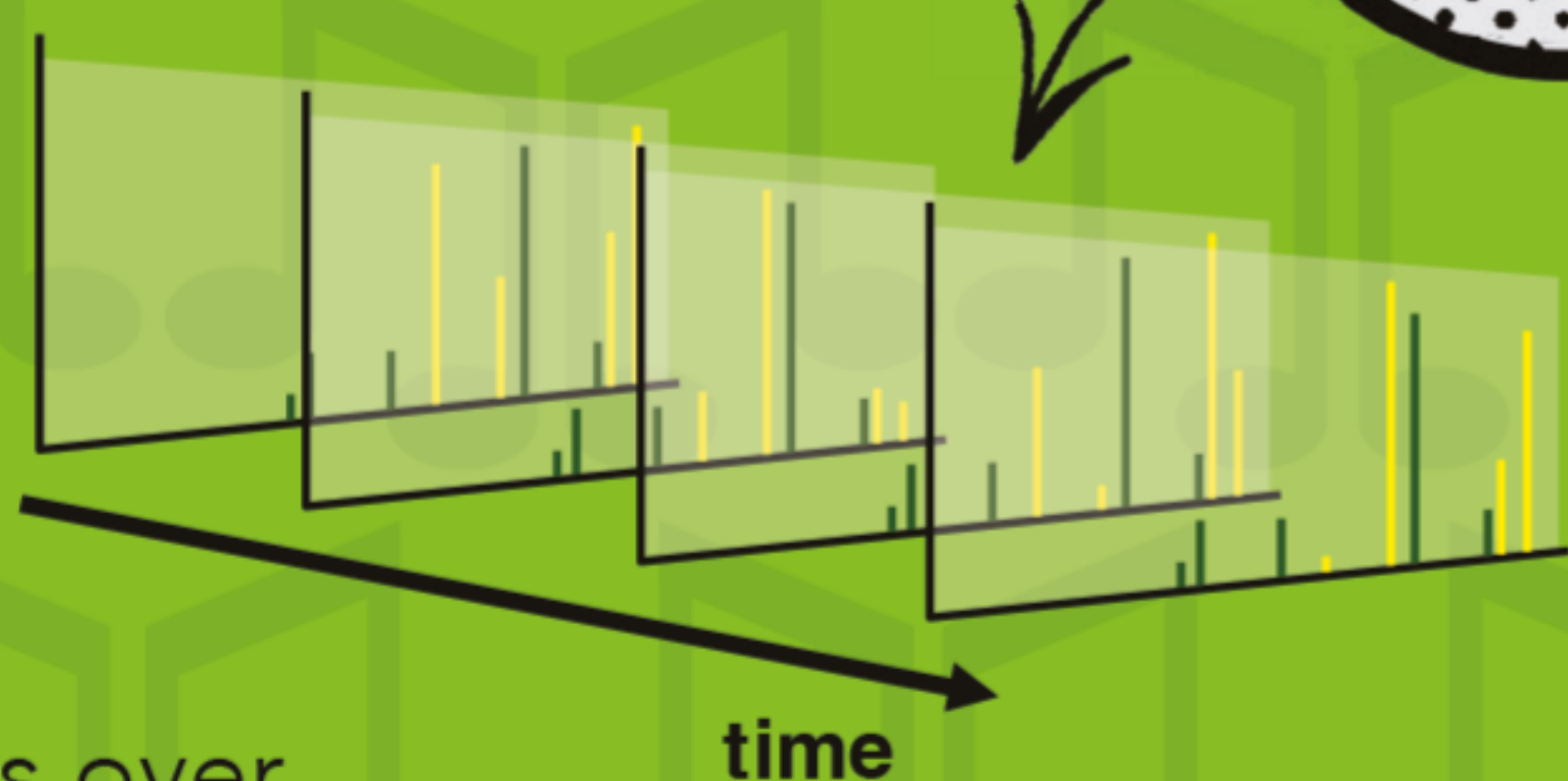


2. Passive filtering



3. Sampling

The song you're listening to changes over time regularly, whereas noise is a random sound. Being random, its time average is constant. Headphones can detect sounds that are more uniform over time, categorizing them as noise.



4. Active filtering

Although random, noise can be described by its waveform, which will most likely have a complicated shape. The last layer produces an additional sound wave whose shape is the upside-down version of that of noise. When these two waveforms overlap, they *interfere destructively*, creating silence and letting us hear the song we wanted, without environmental disturbances!



Physics of noise cancelling

Noise cancelling headphones combine passive and active techniques to reduce environmental noise and give the user a focused listening experience. With a Fourier transform (1), headphones can access frequency information of the signal and passively remove the low-frequency noise with a high-pass filter (2). The obtained sound can still contain unwanted frequencies disturbing the user's experience, which can be removed by active filters. Modern headphones can distinguish noise from signal based on their temporal behaviour (3) and produce an additional sound wave adjusted to the environmental noise. Overlapping this artificial sound to the environmental noise produces destructive interference, which eliminates all remaining noise.



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