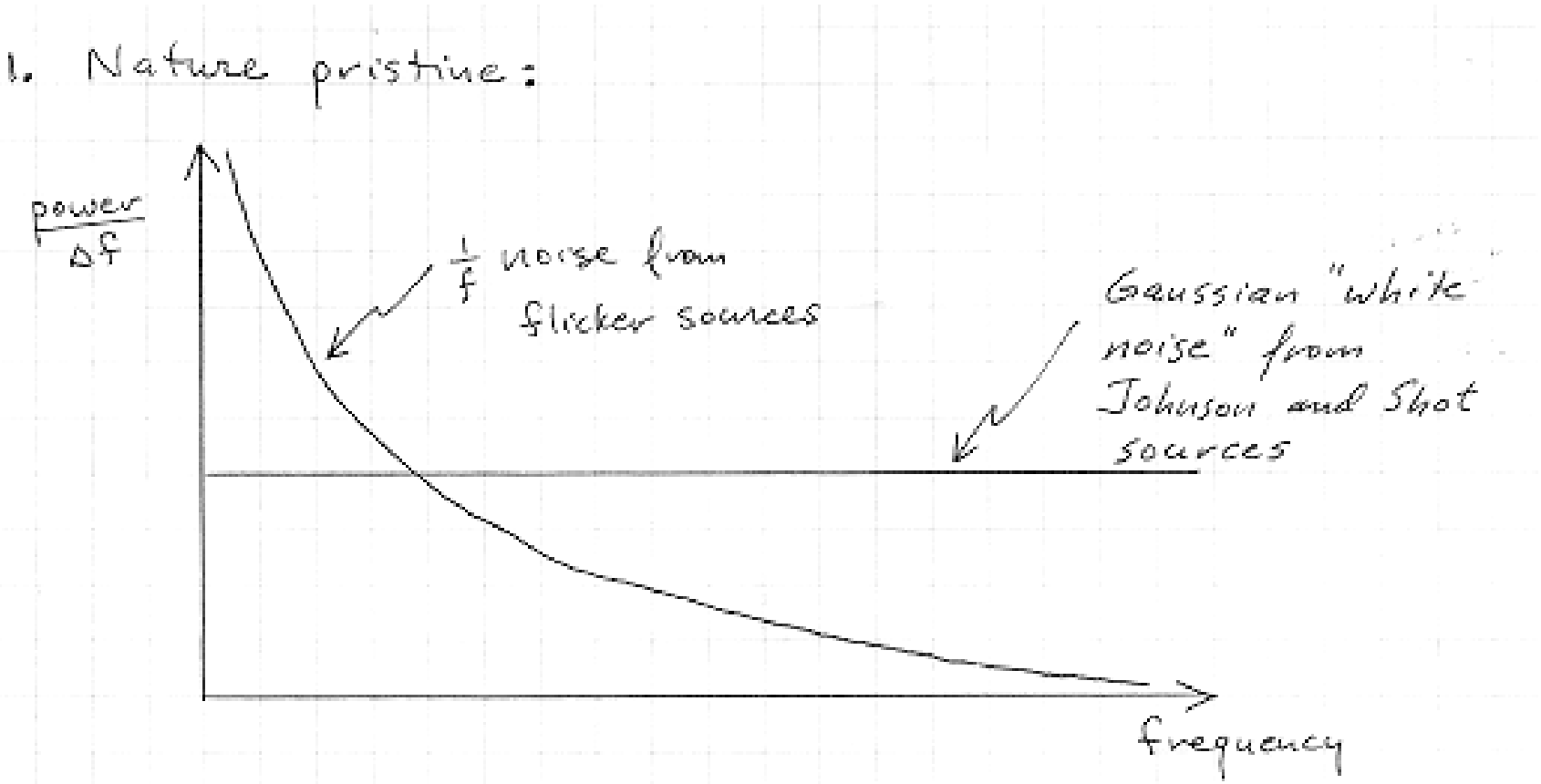
signal & noise power spectra

(illustrate some waveforms)

- using CoolEdit2000 show waveforms and Fourier Transforms of …
  - voice recording
  - 440 Hz tuning fork recording
  - generated 440 Hz tone
  - 440 Hz tone modulated at 2 Hz
  - 440 Hz tone modulated at 220 Hz
  - telephone dialing tones (pairs)
  - white noise
  - pink noise
  - brown noise

fundamental noise spectrum (pink + white)



technical noise

- terrestrial & cosmic radioactivity etc
- TV, radio, computers, etc (~MHz - ~GHz)
- rotating machinery (~KHz)
- power lines (~100 Hz)
- truck and automobile traffic (~1 Hz)
- tides (~10^{-5} Hz)
- seasons (~10^{-7} Hz)
- continental drift etc

continuum & line spectra

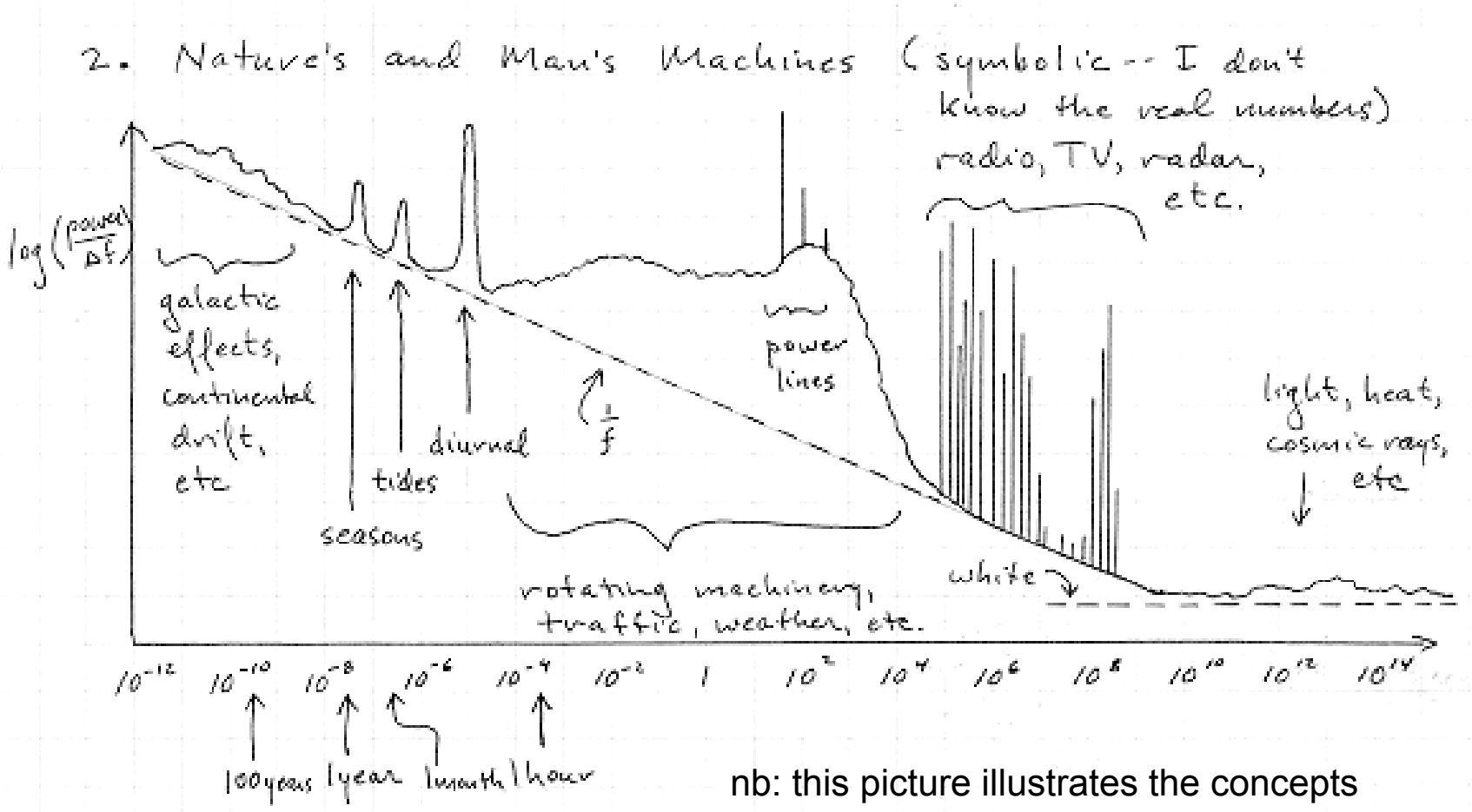
- a pure musical note has a “line” spectrum: one or a few isolated “pure” frequencies
- if signal or noise power can be extracted at any frequency – in some window – then its spectrum is a “continuum” – in that window
- in real life – just as there are no physical points or lines – there are no zero-width spectral “lines”
  - so at a fine enough level of detail “lines” are continuum spectra in very narrow windows

what determines linewidth?

- duration! (usually called “lifetime”)
  - $\Delta f \rightarrow$ linewidth (in the frequency domain)
  - $\Delta t \rightarrow$ duration (in the time domain)
  - $\Delta f \, \Delta t \geq 2 \pi$ (“uncertainty principle”)
    - $\geq \rightarrow \cong$ if envelope is Gaussian
- if a signal changes rapidly
  - either in its “interior” (it is a “pulse”) or
  - because it is “externally” turned on and off

  it must have a wide frequency spectrum
- compare: low-power CW lasers (“line”) and high-power pulsed lasers (“continuum”)

real noise spectrum (continuum + line)



nb: this picture illustrates the concepts but it is not quantitatively precise

assignment

11) Give two examples of technical noise with a continuum spectrum, and two examples of technical noise with a line spectrum.

-- Try to find examples that are not just pulled from the ones mentioned in the slides or in class, and try to find one example from “nature” and one from “engineering” or “man made” in each case.

topics we covered recently ...

- signal, noise, signal + noise, signal:noise
- electrical signals
  - sensor is source of charge, current, or voltage (or maybe electrical power)
  - electrical parameter of sensor changes (resistance, capacitance, inductance)
- sources and nature of noise
  - technical or fundamental?
  - line or continuum spectrum?
    - white or “colored”?

assignment

12) Read Fraden Ch. 1, Data Acquisition.

-- Identify one difference between Fraden's perspective on a topic and my perspective on it

-- Identify one topic that Fraden addresses in this chapter that I didn't address in class

13) Read Fraden Ch. 2, Sensor Characteristics.

-- What do you see in an image when the camera sensor is suffering from saturation?

-- describe two types of "resolution" that are key specifications of a digital camera's capabilities.

-- Verify the last line of Table 2.2 (show your work).