Frequency (Pitch) Fluctuations in Human Music:

A proxy for the instantaneous frequency/frequencies present in human music (and/or human speech) is the instantaneous ***rate*** $Z(t)$ $(\#/s)$ of ***zero crossings*** associated with an audio signal $V(t)$. A low frequency signal will have a small number of zero crossings per second, whereas a high frequency signal will have a large number of zero crossings per second associated with it. For human music, $Z(t)$ approximately follows the melody. Again, temporal correlations in frequency arising from moment-to-moment fluctuations in the frequencies of successive notes of the melody of a song can be obtained via the time-domain autocorrelation function $\langle Z(t)Z(t+\Delta t)\rangle$, which via the Wiener-Khintchine theorem is related to the frequency-domain PSD function $S_Z(f) = 4\int_{\Delta t=0}^{\Delta t=\infty} \langle Z(t)Z(t+\Delta t)\rangle \cos(2\pi f \Delta t)\, d(\Delta t)$. The PSD function(s) $S_Z(f)$ associated with frequency/pitch fluctuations in various kinds/types of human music, as well as for different composers & musical genres are shown below in the following four figures.

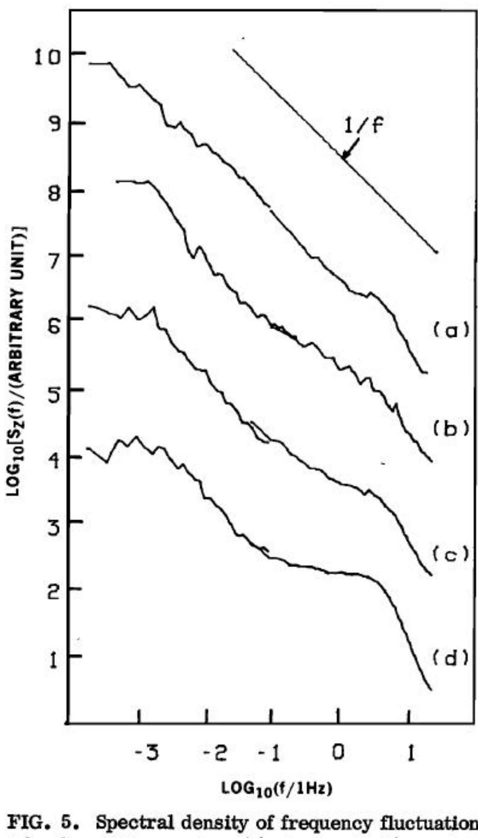

FIG. 5. Spectral density of frequency fluctuations, $S_Z(f)$ vs f for four radio stations (a) classical; (b) jazz and blues; (c) rock; and (d) news and talk.

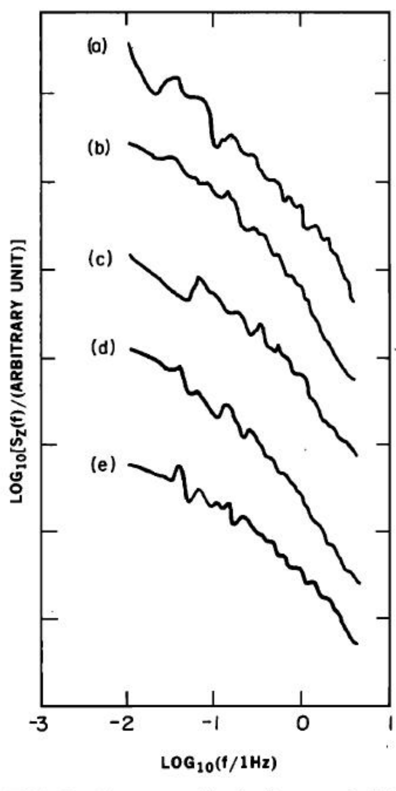

FIG. 7. Frequency fluctuation spectral densities, $S_Z(f)$ vs f for (a) Davidovsky's Synchronism I, II, and III; (b) Babbit's String Quartet number 3; (c) Jolas' Quartet number 3; (d) Carter's Piano concerto in two movements; and (e) Stockhausen' Momente.