Comment on "Fractal Model for the ac Response of a Rough Interface"

In a recent Letter[1] Liu calculates the electrical impedance of a rough interface to be $Z(\omega) \sim (j\omega)^{-\eta}$, where the exponent η is related to the fractal dimension of the interface. Liu correctly notes that the corresponding thermal (or Nyquist) voltage noise spectrum is $S_V(\omega) = 2kT\mathrm{Re}\{Z(\omega)\}$, which for the case $\eta \simeq 1$ is inversely proportional to frequency. He suggests that the so-called "$1/f$ noise" of metals and semiconductors arises from grain boundaries through such a mechanism.

The modified Nyquist noise spectrum calculated by Liu, however, cannot account for the $1/f$ noise observed in metallic thin films and bulk semiconductors. The former noise spectrum is independent of the current (in particular, is present with zero current) and has the same frequency dependence as does the impedance. In contrast, the $1/f$ noise observed in metals and semiconductors is in excess of the Nyquist noise by an amount that is proportional to the square of the current[2] (suggesting that the noise arises from resistance fluctuations that are merely monitored by the measuring current). Furthermore, $1/f$ noise is observed in conductors whose impedance and Nyquist noise are both measured to be independent of frequency, in the range of interest. To my knowledge a Nyquist noise spectrum, $S_V(\omega) \propto \omega^{-1}$, has never been observed across any homogeneous conductor. While the $1/f$ noise of metals and semiconductors may indeed be associated with grain boundaries, the mechanism is not that proposed by Liu.

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[1] S. H. Liu, Phys. Rev. Lett. **55**, 529 (1985).
[2] See, for instance, P. Dutta and P. M. Horn, Rev. Mod. Phys. **53**, 497 (1981).

