The Fourier transform of these autocorrelation functions gives the power spectra according to the well-known Wiener–Khinchin relation. These spectra are shown in Fig. 3. For both the curve fitting and the computation of the power spectra a digital computer was used.

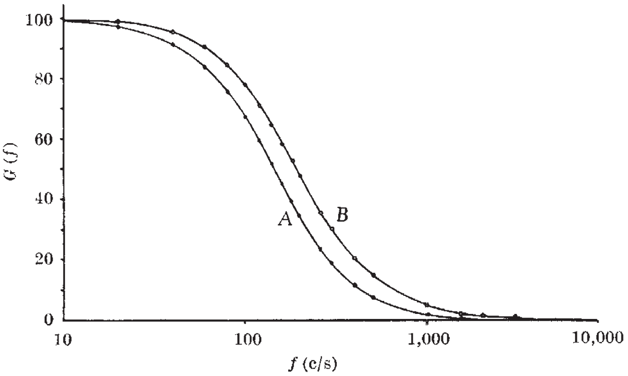

Fig. 3. Power spectra. *A*, at 20° C; *B*, at 50° C

It can be seen from Fig. 1 that the distribution of the pulse height is exponential, which seems to indicate that a multiplication process of the charge carriers takes place in the liquid. This figure also shows that increasing the temperature increases the current fluctuations. This is probably due to the resultant decrease in viscosity which in turn facilitates the motion of charge carriers in the bulk of the liquid. An inspection of the plots for the autocorrelation functions of Fig. 2 shows that no hidden periodicities are present in the random fluctuations. As can be seen from the power spectra of Fig. 3, the frequency-range of these fluctuations lies in the very low audio-frequency range. From Fig. 3 it is also clear that increasing the temperature results in an increase in the relative magnitude of the energy for all frequencies.

The experiments have shown that, as a rule, the effect of increasing the temperature or the applied stress is also to increase the relative magnitude (that is, the energy content) of the high-frequency components of the spectrum.

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Electrostatic Switching of One-dimensional Superconductors

LITTLE[1] has speculated on the possibility of synthesizing an organic superconductor; for an example he considers a macromolecule consisting of an axial long-chain 'spine' of alternately doubly and singly bound carbon atoms with a complex resonating aromatic dye type of side-chain attached to every alternate carbon atom. He argues that it is possible for the virtual oscillation of charge in this type of side-chain to provide a sufficiently attractive interaction with electrons moving in the spine for superconductivity to result. He suggests that since this is essentially an electronic oscillation coupling rather than a phonon-coupled interaction, a very high transition temperature may result and room-temperature superconductivity may be possible; the biological implications of this are, of course, of great significance.

Ferrell[2] has since questioned these predictions on the grounds that the macromolecule is essentially a one-dimensional superconductor and that restricting the BCS Hamiltonian for the interaction to one dimension must introduce compressional modes of vibration to satisfy the requirements of gauge invariance. He suggests that these modes may dominate in one dimension and prevent the establishment of the long-range order required for superconductivity. The effect of these compressional modes will be determined by the side-chain structure and the interactions between an electron travelling along the macromolecule's spine and sites in the side-chain. Little has chosen a well-screened side-chain in order to reduce these interactions. It is to be hoped that a suitable side-chain, which will allow room-temperature superconductivity, can be found.

The type of macromolecule required is essentially a long-chain organic polymer. Little considers that this might be cross-coupled to produce a web-like structure; however, it appears that preferential orientation of the molecules along the macromolecule axis would be relatively simple to synthesize by the 'nylon' spinning technique, and if coupling between molecules can then be arranged—and this is quite feasible for some organic polymers—a long thread of superconductor could be produced. The ends of a thread might also be cross-linked to form a loop.

The superconducting thread would display a strong anisotropy; it would be superconducting along its length, corresponding to the molecular axis, but normal to this direction the types of organic molecules envisaged would probably be good electrical insulators. Magnetic field effects would be very different along and normal to the molecular axis, but it is of even greater significance that it would be possible to maintain an electric field in the superconductor.

The effect of an electric field applied across a superconducting thread will be to distort the screening effects of the side-chain and to modify the wave functions of the side-chain given by Little; the side-chain interaction will be altered and superconductivity will eventually be destroyed.

There is, therefore, the possibility of electrostatically switching a one-dimensional superconductor into its normal resistive state as well as the customary magnetic switching effects.

The matrix elements of the interactions considered by Little are in the range of 1 eV. The order of magnitude of perturbing voltage required to destroy these interactions and produce switching will probably be a small percentage of a matrix element of interaction, perhaps 10 mV. The chain diameter of the macromolecule considered by Little is 30 Å, so that the critical electric field would be of the order of 33,000 V/cm—this could be very convenient for electronic switching applications; much more so than magnetic switching in all probability, since this would probably require extremely high magnetic fields.

An even more interesting speculation is that the sort of switching voltages required, if small superconducting memory loops of this type exist in the brain, would be quite consistent with the sorts of voltage signals known to exist in the nervous system. The type of organic macromolecular superconductor Little has suggested might provide a memory system for the brain, and interrogation or storage could be performed by electrostatic switching with voltages compatible with the nervous system. Further speculation suggests, by comparison with associative cryoelectric computer memories, that interrogation could be non-destructive.

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