take into account that at energies $\sim 5-10$ mev the free betatron and synchrotron oscillations are already sufficiently attenuated. This would be the cheapest way of eliminating the transition energy.

---

*It is necessary to remark that for the calculation of α, only that part of $\Delta p / p$ is important which corresponds to an oscillation of the momentum about some equilibrium value. We denote it by $(\Delta p / p)_{synch}$.

**By parametric resonance we mean one due to a perturbation of the gradient $\partial H_z / \partial r$; by an external resonance, one due to a perturbation of the field H_z.

[1]V. V. Vladimirskii and E. K. Tarasov, *On the Possible Elimination of the Transition Energy in Strong Focussing Accelerators*, Acad. Sci. (USSR) Press, 1955.

Translated by M. Rosen
192

Relaxation Times T_1 and T_2 in Anthracite

N. S. Garif'ianov and B. M. Kozyrev

Institute of Physics and Technology, Kazan Affiliate, Academy of Sciences, USSR

(Submitted to JETP editor March 14, 1956)
J. Exptl. Theoret. Phys. (U.S.S.R.) 30, 1160 (June, 1956)

THE authors were the first to measure the electronic para-magnetic resonance in anthracite (Ref. 1). It was found that the half-width of the absorption line in anthracite is $\Delta H = 0.7$ oersted i.e., considerably smaller than in other types of stone coals. The value $\Delta H = 0.3$ oersted was obtained for anthracite in Ref. 2. Probably the half-width varies somewhat for the different kinds of anthracite. Our last measurements on the samples of Kuzbask anthracite for the frequencies 12.25 and 22 mc gave $\Delta H = 0.5$ oersted. We wanted to determine for anthracite the time of spin-lattice relaxation, T_1. For this purpose, with the above mentioned frequencies, measurements of the degree of saturation (Ref. 3) were made for different amplitudes of the oscillating magnetic field. The magnitude of the amplitude was determined with the method previously used in Ref. 4. The method was checked on $\alpha\alpha$-diphenyl $-\beta-$ picrylhydrazyl, for which $T_1 = 6.6 \times 10^{8}$ sec; moreover, the parameter of the half-width T_2 was taken equal to 6.0×10^{8} sec in correspondence with the halfwidth of the line $\Delta H = 0.95$ oersted found for the monocrystal of the above-named free radical (Ref. 5). The magnitude of T_1 is in good agreement with the researches of Refs. 3 and 6. For the Kuzbask anthracite sample the time T_1 was equal to 12×10^{-8} sec for the core $T_2 = 11.4 \times 10^{-8}$ sec.

The theory of paramagnetic resonance in systems with large exchange interaction (Ref. 5) demands that $T_1 \approx T_2$; therefore, our result confirms the presence of strong exchange in anthracite, noted in Ref. 1.

In conclusion, we point out that for the temperature of liquid air, the relaxation time for anthracite is somewhat longer, since the saturation occurs for smaller amplitudes of the oscillating field. This is in agreement with the concept that the carriers of paramagnetism in anthracite are "broken bonds" between the carbon atoms.

---

[1]N. S. Garif' ianov and B. M. Kozyrev, J. Exptl. Theoret. Phys. (U.S.S.R.) 30, 272 (1956).

[2]A. A. Manenkov, Candidate's Thesis, Moscow, Phys. Inst. Acad, Sci. USSR, 1955.

[3]N. Bloembergen and S. Wang, Phys. Rev. 93, 72 (1954).

[4]A. I. Ryvkind, Izv. Akad. Nauk SSSR , Ser. Fiz. 16, 541 (1952).

[5]C. Hutchisson, J. Chem. Phys. 20, 534. (1952).

[6]M. M. R. Gabillard et J. A. Martin, Compt. rendu 238, 2307 (1954).

Translated by M. Polonsky
243

Concerning the Blatt, Butler, and Shafroth Paper on Superfluidity and Superconductivity Theory

V. L. Ginzburg
P. N. Lebedev Physical Institute, Academy of Sciences, USSR

(Submitted to JETP editor, February 29, 1956)
J. Exptl. Theoret. Phys. (U.S.S.R.) 30, 1151-1152 (June, 1956)

IN a series of papers, Blatt, Butler and Shafroth[1-6] concern themselves with the theory of superfluidity and superconductivity, and come forth with some far-reaching conclusions, with which it is impossible to agree. Two points stand out.[1-6] The first, associated with a consideration of the superfluidity and superconductivity of an ideal Bose gas in a vessel, has already been discussed,[7] and has only methodological significance. The second essential point – the statement concerning the finiteness of the correlation length Λ for the momenta of a pair of particles in all real systems, in contrast to an ideal Bose gas, is incorrect. The momentum correlation coefficient is introduced[3] in such a way that it is not directly applicable for momenta equal to zero, and furthermore, the problem of the correlation length is not connected in any explicit way with the properties of the matrix density (a mixed representation of this matrix, the so-called quantum distribution function is actually used,[3] see for example Ref. 8). In this connection, consideration of the matrix density

$$\rho(\mathbf{r}', \mathbf{r}) = \int \Psi^*(\mathbf{r}', q)\, \Psi(\mathbf{r}, q)\, dq$$

(see Ref. 9) brings a greater clarity to the problem. Actually, for an isotropic body (liquid)

$$\rho(\mathbf{r}', \mathbf{r}) = \rho(|\mathbf{r}' - \mathbf{r}|) \equiv \rho(R)$$

and in the usual liquids $\rho\ (R \to \infty) \to 0$. In this case the corresponding correlation length Λ' is finite (Λ' is the distance R, beginning from which one can say that $\rho = 0$). An infinite correlation length corresponds to the case where $\rho\ (R \to \infty) \equiv \rho_\infty \neq 0$, which occurs (at temperatures below the critical temperature) for an ideal Bose gas, and as follows from a series of considerations, for helium II also and for electrons in superconductors [9,10]. In the case for which $\rho_\infty \neq 0$, the Fourier-representation

$$\rho(\mathbf{k}) = \int \rho(\mathbf{R})\, e^{i\mathbf{kR}}\, d\mathbf{R}$$

contains a term $w_0\, \delta\ (k)$, which corresponds to the presence in the system of a number of particles not equal to zero, possessing momenta exactly equal to zero (we assume that the volume of the system $V \to \infty$). A difference of ρ_∞ and w_0 from zero appears as that property of a degenerate ideal Bose-gas, which establishes its superfluidity and superconductivity in the sense as given in Refs. 1, 2, 7. Thus, the statements contained in Ref. 3 denote in essence that in real systems we always find $\rho_\infty = 0$ or $w_0 = 0$. All the corresponding arguments of Ref. 3 reduce, however, to the observation that for very much larger systems it is improbable that there is present a correlation between particles at opposite ends of the system. However for any monocrystal, for example, there is a correlation between the particles independent of the dimensions so that the actual boundedness of the latter in the plane is clearly not essential; the same pertains to the "remote order" in ferromagnetics etc. Finally, it follows from Ref. 12, in a direct contradiction to Ref. 3, that the consideration weak interaction in a Bose-gas does not lead to the disappearance in ρ (k) of a term of the type $w_0\, \delta$ (k). Therefore, the existence of an analogous situation in helium II and in superconductors, although not strictly shown, is still quite possible and even almost certain (or, in any case, very probable). On the strength of what is shown above, the statement[4] on the non-equilibrium character of the superfluidity of helium II is likewise clearly unfounded, not to mention the fact that such a representation encounters other serious objections. In Ref. 6, no basis or justification is made for, nor any changes brought about, from the basic work[3,5] on the theory of superconductivity.

Comparisons between theory and experiment [6] do not change the conclusions, in particular observations[13] concerning changes in the depth of penetration of the field are linked for (no discernible reason) to a change in frequency (see Refs. 13, 14 ; in these works, experiments[13] interpreted from a different point of view do not agree with those of Ref. 6).

[1] M. R. Shafroth, Phys. Rev. 100, 463, (1955).

[2] J. M. Blatt and S. T. Butler, Phys. Rev. 100, 476 (1955).

[3] Blatt, Butler, and Shafroth, Phys. Rev. 100, 481(1955).

[4] S. T. Butler and J. M. Blatt, Phys. Rev. 100, 495 (1955).

[5] M. R. Shafroth, Phys. Rev. 100, 502 (1955).

[6] M. R. Shafroth and J. M. Blatt, Phys. Rev. 100 1221 (1955).

[7] B. L. Ginzburg, Usp. Fiz. Nauk 48, 25 (1952). Fortschr. d. Phys., 1, 101 (1953).

[8] J. L. Klimontovich and V. P. Silin, J. Exptl. Theoret. Phys. (U.S.S.R.) 23, 151 (1952).

[9] L. Landau and E. Lifshitz, *Statistical Physics*, p. 129, Gostehixdat (1951).

[10] V. L. Ginzburg and L. D. Landau, J. Exptl. Theoret. Phys. (U.S.S.R.) 20, 1064 (1950).

[11] J. L. Klimontovich Dokl. Akad. Nauk SSSR 104, 44, (1955) ; S. Nakajima, Advances in Phys. 4, 363 (1955).

[12] N. N. Bogoliubov, Izv. Akad. Nauk SSSR Ser. Fiz 11, 77, (1947); N. N. Bogoliubov and D. N. Zubarev, J. Exptl. Theoret. Phys. 28, 129 (1955); Soviet Phys. JETP 1, 83 (1955).

[13] A. B. Pippard, Proc. Roy. Soc. (London) 216A, 547 (1953).

[14] V. L. Ginzburg, J. Exptl. Theoret. Phys. (U.S.S.R.) 29, 748 (1955); Soviet Phys. JETP 2, 589 (1956).

Translated by S. Sydoriak
238