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Paramagnetic Absorption in Some Manganese Salts in Parallel Fields at Super-High Frequencies

A. I. KURUSHIN

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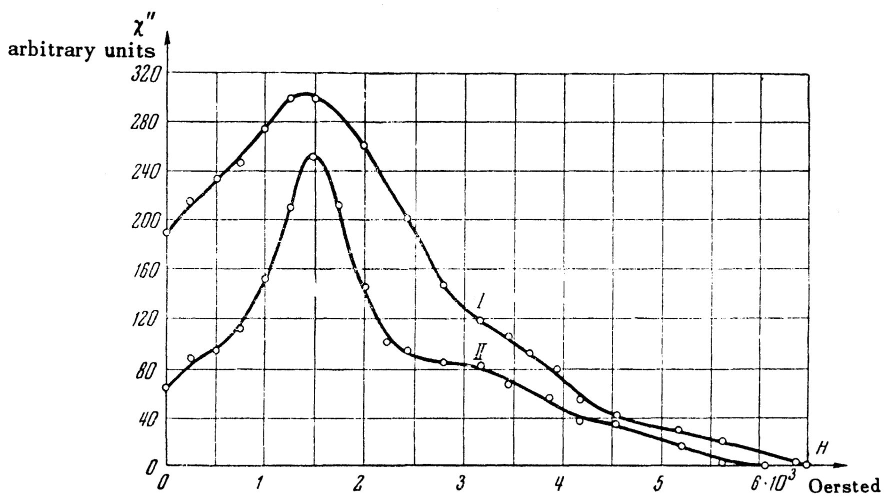
EARLIER,[1,2] WE MEASURED the paramagnetic absorption in some powdered salts of gadolinium and of manganese in parallel fields, at room temperature, at frequencies of the order of 9×10^9 cps. It was found that, as in the case of frequencies of the order of 6×10^8 cps,[3,4] the absorption decreases monotonically with increase of the constant magnetic field. The experimental absorption curves obtained in Ref. 1 to 4 are in good agreement with Shaposhnikov's[5] phenomenological theory of paramagnetic absorption in parallel fields, if it is assumed that the spin relaxation time τ_s of that theory is independent of the value of the constant field.

Recently, Smits *et al.*[6] experimentally established a more complicated type of dependence of paramagnetic absorption on the value of the constant field and on the frequency of the alternating field at temperature 20.4° K, for frequencies of order 10^6 to 10^8 cps. It was found, in particular, that the curves of absorption *vs* value of the constant field, at a given frequency of the alternating field, have a maximum.

The present note communicates the results of measurements of paramagnetic absorption in parallel fields in the powdered salts $Mn(NO_3)_2 \cdot 6H_2O$ and $Mn(NH_4)_2(SO_4)_2 \cdot 6H_2O$ at room temperature ($T = 291°K$), at frequency $\nu = 9.377 \times 10^9$ cps. The method used in the measurements is that described in Ref. 1. The results of the measurements are presented in the Figure, where curves I and II relate respectively to the first and the second of the substances indicated above. Plotted along the ordinate axis is the imaginary part of the magnetic susceptibility in arbitrary units, and along the abscissa axis the value of the constant field, which is parallel to the high-frequency field. It is evident that the absorption curves for the salts under study differ essentially from those obtained earlier for other substances;[1,2] there is an absorption maximum in a range of constant fields of order 1500 oersted. Thus our results, which relate to room temperature, are similar to the results obtained by Smits *et al.*[6] at temperature 20.4° K. In the range of fields of order 3400 oersted, the absorption curves are somewhat irregular; apparently the reason for these irregularities lies in a paramagnetic resonance absorption, caused by a slight deviation from paral-



lelism of the fields (in favor of such an explanation are the locations of the irregularities on the curves, and the fact that the irregularities increase with increase of the angle between the fields).

The results presented in Ref. 6 and in the present note can not be explained within the framework of Shaposhnikov's theory if the spin relaxation time is considered to be independent of the value of the constant field. The problem of a theoretical explanation of these results requires further study.

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On the Theory of "Strange" Particles

V. I. KARPMAN
Minsk Pedagogical Institute

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IN GELL-MANN'S THEORY,[1] which successfully describes the formation and decay of many heavy unstable particles recently discovered, the quantum number S (the strangeness) is introduced by its relation to the electric charge Q, namely

$$Q = I_3 + (n/2) + S/2, \qquad (1)$$

where I_3 is the projection of the isotopic spin, and n is the total baryon number of the system (we shall henceforth call n the nucleon charge of the system). Gell-Mann's scheme is in good agreement with experiment, though it should be complemented with a theory which gives an interpretation to the "strangeness" S.

Among the various attempts to interpret the strangeness, of particular interest is the mathematical formulation of Gell-Mann's scheme which has been suggested by d'Espagnat and Prentki[2]. These authors postulate that the particles with semi-integral isotopic spin can be described by spinors of the first and second kind[3] in isotopic spin space. These spinors differ from each other under inversion in isotopic spin space: the first are multiplied by $+i$ (or $-i$), and the second by $-i$ (or $+i$). The existing particles are called isofermions (nucleons, θ-particles, anti-Ξ-particles) and anti-isofermions (antinucleons, anti-θ-particles, Ξ). Further, it is postulated that the Lagrangian which describes strong and electromagnetic interactions (using Gell-Mann's terminology) is invariant with respect to inversion in isotopic spin space.

It is not difficult to see that the Lagrangian obtained on the basis of these assumptions is invariant under simultaneous changes of the wave functions of all iso- and anti-isofermions according to

$$\varphi \rightarrow \varphi e^{i\alpha}, \quad \varphi' \rightarrow \varphi' e^{-i\alpha}, \qquad (2)$$

where φ and φ' are the wave functions of all the iso- and anti-isofermions, respectively. From this follows a conservation law for the "isofermionic charge" u, which is equal to the number of isofermions minus the number of anti-isofermions. The isofermionic charge u differs from the nucleonic charge n in that n is conserved in all interactions, but u is conserved only in strong and electromagnetic interactions. It is then found that Eq. (1) can be written[2]

$$Q = I_3 + u/2. \qquad (3)$$

It thus follows from (1) and (3) that

$$S = u - n, \qquad (4)$$

so that the strangeness is interpreted as the difference between the isofermionic and nucleonic charges of the system.

We should like to make some remarks ,with reference to the theory of d'Espagnat and Prentki. Similarly as with the nucleonic charge, the isofermionic charge u of a single particle can take on only the values +1 (for an isofermion), −1 (for an anti-isofermion), or 0 (for an isoboson).* From this and

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*When $|u| > 1$ there arise difficulties which can be eliminated only by dropping some terms in the interaction Lagrangian[7]. In this case, however, the ambiguity that arises essentially eliminates the value of the d'Espagnat-Prentki-theory.