crystals. The paramagnetic resonance phenomenon is peculiar to the unpaired spins, and the magnetic centers result in the primary effect observed, not in a small change in the effect of the large amount of diamagnetic material present.[5,9] Paramagnetic resonance absorption will probably permit counting color centers in regions of concentration inaccessible to the optical methods.

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Disintegration of Cr^{51}†

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SPECTROMETER studies made by previous investigators have established that Cr^{51} decays entirely by orbital electron capture partially accompanied by gamma-radiation. Kern *et al.*[1] list the γ-ray energies as 0.32 Mev and 0.267 Mev. Bradt *et al.*[2] find the gamma-energies to be 0.320 and 0.237 Mev, and in addition suggest that the decay proceeds 97 percent directly to the ground state, 3 percent through the 0.32-Mev excited state, and ~1 percent through the 0.237-Mev level. By use of Cr^{51} supplied by the Operations Division of the Oak Ridge National Laboratory, the branching ratio of this nuclide has been investigated with the aid of coincidence counting, x-ray counting, and NaI crystal spectrometry.

Very little β^- or e^- was found associated with the decay, in agreement with the data of Bradt.[2] By use of a helium filled tube as a negatron detector 3.0×10^{-4} e^-/x-ray disintegration was found. The x-rays observed, therefore, are essentially all from orbital capture, and no interference from a conversion process is encountered. A measured aliquot of Cr^{51} was coincidence counted using a krypton-methane filled, thin end window, β-proportional counter as an x-ray detector and an anthracene crystal counter as a γ-detector. X-ray γ-coincidence data were taken as a function of Be absorber placed before the x-ray counter. The disintegration rate of the source so measured was calculated and found to be constant and independent of Be absorber.

A source of Mn^{54}, the disintegration rate of which was known through coincidence counting and ion chamber measurements, was used to determine the efficiency of a Kr-methane counter for Cr K x-rays. (2.29A). A measured aliquot of Cr^{51} (V x-rays, 2.50A) was then counted on this counter, and using the previously determined efficiency, the disintegration rate of the Cr^{51} was obtained. Agreement between this value and that obtained by coincidence counting was within 3 percent. A source of Cr^{51} of known disintegration rate was then placed on a previously calibrated NaI crystal scintillation spectrometer and the gamma-spectrum of this nuclide was obtained. The presence of only one gamma-ray of energy 0.32 Mev was observed. The area beneath this gamma-peak was obtained and multiplied by an appropriate efficiency factor. This total corrected area in disintegrations per minute was then compared to the known decay rate of the sample and the branching ratio obtained. Eight percent of the Cr^{51} disintegrations were found to proceed through the 0.32-Mev excited state. Sunyar[3] has recently stated that the lower energy γ-ray reported by workers can be ascribed to impurities. A preliminary figure ~10 percent branching has been given by him. Decay of a Cr^{51} source has been followed for five half-lives on both a GM counter and an ion chamber. A value for the half-life of 27.75±0.3 days is indicated.

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Similarity Properties of the Two-Fluid Model of Superconductivity

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RECENT measurements[1–3] on superconducting tin isotopes have shown that the threshold curves for the different isotopes are all of the form, $H_c=H_0(T/T_c)$, where H_0 is the critical field at absolute zero of temperature and T_c is the zero-field transition temperature. These form a family of geometrically similar curves, that is, a uniform expansion or contraction of scale transforms one into another. As a consequence of this fact, it can be shown[3] that the corresponding electronic entropies of the superconducting state, $S_{s(\mathrm{el})}(T)$, are also geometrically similar functions of the form

$$S_{s(\mathrm{el})}=\gamma Tf(T/T_c), \tag{1}$$

where γ is a parameter and $f(T/T_c)$ a function, both of which are invariant with respect to the isotopic mass. The function is represented within experimental error by either a polynomial in T/T_c or by a single term of the type $(T/T_c)^n$, where n is a positive but not necessarily integral number. This result is significant because it is consistent with features of the two-fluid model of a superconductor not previously subjected to experimental test.

In the two-fluid model proposed by Gorter and Casimir,[4] the electron assembly is visualized as consisting of two phases, a "gaseous" phase of normal electrons having the properties of a Sommerfeld electron gas and a "crystallized" phase of superconducting electrons in a lower energy state. It is assumed that the normal fraction alone contributes entropy and that the superconducting fraction has zero entropy. The fractional concentration of normal electrons x varies continuously from zero to unity as the temperature goes from zero to T_c. The free energies and entropies of the two electron "phases" are given by

$$F_g=\tfrac{1}{2}\gamma T^2x^\alpha;\quad F_c=-\beta(1-x); \tag{2}$$

$$S_g=\gamma Tx^\alpha;\quad S_c=0. \tag{3}$$

The subscripts g and c refer to the "gaseous" and "crystalline" phases, respectively, and $\beta=(H_0^2/8\pi)V_m$, the molar free energy difference between the normal and superconducting states at the absolute zero, (V_m is the molar volume) and γ has the usual significance as the coefficient of T in the electronic entropy of a Sommerfeld electron gas. α is a parameter, characteristic of the metal but not given by the theory. (Empirically it is found that $\alpha\sim\frac{1}{2}$.) The condition that the total free energy of the electron assembly be a minimum determines the temperature dependence of x as

$$x=(H_0^2V_m/4\pi)^{1/(\alpha-1)}T^{-2/(\alpha-1)}. \tag{4}$$

This two-fluid model was originally proposed to explain some of the thermodynamic properties which had been observed in real superconductors. These are the facts: that the free energy difference between the normal and superconducting states vanishes at T_c, and that the electronic entropy of the superconducting state varies as (approximately) the third power of temperature and contains no term linear in the temperature. In addition to these, however, it may be shown that the model also implies the simi-