defined by the transformation group. It is difficult to imagine how any condition could arise to limit the size of the body in such a treatment if the group possessed infinitesimal elements, and so could describe rotations with infinitesimal angular velocity.

Although this version of the rotation problem underlay my earlier attack, I have not yet been able to give it an acceptable solution, and may take this occasion to pose it as one needing an answer.

[1] N. Rosen, Phys. Rev. **71**, 54 (1947).
[2] E. L. Hill, Phys. Rev. **69**, 488 (1946).

Remarks on C. Frondel's Letter: "Elastic Deficiency and Color of Natural Smoky Quartz"

K. PRZIBRAM
II. Physical Institute, The University, Vienna, Austria
January 27, 1947

HAVING just seen C. Frondel's interesting letter[1] I should like to make two remarks.

1. Anomalies after irradiation with radium and x-rays have also been observed in the piezoelectric constant of quartz, this constant in some cases being increased by irradiation.[2]

2. The fact that the natural color of smoky quartz is more stable than the color produced artificially in irradiated quartz does not contradict the theory that this natural color is of radioactive origin.

As I have frequently pointed out, only the most stable color and luminescence centers will be produced in nature owing to the very small intensity of the radiation acting during long periods, as compared with the strong artificial irradiation during a short time. I have called this "the principle of natural selection of the most stable."[3]

That colorless or relatively light colored bands in natural smoky quartz are more deeply affected by artificial irradiation shows that they contain more unstable centers than stable ones.

[1] C. Frondel, Phys. Rev. **69**, 543 (1946).
[2] J. Laimböck, Wien. Anz. (May 18, 1928); F. Seidl, Wien. Ber. IIa, **142**, 467 (1933); F. Seidl and E. Huber, Zeits. f. Physik **97**, 671 (1935).
[3] K. Przibram, Zeits. f. Physik **68**, 413 (1931).

The Magnetic Quenching of Superconductivity

M. J. SIENKO AND R. A. OGG, JR.
Department of Chemistry, Stanford University, California
February 1, 1947

THE only previously expressed generalization regarding temperature dependence of magnetic threshold fields for super conductors[1,2] appears to be the often-quoted statement that the functional relation is roughly parabolic for a given substance. It has been noted that the curves for mechanically "soft" elements (as well as for a few alloys) tend to display smaller initial slopes than those for "hard" elements (and most alloys) of similar upper critical temperature (*vide* infra). More careful examination of the threshold curves for the "soft" superconductors Pb, Hg, Sn, In, Tl, CuS, Au_2Bi, Zn, and Cd indicates that each is reproduced with remarkable accuracy by a law of the form $H_T=A(T_C^{\frac{3}{2}}-T^{\frac{3}{2}})$. Here T_C represents the upper critical temperature—i.e., at zero field, whereas T represents the critical temperature in a longitudinal field of H_T gauss. A remarkable generality is indicated by the fact that the parameter A is found to have nearly the same value for all of the substances listed, the deviations being of the same order as those for the individual curves. For the initial slope at $T=T_C$, one derives

$$(dH_T/dT)_{TC}=-\tfrac{3}{2}AT_C^{\frac{1}{2}}.$$

The practical identity of A for the various substances is most readily verified by use of this corollary law, since the initial slopes are generally measured with greatest accuracy. For the listed substances (with a range of T_C from 7.26 to 0.54°K) the average value of A is some 50 gauss-degree$^{-\frac{3}{2}}$, with a mean deviation of only a few percent. Studies of thin films and wire, as well as of colloidal particles[1,2] of "soft" superconductors, have shown the threshold fields to increase for sufficiently small linear dimensions, by a factor which is the greater, the closer the approach to the critical temperature. This suggests that mechanical sufficient to cause a micro-lamellar, fibrous, or mosaic structure in a massive sample should result in serious deviations from the above law—in the sense of an increase in the parameter A, differentially greater the higher the temperature. The threshold curves for the few "hard" superconductors subjected to careful study seem to bear some such relation to those of "soft" superconductors of similar upper critical temperature, the ratio of initial slopes being much greater than the ratio of extrapolated threshold fields at the absolute zero. It is proposed that the above law represents the limiting "ideal" behavior for a truly homogeneous specimen of macroscopic dimensions. The apparent exceptions displayed by the more numerous class of "hard" superconductors are attributed to irreducible structural inhomogeneities on a micro-scale. The incompleteness of the Meissner effect (expulsion of magnetic flux) in typical "hard" superconductors is further evidence of such structural inhomogeneities.

A law of such simplicity as the above suggests that the electronic nature of the superconducting state may prove to be simpler than has usually been proposed. In particular, a satisfactory model must presumably allow the experimental value of the parameter A to be found by combination of universal constants only.

[1] E. F. Burton, H. Grayson Smith, and J. O. Wilhelm, *Phenomena at the Temperature of Liquid Helium* (Reinhold Publishing Corporation, New York, 1940).
[2] D. Shoenberg, *Superconductivity* (Cambridge University Press, 1938).

Decay of Mesons Stopped in Light Materials

T. SIGURGEIRSSON AND A. YAMAKAWA
Palmer Physical Laboratory, Princeton University, Princeton, New Jersey
February 8, 1947

WE are carrying out an experiment to observe the decay of mesons stopped in different light materials. The preliminary results seem to indicate that there are more decay electrons emitted for each stopped meson if the meson is brought to rest in material of low atomic number than if it is stopped in aluminum or some material with a higher atomic number.

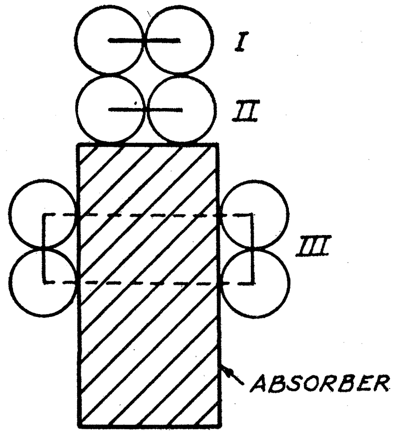

FIG. 1. Experimental arrangement.

The experimental arrangement is shown in Fig. 1. The moderator is 2″×4″×14″. The G-M counters for detecting the mesons and the decay electrons all have 1″ diameter and 12″ sensitive length. The mesons entering the absorber are observed as a double coincidence in counter trays I and II. The decay electrons coming out from the absorber are detected in counter tray III containing four counters.

Absorbers of the following materials have been used: Be, C, NaOH, Al, SiC, and S. The decay curves for the different absorbers are still rather inaccurate and do not show any definite disagreement with a mean life of 2.2 μsec.

To compare the number of decay electrons from the different absorbers, we count the number of impulses from counter tray III that are delayed between 1 and 6 μsec. with respect to the coincidences I×II. The most reliable results come from a comparison of beryllium and sulphur absorbers of equal stopping power. The same number of mesons will be stopped in both, and in both cases the same fraction of the decay electrons will be stopped in the absorber before reaching the counters. We have counted the delay pulses with and without absorber, changing absorber every day. An 8-day long run gives the result of Table I.

Similar runs have been made for other absorbers. The

TABLE I.

Absorber	Be	S	None
Mass	3290 g	3440 g	
Relative stopping power per g/cm^3	1.05	(1.00)	
Relative number of mesons calculated to be stopped	1.00	(1.00)	
Delayed counts	219	213	29
Time of observation	58 hr.	84.3 hr.	44 hr.
Counts per hour corrected for background	3.12±0.18	1.87±0.10	
Relative number of disintegrations for equal number of mesons stopped	1.67±0.14		
Ratio of total number of mesons at sea level to number of positively charged mesons[a]	1.8		

[a] D. J. Hughes, Phys. Rev. 57, 592 (1940).

TABLE II.

Absorber	Al	C	NaOH	SiC
Mass	4680 g	2730 g	3440 g	3780 g
Counts, corrected for background, and reduced to equal numbers of mesons stopped	(1.00)	1.7±0.2	1.4±0.1	1.0±0.1

results are given in Table II. To get the ratios for the number of emitted decay-electrons the figures of Table II have to be corrected for the absorption of the decay-electrons. The detailed evaluation of this effect has not yet been completed, but the ratio will have to be reduced by an amount estimated to be roughly of the order of 20 percent for C and 10 percent for NaOH and SiC.

The present results confirm the findings of Conversi, Pancini, and Piccioni,[1] that negative mesons absorbed in carbon emit decay-electrons whereas no decay-electrons are observed if they are absorbed in iron. The absence of decay-electrons is easily explained by assuming that the negative mesons are captured by the nucleus.[2]

Our results indicate that the capture probability (*a*) increases gradually with increasing atomic number, but (*b*) disagrees completely in absolute value with the predictions[2] of the meson theory of nuclear forces.

This work has been supported by Navy Bureau of Ordnance Contract 7920 with Princeton University. We are indebted to the Radio Corporation of America, Princeton Laboratories, for development of a special time measuring and recording device used in these experiments, which are continuing and will be further reported.

[1] M. Conversi, E. Pancini, and O. Piccioni, Phys. Rev. 71, 209 (1947).
[2] S. Tomonaga and G. Araki, Phys. Rev. 58, 90 (1940).

Mechanism of Capture of Slow Mesons[1]

JOHN A. WHEELER
Palmer Physical Laboratory, Princeton University, Princeton, New Jersey
February 8, 1947

THE Rome group[2] observe that negative mesons stopped in carbon undergo radioactive decay but that those stopped in iron do not. The measurements of Sigurgeirsson and Yamakawa[3] indicate (1) that for other light elements the probability of nuclear capture is likewise small, relative to the probability of radioactive decay ($1/\tau_0 = 1/2.15\times10^{-6}$ sec.); and (2) that the ratio of the two transition probabilities rises with atomic number, passing through the value unity for an atomic number, Z_0, probably in the neighborhood of $Z_0 \sim 10$.

It follows from these observations that the time required for nuclear capture in light elements is 10^{-6} sec. or more, far longer than the time taken by the meson to reach its lowest Bohr orbit about the nucleus *via* radiation and Auger effect.[4] Consequently it is only for a negative meson *moving in a K-orbit* of a nucleus of charge Z_0 that nuclear capture and normal radioactive decay must be considered to have the same probability. For mesons in higher orbits