magnetic field. The results for tin and thallium suggested that one should seek other properties that are very nearly alike for these two elements with the hope that some general empirical relation might be obtained. It was found that the ratio of T_c/Θ, where Θ is the Debye characteristic temperature, was very nearly the same for tin and thallium. Combining this information with the relation previously given by Steele[2]

$$E_0=\gamma T_c^2/3e \tag{1}$$

(where γ is the electronic specific heat in the normal state, e is the electronic charge, and E_0 is the value of E at the absolute zero of temperature) suggested that

$$E_0\sim(T_c/\Theta)^2 \tag{2}$$

and

$$\gamma\sim\Theta^{-2}. \tag{3}$$

The γ appearing in Eq. (1) may not be identical to the γ determined from equilibrium phenomena such as specific heat.[1]

The correlation indicated by Eq. (2) can be tested by the recent thermoelectric data. In Table I the pertinent data is given for

TABLE I. Data for the superconductors.

Element	$E_0\times10^3$ volts	T_c°K	Θ°K	$(E_0\Theta^2/T_c^2)\times10^3$ volts
Lead	59.0	7.26	90[a]	9.1
Indium	10.4	3.41	106[b]	10.0
Tin	5.5	3.72	150[c]	9.0
Thallium	5.5	2.40	96[a]	8.8

[a] J. de Launay and R. L. Dolecek, Phys. Rev. **72**, 141 (1947).
[b] Value calculated from data of J. R. Clement and E. H. Quinnell, Phys. Rev. **79**, 1028 (1950), by assuming that the specific heat in the normal state can be represented by a T^3 law plus a linear term in T.
[c] Value calculated from the combined data of W. H. Keesom and P. H. Van Laer, Physica **5**, 193 (1938); and W. H. Keesom and J. N. Van den Ende, Proc. Acad. Sci. Amst. **35**, 143 (1932); by assuming that the specific heat can be represented by a T^3 law plus a linear term in T.

lead, indium, tin, and thallium. It is seen that the values of $E_0\Theta^2/T_c^2$ for the particular elements are less than 10 percent different from the mean value of 9.2×10^{-3} volt. In the light of the experimental limitations on the value of E_0 (reported[1] as subject to an error of the order of 10 percent) and the spread in possible values of Θ, it is felt that the data for these four elements substantiates the correlation given by Eq. (2).

Preliminary measurements with mercury ($T_c=4.16$°K) have shown that E_0 for that element is about 250×10^{-3} volt. In order that this be consistent with the results for the other elements and the relation given by Eq. (2), it is necessary that Θ for mercury should be about 25°K. Although this Θ is very much smaller than the value obtained from specific heat measurements ($\Theta=96$°K), it is in fair agreement with the value given by resistance measurements ($\Theta=37$°K).

Additional thermoelectric measurements are needed to test Eq. (2) further. For example, aluminum, with a $\Theta\sim400$°K, would have $E_0\sim10^{-9}$ volt if Eq. (2) were applicable. Such measurements are now in progress at this Laboratory. The results will be reported at a later date.

[1] M. C. Steele, Phys. Rev. **81**, 262 (1951).
[2] M. C. Steele, Phys. Rev. **78**, 308 (1950).

Further Search for Nuclear Transitions with Lifetimes between 3×10^{-9} sec and 10^{-7} sec*

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THE method of delayed coincidences has been utilized in a search for nuclear metastable states with lifetimes less than 10^{-7} sec. Scintillation counters, using stilbene or anthracene with RCA 5819 photomultiplier tubes, were used with wide band amplifiers of a design due to Elmore and a fast electronic coincidence circuit. Under favorable circumstances a half-life of 3×10^{-9} sec could be detected with this apparatus. In most cases studied, the lifetimes were too short to be measured by this apparatus, and only upper limits could be set. Typical curves of coincidence counting rate *vs* delay and some of the results have been reported previously.[1]

Coincidence absorption studies were undertaken in order that an upper limit on the half-life of a specific transition might be set, even though only prompt coincidences were observed. The detectors were so arranged that both single- and double-channel coincidence absorption experiments could be conducted. Electromagnetic radiation was identified by comparing the observed half-thickness values with the curves published by Glendenin.[2] For the identification of electronic radiation, an empirical range-energy curve was constructed from the observed absorption curves for Dy^{165}, Re^{188}, and Au^{198}. These isotopes were selected because of the simplicity and well-known character of their decay schemes, and because of the wide range in energy of their radiations. In most cases, a determination of the energy and reference to the literature permitted a differentiation between the preceding and succeeding radiations.

The results are summarized in Table I. Column 1 lists the

TABLE I. Observed upper limits on the half-life of excited states.

Daughter isotope	Energy (kev)	Observed $T_{\frac{1}{2}}\times10^9$ sec
Br^{80}	37	<4
Xe^{131}	82 284	<4
Gd^{152}	120 370	<3
Ho^{165}	91	<5
W^{182}	114 310	<4
Os^{188}	160	<5
Pt^{192}	240	<3
Hg^{199}	160	<3

daughter isotopes of the decays investigated. Column 2 lists the energy in kev of the transition observed. Where two energies are listed for a single isotope, it has not been possible to differentiate between the preceding and succeeding radiation. Column 3 gives in units of 10^{-9} sec the upper limits for the half-life observed for the transitions listed in columns 1 and 2.

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[1] M. Deutsch and W. E. Wright, Phys. Rev. **77**, 139 (1950).
[2] L. E. Glendenin, Nucleonics **2**, No. 1, 12 (1948).

Delayed Coincidence Angular Correlations

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WE consider the directional correlation of successive particles emitted in the nuclear cascade $j_1\rightarrow j\rightarrow j_2$, where the j's are the angular momenta of the nuclear levels, when the source is placed in a constant homogeneous magnetic field. The existence of remarkable nuclear spin phase memory phenomena[1] in nonparamagnetic solutions leads one to believe that it might be possible to determine the gyromagnetic ratio of the intermediate