Mo-Tc region. The γ-ray of lower energy was twice as abundant as that of higher energy in agreement with Huber *et al.*[4] In addition, conversion electrons of ~180-kev energy were observed (visual range 40 mg Al/cm^2). The predominantly greater yield of this 50–60-day Tc activity from Mo enriched in Mo^{95} supports its assignment to Tc^{95}.

90-day Tc. Our earlier work[5] on the approximately 90-day Tc had indicated its assignment to mass 97. It was to be expected, then, that a *d,2n* reaction would give the greatest yield of Tc^{97} when carried out on Mo enriched in Mo^{97}. This result was actually found and confirms the assignment of the 90-day Tc. Soft electrons of ~85-kev energy ($\tau\frac{1}{2}=1.5$ mg Al/cm^2), and 17–18-kev x-rays were again found associated with this period. The yield of any unconverted soft gamma-radiation (~97 kev) was so small that its presence was doubtful. The decay curve (Fig. 2B) gave a 90±2-day half-life.

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Increase in Vapor Pressure of Liquid Helium Due to He^3 in Solution*

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WITH a thermal diffusion column[1] we have recently produced about 100 standard cm^3 of helium gas containing approximately 0.16 percent He^3. This sample, therefore, contains about ten thousand times more He^3 than ordinary gas well-helium. It seemed, therefore, worth while to attempt to measure differences in the vapor pressure between this enriched gas and the normal well-helium, the latter being practically pure He^4.

The apparatus consisted of two identical thin-walled copper vessels, each of volume approximately 0.16 cm^3, the two being silver-soldered together. A pair of thin-walled stainless steel tubes ran from each vessel out of the cryostat to the respective legs of an oil manometer, the latter containing low vapor pressure diffusion pump oil (Octoil-S). The two levels in the manometer were read with a cathetometer, and with this apparatus vapor pressure differences of the order of 10^{-2} mm Hg could be detected. The two copper vessels were surrounded by a bath of liquefied well-helium whose temperature could be controlled by pumping in the usual way. Corresponding absolute temperatures were computed from the vapor pressure of this bath using the Leiden 1937 tables.

The results of the measurement are shown in Fig. 1. As was expected, the He^3-enriched material showed a higher vapor pressure than the He^4 at all temperatures. In order to check the reliability of our apparatus we performed a blank experiment using well-helium in both copper vessels. Under these conditions, the vapor-pressure difference was less than the least count of our manometer (~10^{-2} mm Hg) at all temperatures in the range shown in Fig. 1. In view of this it seems unlikely that the discontinuity at the λ-point shown in Fig. 1 is due to small-temperature inhomogeneities in the bath when it is in the He I region. Further, the results were quite reproducible.

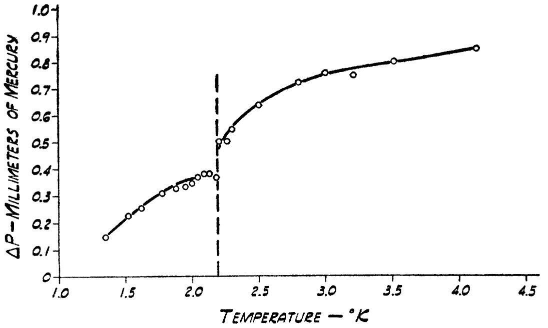

FIG. 1. The difference in vapor pressure (ΔP) between helium containing 0.16 percent He^3 and well-helium as a function of temperature. The vertical broken line passes through the λ-point.

The possibility that the λ-point discontinuity is due to a secondary effect connected with the creeping film is being investigated. One possibility is that the evaporated film on recondensing produces a downward heat flush in the liquid in the copper bulb disturbing the isotope distribution.[2]

If one assumes that this solution of He^3 in He^4 is ideal, that is, obeys Raoult's and Henry's laws, then it can be shown that the following relations hold:

$$\Delta P = C_L[(C_V/C_L)-1]\pi_4, \tag{1}$$

$$\Delta P = C_L(\pi_3-\pi_4). \tag{2}$$

Here the π's represent the saturated vapor pressures of the two pure isotopes, and C_V, C_L are, respectively, the He^3 to He^4 concentrations in the vapor and liquid. Previously values of C_V/C_L as a function of temperature in the He I region for very dilute solutions have been measured by us.[3] If we suppose that the much more concentrated (by about 10^3) solution we have here obeys the same relationship, then C_L as a function of temperature may be computed from this and the balance of mass and composition equations. This is tantamount to supposing Henry's law to be valid in this concentration range. Since now all quantities on the right of Eq. (1) are known, ΔP may be computed as a function of temperature in the He I region. The results of this give only order-of-magnitude agreement, the computed values being around 40 percent lower than the measured values, but the calculation nevertheless suggests that, in the He I region, the solution is not far removed from an ideal classical solution. Similarly, from Eq. (2) a rough estimate may be made of the vapor-pressure curve[4] for He^3. A plot of $\log\pi_3$ *versus* $1/T$ made from the above data gives a straight line, from which the normal boiling point is approximately 2.9°K.

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* A short report of this measurement was given by one of us (C.T.L.) at the Shelter Island Conference on Low Temperature Physics on June 1, 1948.

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Nuclear Paramagnetism at Low Temperatures

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FURTHER measurements on nuclear paramagnetism at low temperatures have been made using the magnetic resonance absorption method.[1,2]

Experiments have been made on single crystals of calcium fluoride in order to determine the effect of temperature, magnetic field strength, and paramagnetic impurities on the spin-lattice equilibrium time of the fluorine nuclei. The results of measurements at a frequency of 5.3 mcs/sec. on two specimens of natural fluorite are given in Table I. Crystal *A* was colorless and *B* was a greenish-blue color.

The remarkable difference between *A* and *B* is probably due to the presence of paramagnetic rare earth impurities or *F*-centers in specimen *B*; but as the line width was only about 8 gauss in both specimens, the concentration of paramagnetic impurity could not have greatly exceeded 1 in 10.[4]

In order to investigate the effect of *F*-centers,[3] specimen *A* was irradiated with x-rays at liquid air temperature for a time sufficient to give a blue coloration. As a result of the irradiation, the relaxation times at 4.2°K and 1.2°K were reduced to about half of the previous values.

These results suggest that impurities or *F*-centers play a predominant part in the relaxation process and that even concentrations as low as 1 in 10^6 may have an appreciable effect.

The dependence of T_1 on magnetic field strength has been investigated by making measurements on specimen *A* at a frequency of 2.05 mc/sec. The values of T_1 obtained at this frequency were about half those obtained at 5.3 mc/sec.

TABLE I. Relaxation time of two specimens of calcium fluoride crystals.

Specimen	Temperature T°K	Relaxation time T_1 (sec.)
A	20.0°	17.0
	4.2°	67.0
	1.2°	280.0
B	20.0°	0.1
	4.2°	0.46
	1.2°	1.0

It is not possible at the present time to give a complete explanation of these results, but the approximate proportionality between $1/T_1$ and T°K suggests that only those Debye waves which are fully excited at 1°K are effective in the relaxation process, the nuclear transition probability being proportional to the energy in these waves. The increase of T_1 with increase of magnetic field strength cannot be accounted for by a mechanism of direct interaction between nuclear spins and lattice waves, and suggests that the relaxation process may be associated with magnetic field fluctuations caused by change of direction of the electron spins in the paramagnetic impurities or *F*-centers.

By making use of the long relaxation time of specimen *A* we have carried out a nuclear demagnetization experiment. At a temperature of 1.2°K, the specimen was maintained in a field of 4000 gauss for 12 minutes. On reducing the field to 500 gauss, the nuclear spin temperature was observed to fall to 0.17°K and then subsequently to rise to the lattice temperature of 1.2°K with a relaxation time of 1 minute.

Previous experiments on solid hydrogen[2] have been extended to lower temperatures, using an improved design of apparatus. It is found that at 1.3°K, in addition to the main resonance, a subsidiary peak appears on either side of the main peak at a distance of 18 gauss. On reducing the temperature to 1.1°K, the intensity of the side peaks increases while that of the central peak diminishes. The measurements were made on a polycrystalline specimen. This splitting of the resonance is presumably associated with the increase in the state of order of the molecular rotation which occurs in this temperature region.

In order to determine the relaxation time of the nuclei in a metal, experiments have recently been made on a specimen of aluminum in the form of a spiral of thin foil. Using a frequency of 2.45 mc/sec. the value of T_1 at 1.1°K and 4.2°K was found to be approximately one second which is in agreement, as regards order of magnitude, with the theoretical estimate of Heitler and Teller.[4] The width of the resonance was about 10 gauss.

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The Isotopic Effect of the Potential Function of Molecular States

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BESIDES the known isotopic effects in the band constants, a difference of 350 cm^{-1} in the energy distance of the minimum of the potential function from the asymp-