tions. The K-capture transition goes to the 1.28-Mev excited level of Cd^{114}, which is followed by cascade gammas of energy 0.722 and 0.556 Mev.[1,2] On the basis of our angular correlation measurements[3,4] the spins of the three states of Cd^{114} are $2-2-0$. These measurements are in agreement with those of Steffen,[5] who has also shown that the transitions to the K-capture branch originate in the ground state of In^{114} and that hence the alternative $4-2-0$ interpretation of the angular correlation data is untenable.[6] Boehm and Preiswerk[1] have estimated the number of positrons per disintegration as 10^{-4} and suggest that the end point of the positron spectrum is about 0.650 Mev.

Using the Siegbahn type beta-spectrometer of radius 50 cm built in this laboratory, we have examined the beta- and gamma-spectra of this nuclide. In addition a number of coincidence experiments have been carried out using anthracene detectors in conjunction with a coincidence circuit of resolving time 5×10^{-9} sec.[7] The source consisted of 150 mg of indium metal with an initial specific activity of 1 mC/mg. On the basis of these studies and previous work on this isotope we believe that the decay scheme is as shown in Fig. 1. Our evidence for this scheme is presented below.

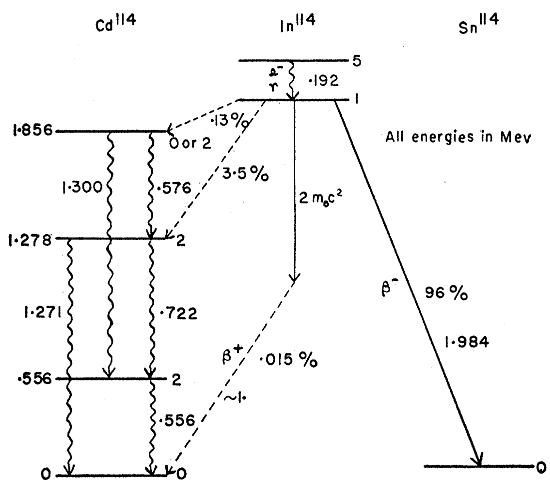

FIG. 1. Proposed decay scheme for In^{114}.

TABLE I. Energies and intensities of the gamma-rays of In^{114}.

Energy Mev	Relative intensities	Quanta per 100 disintegrations of In^{114}
0.192	5.4	19.3
0.556 ± 0.001	1.02	3.6
0.576 ± 0.003	0.03	0.1
0.722 ± 0.001	1.00	3.5
1.271 ± 0.006	0.008	0.02
1.300 ± 0.003	0.043	0.12

(a) Using the 50-cm spectrometer, the energies of the gamma-rays were measured by observing the photoelectrons ejected from an 18-mg/cm² Pb radiator of dimensions 2.5×0.5 cm and an instrumental resolution of 0.6 percent. With this resolution a weak photoelectron peak corresponding to a gamma-energy of 0.576 Mev appears between the K and L photoelectron peaks of the 0.556-Mev radiation. In addition the 1.30-Mev peak shows a partially resolved peak on its low energy side corresponding to an energy of 1.27 Mev. The energies of the 0.576- and the 1.300-Mev gamma-rays establish a third excited level in Cd^{114} at 1.856 Mev. A search for the direct transition from this level to the ground state of Cd^{114} gave negative results. If a 1.85-Mev gamma-ray exists, its intensity is less than 0.25 of that of the 1.300-Mev radiation. The relative intensities of the gamma-rays and the number of quanta of each per disintegration were obtained by comparing their intensities with the strongly converted 0.192-Mev radiation. The results of these measurements are summarized in Table I.

(b) With a source of thickness 1 mg/cm², the beta-spectrum has been examined with an instrument resolution of 0.5 percent. The end point of the beta-spectrum was found to be at 1.984 ±0.004 Mev. The strong beta-spectrum made it impossible to detect the internal conversion of the weak gamma-rays listed in Table I.

(c) A coincidence absorption experiment in lead using the circuit and source mentioned above showed that the 1.300-Mev gamma-ray is in cascade with the 0.556-Mev radiation. In this experiment one counter was unshielded while the other was shielded with from 0 to 10 cm of Pb. For thicknesses greater than 5 cm the absorption curve followed the correct slope for a 1.3-Mev gamma-ray as determined by a repetition of the experiment with a Co^{60} source.

(d) Since the two 0.511-Mev quanta produced upon annihilation of a positron are emitted in opposite directions, positron absorption in the source will affect the $\gamma-\gamma$ coincidence rate only when the angle formed by the counters at the source is 180°. By measuring the positron contribution to the $\gamma-\gamma$ rate with a small source enclosed in sufficient matter to stop all the positrons, we have determined that $1.5\pm0.5\times10^{-4}$ positron occur per disintegration. (The previous value reported[4] is in error.)

(e) By using an indium foil (100 mg/cm²) as source and aluminum absorbers we have been able to measure the number of positrons stopped as a function of the thickness of aluminum placed around it. The experimental data is consistent with that expected for a beta-spectrum whose end point lies in the range 1.0 to 1.4 Mev. This result supports the value of the $In^{114}-Cd^{114}$ mass difference of 2.07 ± 0.2 Mev as obtained by McGinnis[8] from $p-n$ threshold measurements.

Using the 2.07-Mev energy difference and the intensities in Table I, the logft values for the transitions from the ground state of In^{114} to the 0, 0.556-, 1.28-, and 1.85-Mev levels of Cd^{114} are 5.0, >5.3, 3.5, and 3.7, respectively, while that of the β^- branch is 4.4.

One might surmise that the spin of the 1.85-Mev level is either 0 or 2. It is known from the angular correlation measurements that the experimental data does not give a good fit to the theoretical $2-2-0$ curve even with a dipole-quadrupole mixture for the $2-2$ transition. This discrepancy may be due to the $1.300-0.556$ Mev cascade which would be expected to distort the observed correlation. If this cascade were either $0-2-0$ or $2-2-0$ its effect would be of the correct magnitude to remove the discrepancy between theory and experiment in the strong 0.722 -0.556 Mev cascade.

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Helium Film Transport over Copper below 1°K*

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RECENTLY Ambler and Kurti[1] have measured the transport rate of the He II film over glass down to 0.15°K. The results show the very interesting feature of an increased rate beginning at about 0.9°K and rising thereafter down to the lowest temperatures. The purpose of this letter is to report the result of some film measurements over a copper surface carried out with an electronic technique[2] over the temperature range from the λ-point to 0.75°K.

Earlier results[2] from this laboratory showed that the transport rate over machined copper is reasonably reproducible and for this reason, as well as for convenience, a copper surface was used in the present experiments. Temperatures below 1°K were obtained by adiabatic demagnetization of iron ammonium alum (Fig. 1, curve A) and of gadolinium sulfate octahydrate (Fig. 1, curve B) and were measured by means of the changes in self-inductance of a single layer coil which currounded the salt. The self-inductance was determined by the use of an Anderson bridge operated at 1000 cps. The sensitivity of balance was made independent of the temperature of the coil by placing a variable resistance in the inductive arm. It was possible at all temperatures to determine variations of 0.2 μh in a self-inductance of approximately 2.5 mh. The self-inductance was plotted against the reciprocal of the Kelvin temperature determined from equilibrium vapor pressure readings. The resultant straight line had a slope of approximately 180 μh per reciprocal degree for gadolinium sulfate and 85 μh per reciprocal degree for iron alum.

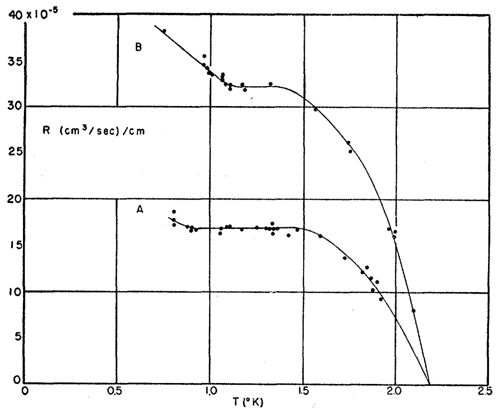

FIG. 1. Transport rate of the He II film as a function of temperature. (A) clean machined copper; (B) contaminated machine copper.

The electronic technique previously described[2] required a calibration based on visual observation of the helium level in the apparatus. In the present measurements this procedure was no longer necessary since convenient markers of the helium level were provided by grooves or shoulders (Fig. 2) which had been cut into the core of the cylindrical capacitor. This modification enabled the rate measurement to be made by noting the elapsed time required to empty the known annular volume of liquid helium from the region between the markers.

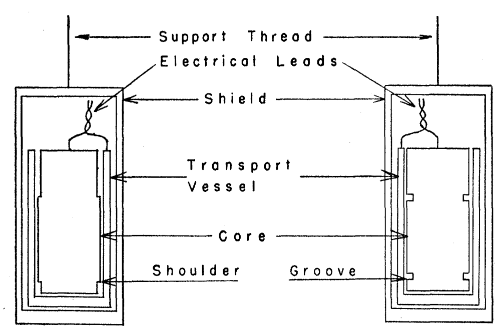

FIG. 2. Simplified sectional views of transport vessel and shield.

In all the experiments the salt and liquid helium were contained in a completely silvered glass vessel in which the temperature could be reduced to about 1°K by pumping on the liquid helium. The capacitor type transfer vessel was suspended in the helium-and-salt chamber by a thread attached at its upper end to a winch so that the vessel could be raised or lowered. Considerable difficulty was experienced in maintaining sufficient thermal isolation. Although temperatures as low as 0.4°K were obtained with the small magnet at our disposal, the initial rates of heating were too large to obtain reliable measurements below 0.75°K. It was expected that various modifications which were made from time to time would improve the isolation but this has not proved to be the case. Since the experiments are being temporarily discontinued, we are reporting the data thus far obtained.

The results are shown in Fig. 1. The data shown on curve A represent three experimental runs, the part below 1°K consisting mostly of results obtained in one of the runs (8/2/51). It is to be noted that these rates are approximately in agreement with those of Dash and Boorse for an uncontaminated machined copper surface. Curve B, on the other hand (data of 11/12/51), shows much higher rates than curve A. The high rates are believed to have been due to contamination.[3] Attention is directed to the fact that curve B shows a much more pronounced rise at the lower temperatures whereas curve A is essentially constant down to at least 0.9°K with perhaps the start of a rise at 0.8°K.

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α-Energy Systematics and Proton Shells for Heavier Nuclei

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THE variation of α-energies of different isotopes of a nuclei has been studied by a number of authors.[1–4] They have shown that E_α for different isotopes of an element decreases almost linearly with increasing neutron number. However, at certain points the relation is reversed and there is a very sudden increase in the α-energy. These reversals are associated with particularly stable neutron shells and consequent sudden drops in the binding energy of the neutrons. From the point of reversal we can easily determine the magic neutron number for which a completed shell exists.

Recent extension of the tab'e of known α-active nuclei[5] makes possible a similar study of the α-energies of different isotones. Great regularities are noticed if the α-energies for nuclei with the same number of neutrons are plotted against Z. In Fig. 1 such a plot is given for several neutron numbers. The data are all taken from Seaborg *et al.*[5] and Perlman *et al.*[4] E_α in the figure denotes the total decay energy. It is seen from the figure that the general trend here is an increase of E_α with Z. The curves are fairly well represented by approximately parallel straight lines. It is also clearly seen that at certain proton numbers there is a very sudden increase in E_α. These jumps are quite well marked and cannot be confused with the regular trend.

If $B_p(N, Z)$ be the binding energy of the last proton in the nucleus (N, Z), then it can easily be shown that

$$E_\alpha(N, Z) - E_\alpha(N, Z-1) = B_p(N-2, Z-2) - B_p(N, Z).$$

If we are proceeding from higher to lower Z, then a sudden drop in the value of $E_\alpha(N, Z-1)$ must be due to either a sudden increase of $B_p(N-2, Z-2)$ or a sudden decrease of $B_p(N, Z)$. The latter cannot be true since B_p values always increase with decreasing Z (see Fuchs[6]). Thus we conclude that, for decreasing Z, a sudden drop in E_α at (N, Z) is associated with a sudden increase in the proton binding energy at $(N-2, Z-2)$. Thus the proton number $Z-2$ must be regarded as a magic number giving rise to a closed proton shell.