elements so far measured. The curves drawn are the predictions of the transparent nucleus theory[4] neglecting coulomb effects and using constants which fit the neutron results. The errors shown are the usual standard deviations based upon counting statistics. Further calibration is under way to detect any possible systematic errors.

The lack of sharp minima may be partially explained by the finite angular resolution. It is noteworthy that, while the angular resolution is the same for all data shown, the smearing is greater in the lighter elements. The transparency effect is expected to be a smooth function of mass number, but the model upon which it is based may not be correct for light nuclei, with their small numbers of nucleons.

Further experiments are contemplated with much improved angular resolution in order to look for any dissimilarities in the patterns from adjacent nuclei whose structures are expected to differ appreciably.

* This work was performed under the auspices of the AEC.
[1] Amaldi, Bacciarelli, Cacciapuoti, and Trabacchi, Nuovo cimento 3, 15, 203 (1946).
[2] Bratenahl, Fernbach, Hildebrand, Leith, and Moyer, Phys. Rev. 77, 597 (1950).
[3] C. E. Leith, Phys. Rev. 78, 89 (1950).
[4] Fernbach, Serber, and Taylor, Phys. Rev. 75, 1352 (1949).

The Vapor Pressure of Liquid Helium at the Lambda-Point

Earl Long and Lothar Meyer
Institute for the Study of Metals, University of Chicago, Chicago, Illinois
(Received June 21, 1951)

THE vapor pressure of liquid helium at the lambda-point was established by Schmidt and Keesom[1] as 38.3±0.2 mm Hg, corresponding to a temperature of 2.186°K in the so-called 1937 to 1949 temperature scale.

In the course of experiments on adsorbed helium films we recently had occasion to redetermine this pressure, using in principle the same method as that of Schmidt and Keesom. A copper-vapor pressure thermometer bulb was mounted at the bottom of the cryostat, connecting to an oil manometer which could be used either to measure the absolute vapor pressure or to measure any pressure differences between the vapor pressure bulb and the pressure at the top of the cryostat. In addition the bath was provided with a stirrer.

The criterion Schmidt and Keesom used to determine the lambda-point pressure is as follows: In helium I with its poor heat conductivity vertical temperature gradients arise because the liquid at the bottom of the cryostat is boiling under higher pressure than the liquid at the top, owing to the hydrostatic pressure head. These temperature differences instantly disappear when passing the lambda-point, as a consequence of the sudden extreme increase in heat conductivity of the liquid. A vapor pressure thermometer placed at the bottom of a cryostat bath will therefore show a higher pressure than the bath, above the λ-point but not below.

A series of careful experiments showed that the expected difference in vapor pressure appeared at 38.10±0.02 mm Hg (and higher pressures) measured at the top of the bath, using Octoil-S oil manometers and an accurate wide-bore Hg manometer, which were intercompared.

At this and higher pressures the vapor pressure thermometer showed higher values than the bath pressures, the differences depending on the height of the bath and the speed of the stirrer. Below this pressure no differences were observed (±0.05 mm oil). Moreover, at this point bubbling started throughout the liquid and the fluctuations in control of the bath temperature increased to the relatively high values known for the He I region.

We therefore believe that the vapor pressure of liquid helium at the λ-point (p_λ) should be revised to

$$p_\lambda = 38.10 \text{ mm Hg}.$$

In the conventional temperature scale this would reduce the λ-temperature to 2.184°K. However, Kistemaker[2] reports that a vapor pressure of 38.25 mm Hg corresponds to a temperature of only 2.17°K, which would reduce T_λ to 2.169°K. The uncertainty of the λ-temperature seems at present to be at least 0.01°.

[1] G. Schmidt and W. H. Keesom, Leiden Comm. 22, No. 250b (1937); Physica 4, 963 (1937).
[2] J. Kistemaker, thesis, Leiden (1945), Table XXI; Physica 12, 281 (1946); Leiden Comm. Suppl. No. 95a (1948).

On the Decay of I^{131}

Sigvard Thulin
Nobel Institute of Physics, Stockholm, Sweden
(Received July 3, 1951)

ALTHOUGH the decay scheme of I^{131} has been extensively studied, there still remain several inconsistencies. The greatest difficulty seems to be associated with the position of those levels from which the high energy γ-rays are emitted. The present investigation concerns this question.

The upper limit of the low energy β-component is of great importance for the whole decay scheme. Energies from 250 to 336 kev have been reported.[1-5] A redetermination of this energy therefore seemed desirable. A carrier-free β-spectrometer sample was obtained by separating *n*-irradiated Te in the electromagnetic isotope separator. The activity of mass number 131 was collected on a 0.15 mg/cm² Al foil. According to earlier measurements on other separated activities, such a sample does not give any distortion of the β-continuum above 50 kev. The β-spectrum was measured in a magnetic lens spectrometer. The upper limits of the two β-components were found to be 607 and 255±30 kev. A β-sample, prepared by evaporation of the *n*-irradiated Te on 0.15 mg Al/cm² was measured in another spectrometer and gave the value 260 kev for the low energy component. This result would support the term scheme of Kern.

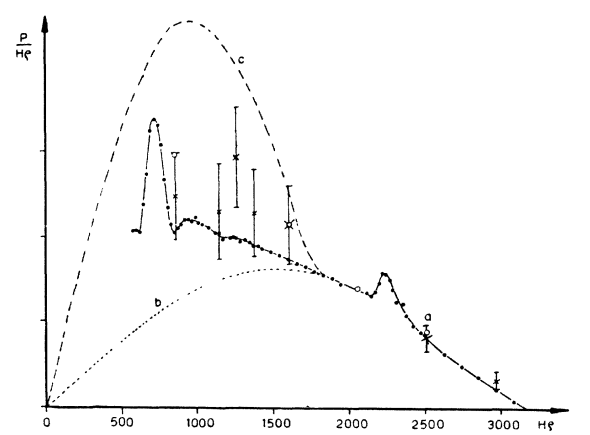


Fig. 1. Coincidence spectrum of I^{131}: a = β-spectrum measured in one of the lenses; b = 607-kev β-component. The crosses and circles are the measured coincidence points corrected for coincidence background and normalized to the upper part of curve a. c = theoretical coincidence spectrum, assuming that the 284- and 638-kev γ-transitions feed the 80-kev level with approximately the same intensity.

Some of the inconsistencies mentioned above might be clarified by coincidence measurements. For this reason, coincidences were measured in a double-lens β-spectrometer (β-spectrogoniometer)[6] between the *K* conversion line of the 80-kev γ-ray and different energies of the β-continuum. The results are shown in Fig. 1. The

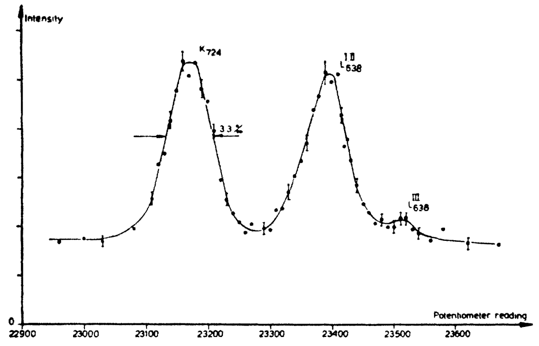


FIG. 2. The K_{724} and L_{638} photolines from a uranium converter.

presence of coincidences between the 80-kev γ-ray the 607-kev β-component definitely rules out the third decay scheme of Cork *et al.*[7] It seems probable that there is a small coincidence effect also between the 80-kev γ- and the 255-kev β-component.

Earlier measurements indicate that the energy difference between the two high energy γ-rays (724 and 638 kev) is approximately 80 kev, i.e., the energy of a third γ-ray. A high precision determination of this energy difference can be obtained by measuring the photoelectron lines from a uranium converter, since the K_{724} line and L_{638} line appear as a narrow doublet. Such a measurement was carried out in the double focusing spectrometer using a 250-mC I^{131} sample and a uranium radiator (1.3 mg/cm^2). The doublet is shown in Fig. 2. The energies of the two γ-rays were found to be 638.0±0.6 kev and 723.9±0.7 kev. The relative intensity, estimated from the K photo lines, is 7.8:1. The energy difference as determined from the doublet lines is 85.7±0.4 kev. A difference of 80.1 kev would give a doublet with approximately twice as large a distance between the lines. The value 85.7 kev definitely excludes the possibility of a cross-over transition for the 724-kev γ-ray as assumed by Zeldes *et al.*[8] and Bell *et al.*,[2] which, in fact, had seemed to be a satisfactory suggestion.

[1] Kern, Mitchell, and Zaffarano, Phys. Rev. **75**, 1632 (1949); **76**, 94 (1949).
[2] Bell, Cassidy, and Kelley, Phys. Rev. **82**, 103 (1951).
[3] I. Feister and L. F. Curtiss, Phys. Rev. **78**, 179 (1950).
[4] F. Metzger and M. Deutsch, Phys. Rev. **74**, 1879 (1948).
[5] Verster, Nijgh, van Lieshout, and Bakker, Physica, to be published.
[6] K. Siegbahn, Arkiv Mat. Astron. Fysik, to be published.
[7] Cork, Rutledge, Stoddard, Branyan, and Childs, Phys. Rev. **81**, 482 (1951).
[8] Zeldes, Brosi, and Ketelle, Phys. Rev. **81**, 642 (1951).

A Photographic Study of the $\pi^+\rightarrow\mu^+\rightarrow\beta^+$ Decay Process and the Energy Spectrum of the β^+

H. BRAMSON AND W. W. HAVENS, JR.
Columbia University, New York, New York
(Received June 29, 1951)

An investigation of meson decay has been undertaken using thick electron sensitive emulsions and the beam of mesons produced by the 385-Mev Nevis cyclotron.

The emulsions were exposed in a collimating chamber[1] which yields plates of low background while restricting entrance of π-mesons to a nearly monoenergetic monodirectional beam of π^+ mesons. The μ^+ mesons entering these plates can, except in exceedingly rare instances[1] be readily distinguished from the main π^+ beam. In addition, the appearance of the decay particle at the terminus of the μ^+ meson can be regarded as a final check of its identification.

Ilford G5 emulsions, approximately 0.6 mm and 1 mm thick, were used in order to investigate the energy spectrum of the charged particle from the decay of the μ^+ meson. To date, 1158 cases of π^+ decay have been observed where the μ's have ended in the emulsion. In each of these cases, an attendant minimum ionization track was always visible, attesting to the uniform minimum ionization achieved throughout the film. Steep angles of the decay track did not introduce difficulties in their identification.

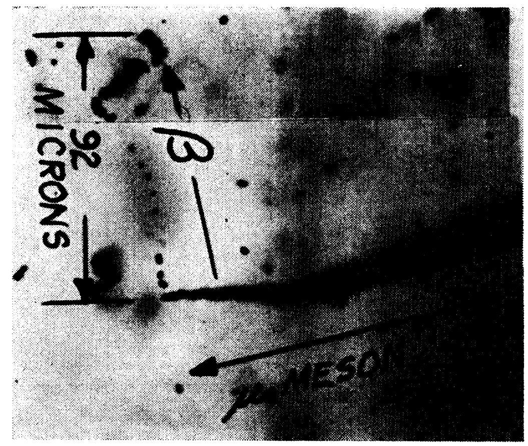
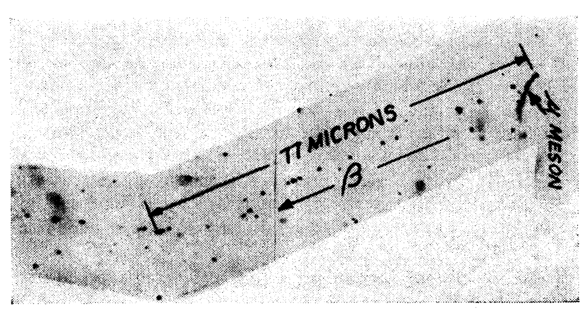


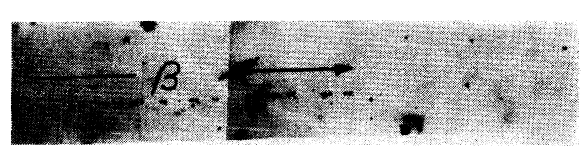
FIG. 1. Slow positron of a $\pi\rightarrow\mu\rightarrow\beta$-sequence in 1-mm emulsion.

Throughout these studies anomalous ranges of μ-mesons were searched for without success. Since W. F. Fry[2] has reported four μ-meson ranges which were clearly anomalous, our results were rescanned, specifically in a search for μ-meson ranges less than 420 microns. However, no such anomalous events have been found. Therefore, we believe either that such events are not as common as indicated by Fry's results, or that the statistical fluctuations of scattering measurements and grain counting over such short track lengths can permit such variations in usual μ-meson tracks to account for Fry's results.

Three interesting examples of μ^+ decays are shown here. Figure 1 shows the slowest positron yet observed in this study. From its range, which lies entirely within the emulsion, the energy was estimated to be about 0.1 Mev. Figure 2(a) shows an instance of an unusually sharp scattering of the decay particle shortly



(a)



(b)

FIG. 2. (a) Instance of large scattering of positron (0.6-mm emulsion). (b) Example of positron annihilation in 1-mm emulsion. (Annihilation takes place 4900 microns from μ-meson, 190 microns beneath air surface, 600 microns above glass surface.)