ceptibly the results in the correlations presented in Table I and Fig. 1.

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The Vapor Pressure of He^3-He^4 Mixtures*

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The saturated vapor pressure of helium isotopes and mixtures of the helium isotopes can be discussed on the basis of the clustering avalanche theory of condensation applied to quantum degenerate gases.[1] The saturated vapor pressure is expressed in this theory in terms of the surface energy of small clusters. We calculated the surface energy per atom in clusters in pure He^4 and in pure He^3 to fit the theory to observed vapor pressures of the pure isotopes.[2,3] We then tentatively adopted an interpolation formula in an attempt to predict the vapor pressure of mixtures of the two isotopes. This formula was linear in the concentration; in other words, it assumed the same average concentration of He^3 in the surface of the clusters as in the vapor.

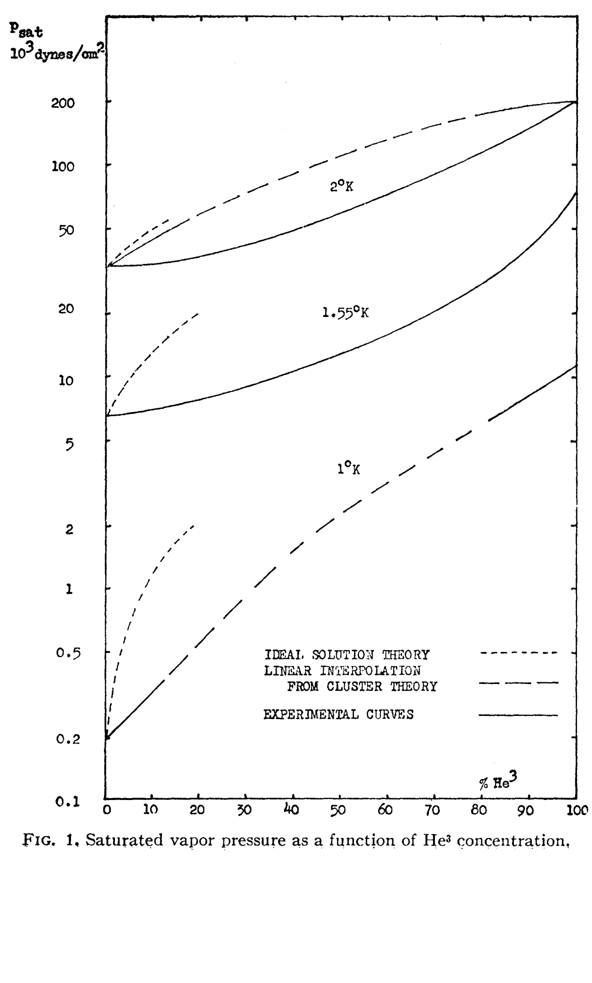

FIG. 1. Saturated vapor pressure as a function of He^3 concentration.

The results of these calculations were given in detail in a technical report to the Office of Naval Research dated June 16th, 1952. Since then the experimental data of Sommers[4] have become available. Figure 1 shows the theoretical curves we found at 2°K and 1°K compared with the ideal solution theory curves and smoothed curves for 2° and 1.55°K taken from Sommers' data. Clearly, although the theoretical curves lie appreciably lower than those of an ideal solution, the experimental curves are very considerably lower still.

This can be accounted for in theory if we use another interpolation formula that is nonlinear in the concentration, and is such as to decrease the average concentration of He^3 in the surface of clusters compared with that in the vapor. A long and tedious computation, however, is needed to find the best formula, and we plan to complete this before publishing a full report.

Sommers analyzed the relation between his saturated vapor pressures and the relative concentrations in the liquid phase, and noted that it was quite doubtful whether there was any significant effect resulting from the lambda-transition in the liquid. Our point of view coincides with this in that the liquid phase does not enter our analysis as such: saturation is an effect of clustering in the vapor. However, we do find that an anomalous decrease of He^3 in the surfaces of clusters is required to explain the data at 2°K. Whether this anomaly is connected with the similar anomaly that exists in the liquid phase below the lambda-point is an open question. It can perhaps be decided after we find whether or not the same anomaly in the clusters is required to explain the vapor pressure curves above as below the lambda-transition.

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Multiple Coulomb Scattering of High Energy Pions in Photographic Emulsions*

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The small angle scattering in photographic plates of negative pions from the Chicago cyclotron[1] has been measured by the saggitta method. The measurements were undertaken in order to provide information on the multiple scattering of high energy pions over very long cell lengths which is of great importance in numerous cosmic-ray studies.

This investigation was made by methods similar to those initiated by Goldschmidt-Clermont *et al.*[2] and Fowler[2] which were worked out in considerable detail by others.[3,4] Negative pions of 226 ± 7 Mev energy were allowed to pass through two Ilford G5 plates 200 microns in thickness with surfaces nearly parallel to the pion beam. The microscope and techniques were identical to those described by Berger *et al.*[4] The lateral displacement of the tracks y_i were measured at equal distances t (cell length) along a straight line defined by the rectilinear motion of the precision microscope stage.[4] The set of second differences of these lateral displacements $\Delta^2 y_i = y_{i+2} - 2y_{i+1} + y_i$ obtained from the tracks provides a measure of the multiple scattering of the pions. The 89 tracks which were measured were selected along a line 2 cm from the edge of the plate. Then only tracks nearly parallel to the surface were selected and measurements made until they were 5 microns from the surface. The energy of the pion beam before entering the plates was 227 ± 7 Mev from previous calibrations.[1] When corrections were made for energy loss in the plates and wrapping material, the average energy of the pions used in this experiment was 218 ± 11 Mev. The average measured length of the tracks in this investigation was 8000 microns and only 10 percent were shorter than 5600 microns. No measured length of track shorter than 3500 microns was found by the above selection

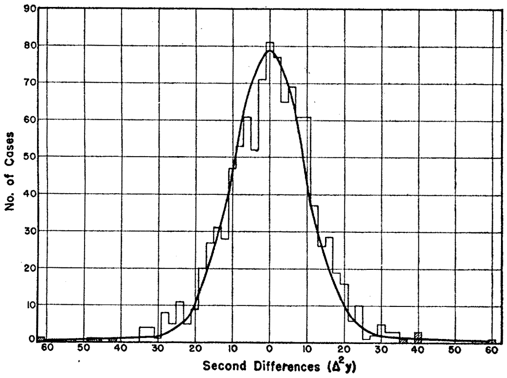

FIG. 1. Frequency distribution of 2nd differences for 218±11 Mev negative pions, using a 250-micron cell length. One unit of the abscissa equals 0.0693 micron. Second differences greater than 4 times the mean absolute value are shaded. The solid curve is the theoretical curve calculated from theory.

scheme. This serves to indicate that the finite thickness of the emulsion (200 microns) had little tendency to bias the data in favor of tracks with small scattering. The influence of emulsion distortion was tested by a statistical analysis of the distribution of the algebraic signs of the observed successive second coordinate differences (run test) and found to be negligible within statistical fluctuations.

The measurements were made in a temperature controlled room with a special precision stage[4] described previously. Evaluation of the noise level was first determined from cosmic-ray tracks of extreme energy[5] (>15 Bev) for which the average value of the second differences is only the result of "noise" and in this case $\langle|\Delta^2y|\rangle_{Av}=0.06$ micron. Since each measurement of the coordinate y_i is a length averaged over about a 10-micron section of the track, it is to be expected that the noise level would be dependent upon the degree of scattering of the track. This was determined by making 10 successive measurements of relatively strongly scattered tracks (pions and protons of energies from 200 to 400 Mev) at 30 positions. A statistical analysis then showed that the noise level for the tracks measured in this experiment was $\langle|\Delta^2y|\rangle_{Av}=0.21$ micron.

The relation of the measure of multiple scattering to cell length, energy, and type of the scattered particle is given by:

$$\langle|\alpha|\rangle_{Av}=\langle|\Delta^2y|\rangle_{Av}57.3/t=\frac{K_1^cZ(t/100)^{\frac{1}{2}}}{pv},$$

where $\langle|\alpha|\rangle_{Av}$ is the mean angle in degrees between successive chords through the points dividing the track into cells of length t in microns. Z, p, and v are the charge, momentum, and velocity of the scattered particle with pv expressed in Mev. The scattering factor K_1^c is only slightly dependent upon Z, v, and t; and in accordance with convention $\langle|\Delta^2y|\rangle_{Av}$ and $\langle|\alpha|\rangle_{Av}$ refer here to averages based only on those values less than 4 times the experimental mean. A histogram of the frequency distribution of Δ^2y is given in Fig. 1 for cell lengths of 250 microns. The curve drawn through the histogram and normalized to equal area is calculated for convenience from the theory of Molière,[6] although the agreement with experiments would be quite as satisfactory for other theories.[7] In Table I a summary is given of the average second differences and scattering factors for the pions as well as for previous measurements with protons[4] and carbon nuclei.[8] In the last column of Table I comparison is made with the Molière[6] theory, which is in general agreement with the other theories.[7] Figure 2 gives the variation of the average second difference with cell length, and it is to be noticed that this variation with cell length is slightly less than that predicted from theory. This slight difference from theory was also present in the previous scattering data for protons.[4] By using cell lengths of 2000 microns and longer, it might be of interest to further investigate this dependency of scattering upon cell length.

TABLE I. Summary of multiple scattering data.

Particle	Energy Mev	Cell length, microns	$\langle\lvert\Delta^2y\rvert\rangle$ micron	Scatt. factor K_1^c (4×mean excluded) Expt.	Theory
Pions (neg.)	218±11	250	0.58±0.014	25.5±0.7	24.5
		500	1.69±0.28	26.3±0.7	25.5
		750	2.85±0.14	24.4±1.0	26.0
		1000	4.75±0.104	26.0±0.9	26.4
		2000	12.89±0.693	24.9±1.5	27.3
Protons	337±1	500		24.5±0.7	25.8
	218±2	500		25.4±1.0	26.2
Carbon nuclei	10 to 1000	250		24.8±1.4	26.4
		500		26.2±2.2	27.2

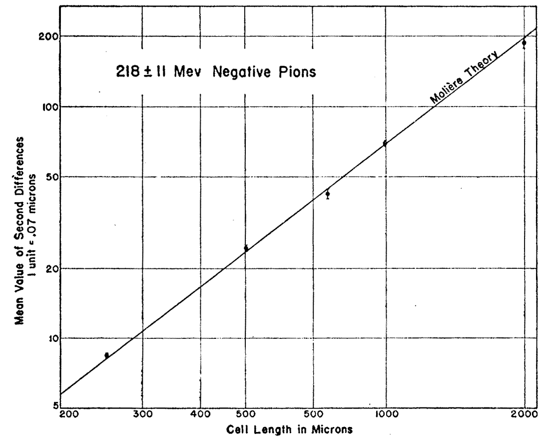

FIG. 2. Variation with cell length of the average absolute value of the second difference computed with quantities 4 times the calculated mean excluded. The solid curve is from theory (Molière). One unit of the ordinate is equal to 0.0693 micron.

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Polarized γ-Rays from Nuclei Aligned at Low Temperatures

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THE γ-radiations from aligned nuclei, besides exhibiting an anisotropic polar diagram which depends on the multipole order of the transition, should also be polarized in a manner which depends on the parity change. The technique for aligning cobalt nuclei has already been established.[1,2] We have used this method to produce an assembly of aligned nuclei and have observed that the radiations are in fact polarized. We have investigated both Co^{60} and Co^{58}; our result for Co^{60} is in agreement with the well-