achieved by measuring the angular correlation between inelastically scattered neutrons and γ-rays produced during nuclear transitions to the ground state. The photons here carry two units of angular momentum; applying the well-known formula for the angular distribution of photons, one obtains the following exrpession for the transition cross section, wherein the neutrons are inelastically scattered at an angle θ and the photon makes an angle ϑ with the direction k

$$\sigma(\theta, \vartheta)\, d\Omega_n d\Omega_\gamma \tag{7}$$

$$= \frac{5}{8\pi}\left[3(x^2 - x^4)\,\sigma_0(\theta) + (1 - x^4)\,\sigma_2(\theta)\right] d\Omega_n d\Omega_\gamma,$$

where $x = \cos\vartheta$.

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[1] G. Scharff-Goldhaber and J. Weneser, Phys. Rev. 98, 212 (1955).

[2] A. Bohr, Dan. Mat. Fys. Medd. 26, 14 (1952).

[3] S. I. Drozdov, J. Exptl. Theoret. Phys. (U.S.S.R.) 28, 734 (1955); Soviet Phys. JETP 1, 591 (1955).

[4] A. I. Akhiezer and V. B. Berestetskii, *Quantum Electrodynamics*, GITTL, Moscow, 1953.

Translated by M. A. Melkanoff
192

Density of the Normal Component for Solutions of the Isotopes of Helium

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IN accordance with current ideas[1] there are to be associated with atoms of He^3 in solution He II elementary excitations characterized by the following dependence of energy upon momentum:

$$E = E_0 + (p - p_0)^2 / 2\mu, \tag{1}$$

where μ is the effective mass of the impurity atom. The minimum of the energy corresponds either to $p_0 = 0$ or to $p_0 \neq 0$. The contribution of the impurity to the density of the normal component of the He II depends critically upon the form of the energy spectrum, and can be written in the following manner[2]:

$$\rho_n = \rho_{n0} + (\rho/m)\,\mu x \quad \text{for} \quad \rho_0 = 0, \tag{2}$$

$$\rho_n = \rho_{n0} + (\rho/m)\,(p_0^2 / 3kT)\, x \quad \text{for} \quad p_0 \neq 0, \tag{3}$$

where x is the molar concentration of the He^3 in the solution. From this it is immediately evident that an experimental determination of the temperature dependence of the normal component density for solutions of He^3 and He^4 will make it possible to establish the form of the energy spectrum.

For this purpose an experiment was performed to determine ρ_n for solutions of the helium isotopes by means of the customary method, i.e., the measurement of the period of oscillation Θ of a stack of discs immersed in the solution[3,4]. From this the ratio of ρ_n to the density ρ_λ of the solution for the corresponding λ-point was computed. The results thus obtained* are presented in Fig. 1.

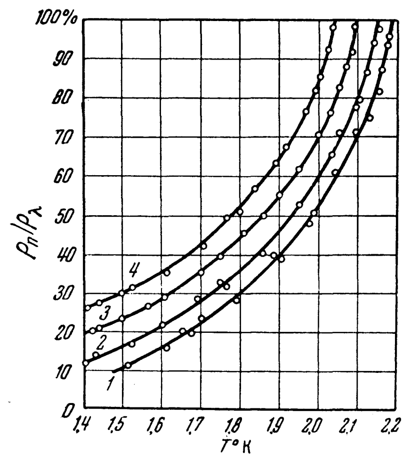

FIG. 1. Dependence of ρ_n / ρ_λ upon temperature: *1*–pure He^4 ; *2*–3.0% He^3 ; *3*–5.6% He^3 ; *4*–8.2% He^3

Using the indicated values of ρ_n / ρ_λ, and determining ρ_λ from the known densities of He^4 and He^3 [6-7], assuming them to be additive, it is possible to derive the dependence of ρ_n upon x for various temperatures, as shown in Fig. 2.

It is clearly evident that this dependence is linear down to a temperature of 1.8° K, the isotherms thus obtained being parallel to one another. A relation of this sort among ρ_n, T and x, in accordance with Eq. (2), testifies to the fact that the energy spectrum for the solution is characterized by the value $p_0 = 0$; the effective mass of the He^3 in solution can be determined from the slope of these lines. The calculations lead to the value $\mu = 3.0\ m_3$, the effective mass depending upon neither temperature nor concentration. These results fully confirm the conclusions previously reached[8]; the value for μ given here, however, is somewhat more exact, insofar as it has been determined by averaging the data obtained for several solutions having different concentrations of He^3.

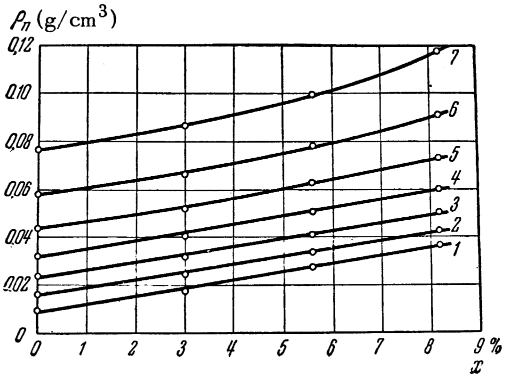

FIG. 2. Dependence of the normal component density ρ_n for solutions upon the concentration x for various temperatures: *1*–1.4; *2*– 1.5; *3*–1.6; *4*–1.7; *5*–1.8; *6*–1.9; 7–2.0° K.

It should be mentioned that the sharp break of the $\Theta - T$ curve at the λ-point may serve to locate the latter; the values for T_λ thus obtained agree well with other data reported recently[9].

We take this opportunity to thank Prof. B. G. Lazarev for his consideration of these results.

* In the present experiment the temperature was determined from the He^4 vapor pressure, with the aid of the 1949 tables[5].

1 L. Landau and I. Pomeranchuk, Dokl. Akad. Nauk SSSR 59, 669 (1948).

2 I, Pomeranchuk, J. Exptl. Theoret. Phys. (U.S.S.R.) 19, 42 (1949).

3 E. L. Andronikashvili, J. Exptl. Theoret. Phys. (U.S.S.R.) 18, 424 (1948).

4 A. C. Hollis-Hallet, Proc. Roy. Soc. (London) A210, 404 (1952).

5 H. van Dijk and D. Shoenberg, Nature 164, 151 (1949).

6 H. Kammerlingh Onnes and J.D.A. Boks, Leid . Comm. 170b.

7 Eugene C. Kerr, Phys. Rev. 96, 551 (1954).

8 N. G. Berezniak and B. N. Esel'son, Dokl. Akad. Nauk SSSR 111, 2 (1956).

9 Esel'son, Berezniak and Kaganov, Dokl. Akad. Nauk SSSR 111, 3 (1956).

Translated by S. D. Elliott
193

On the Total Energy of the β-Transition RaC – RaC′

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THERE exist a large number of works devoted to the study of the β-spectrum of RaC and the γ-spectrum of the excited RaC′ nucleus. Owing to the great complexity of these spectra, for a long time the diverse data obtained could not be made to conform, and to yield a perfectly definite scheme of the energy states of the RaC′ nucleus. Some authors[1,2] assume that the β-tansition with the highest limiting energy of 3.17 mev proceeds not to the ground level of the RaC′ nucleus but to an excited level with an excitation energy of 609 kev, which corresponds to a total β-transition energy of 3.78 mev.

In 1955, data obtained by studying the γ-ray spectrum of RaC′ by means of measurements of γ-γ and β-γ coincidences[3,4] were published. The absence of β–γ coincidences for the β-spectrum with the highest limiting energy furnished the basis for proposing the scheme according to which the β-transition with limiting energy 3.17 mev proceeds to the ground level[4]. It should be noted that the data of works published up to now do not exclude the possibility that the transition we are studying proceeds entirely to a metastable level rather than to the ground level.

During recent years, transitions of the type $E\,3$ or $M\,3$ were observed for some nuclei with half-lives of the order of a few hundred microseconds[5,6]. That an isomeric state with such a half-life also occurs in the case of RaC′(Po^{214}) is not ex-