$$\Delta E_m(s) = \langle C^*_{(s)} HC_{(s)}\rangle - \langle C^*_{(n)} HC_{(n)}\rangle$$
$$= -\frac{1}{2}\varepsilon_m(s) - \frac{\{\bar{E}(s, m) - E_F\}^2}{2\varepsilon_m(s)} + \{\bar{E}(s, m) - E_F\}\{1 - 2\theta_F(s, m)\}, \quad (8)$$

and for $s = s_0$, $m = m_0$

$$\Delta E_{m_0}(s_0) = -C_{m_0}(s_0)/2. \quad (8')$$

From this it may be seen that the superfluid state turns out to be more advantageous energy wise than the normal state and is separated from it.

Thus the interaction among protons of the same shell having equal and opposite z components of angular momentum gives rise to a superfluid state of the atomic nucleus. The presence of an energy split between the first excited and ground superfluid states confirm the considerations of Bohr, Mottelson, and Pines on the possibility of explaining in this way the energy split in heavy even-even nuclei.

In conclusion the author wished to express his profound gratitude to academician N. N. Bogoliubov for his constant interest in this work and for very valuable remarks.

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PRODUCTION OF PIONS IN CONDENSED MEDIA BY COSMIC RAYS IN THE STRATOSPHERE

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EXPERIMENTS designed to study the dependence of the cross section for meson production by low energy particles on the atomic weight A have shown that this dependence is not stronger than the $A^{2/3}$ law for elements up to aluminum, and somewhat weaker than $A^{2/3}$ for heavy nuclei.[1,2] For primary protons with an energy of 3 Bev the cross section for meson production increases as A for elements up to aluminum and somewhat faster than $A^{2/3}$ for heavier elements.[3]

We report here data on production of very slow π mesons in condensed media by cosmic rays in the stratosphere. Unbounded photoemulsions of 10 cm diameter and 400 μ thickness were used to detect the slow mesons; 12×12 cm aluminum and lead plates of varying thicknesses were used as targets. The photoemulsions were pressed between two plates of aluminum or lead, lifted into the stratosphere in balloon probes and irradiated by cosmic

TABLE I

Substances surrounding the emulsion	Thickness in g/cm²	Number of mesons per cm² including prongless stars: π^+	Number of mesons per cm² including prongless stars: π^-	Total number of π-mesons in a g/cm² of the substance and in a cm² of the emulsion after geometric correction	Upper limit of meson energy E_0 in Mev, estimated from the thickness of the target substance
Packing material		0.17±0.06 *	0.53±0.12		
Aluminum	1.62	0.58±0.09	1.28±0.15	0.75±0.13	13.5
	2.7	0.84±0.12	1.68±0.21	0.73±0.11	18
	5.4	1.79±0.17	3.19±0.25	0.94±0.07	27.5
Lead	2.27	0.34±0.07	1.90±0.19	0.68±0.1	12
	4.54	0.92±0.13	3.96±0.32	0.94±0.08	18
	6.80	1.51±0.16	4.30±0.32	0.80±0.06	23
	11.34	2.04±0.20	4.84±0.37	0.59±0.05	31

*The errors shown are purely statistical.

rays for 12 hours at an altitude of 28 to 30 km. The developed photoemulsions were scanned under microscope and $\pi \rightarrow \mu$ decays and σ captures were noted. Table I shows the results of the study.

In order to allow conclusions about the π-meson production cross section to be drawn from the table, we calculated and included corrections for the geometry of the experiment. As can be seen, the geometry of the experiment significantly affects the results, particularly when the target substance and detector are of comparable dimensions.

Assuming that the energy spectrum of the mesons produced in aluminum and lead in the energy region under study is of the form $n(E)dE = kE^{0.6}dE$ (E is the kinetic energy of produced mesons),[4] the total number of mesons with energy less than E_0 is given by

$$N(<E_0) = aE_0^{1.6}$$

Using this relation and the data of Table I we calculated lead to aluminum ratios of cross sections for production of mesons for various thicknesses of the target substance. They are given in Table II together with values of the coefficient a.

TABLE II

Target substance	Thickness (cm)	$a \cdot 10^{-4}$	σ_{Pb}/σ_{Al}
Al Pb	0.6 0.2	186.6±32.6 128 ±19	5.30±0.22
Al Pb	0.6 0.4	186.6±32.6 147.0±12.7	6.03±0.51
Al Pb	0.6 0.6	186.6±32.6 84.8± 6.6	3.70±0.88
Al Pb	1 1	147.7±15.7 38.8± 2.5	2.60±0.46

As can be seen from Table II, the lead-to-aluminum meson production cross section ratio increases with decreasing E_0 and, probably, becomes larger than the geometric $\sigma_{Pb}/\sigma_{Al} = 3.9$ for low-energy mesons.

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METHOD FOR DETERMINING HYPERON POLARIZATION IN THE REACTION $\pi + p \rightarrow Y + K$

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THE polarization of hyperons is one of the main features of the interactions that lead to the production of strange particles. On the other hand, the asymmetry in the subsequent decay of the polarized hyperons is specified by the product of the polarization and the asymmetry coefficient;[1,2] for the determination of the latter quantity, the polarization of the hyperon has to be known.

In the present note we propose a method for determining the polarization of the hyperon in the reactions

$$\pi + p \rightarrow (\Sigma, \Lambda) + K, \quad K + p \rightarrow (\Sigma, \Lambda) + \pi. \tag{1}$$

The method consists of measuring the asymmetry of the K or π mesons produced in the reactions (1) with a polarized proton target. We shall show that in this case the asymmetry gives directly the polarization of the hyperon in the reaction with an unpolarized proton target.

The matrix for a reaction of type (1) in the most general form can be written as

$$M = a + \mathbf{b} \cdot \sigma \tag{2}$$

(the hyperon spin is $1/2$, the K-meson spin is zero). The density matrix of the initial state is

$$\rho_0 = (1 + \mathbf{P}_0 \cdot \sigma)/2, \tag{3}$$

where $\mathbf{P}_0$ is the polarization of the target protons.

Using (2) and (3) we obtain the following expression for the differential cross section

$$\sigma(\theta, \varphi) = (aa^* + \mathbf{b} \cdot \mathbf{b}^*)\left(1 + \mathbf{P}_0 \frac{a^*\mathbf{b} + a\mathbf{b}^* + i[\mathbf{b}^* \times \mathbf{b}]}{aa^* + \mathbf{b} \cdot \mathbf{b}^*}\right). \tag{4}$$

Now we compute the polarization of the hyperon for the case of the unpolarized proton target and obtain

$$\mathbf{P} = \frac{a\mathbf{b}^* + a^*\mathbf{b} + i[\mathbf{b} \times \mathbf{b}^*]}{aa^* + \mathbf{b} \cdot \mathbf{b}^*}. \tag{5}$$

Two cases arise according to the intrinsic parity of the particles involved in the reaction.

1. The intrinsic parity does not change, i.e., $I_\pi I_p = I_Y I_K$. Here the matrix (2) is scalar and $\mathbf{b} = b_0 \times [\mathbf{k} \times \mathbf{k}']$, where $\mathbf{k}$ and $\mathbf{k}'$ are unit vec-