hypothesis of a decay-scheme of the hyperon: $\Sigma^+ \to \pi^+ + n$ fits best the observed values of the momentum, of the angle and of the ionization ratio pertaining to the primary and secondary particles. The observed half-life of the particle is also in good agreement with this hypothesis. For the energy of decay of the hyperon we get

$Q = (125^{+175}_{-20})$ mev.

Figure 2 shows the photograph of case 120.54: generation of V^0-particles in a shower. Two types of neutral V-particles are known: the Λ^0 and θ^0-particles. The analysisof the decay-schemes of these particles [$\Lambda^0 \to p + \pi^-$ and $\theta^0 \to \pi^+ + \pi^-$] has shown that, in the observed case, a Λ^0-particle decayed into a fast proton and a slow π^--meson. In case 112.66 one also observes the decay of a V^0-particle formed on the beryllium plate. The positively charged secondary particle cannot be a proton because of the observed values of the momentum and of the ionization. One must then assume that the decay follows the scheme $\theta^0 \to \pi^+ + \pi^- + 214$ mev. In this case, the momentum of particle l must be equal to 6.3×10^8 ev, which is in good agreement with the experimental value. In all the observed cases the direction of the charged particle (which generated the V-particle on a Be nucleus) is known; hence, one can measure the angle φ between the plane of generation of the V-particle and the plane of its decay (see Table II).

Table III shows the data on angles φ for all cases known in the literature of pair generation of hyperons and K-particles resulting from irradiation of hydrogen by π -mesons.

For all 9 observed cases of formation of hyperons in a π^-_p interaction, the angle $\varphi$is such that $\varphi \leq 40°$; this indicates that hyperons have large spins. At the same time, for hyperons formed on a Be nucleus, we have $\varphi \geq 40°$ (Table II). This is probably due to the Be nucleus (such as scattering of hyperons or their generation by secondary particles of the shower).

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Linearization of the Hartree Equations

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In addition to the existing methods of description of collective interactions[1-4] we may consider another one based on the linearization of the Hartree equation near the solutions with constant density.

In the equations

$$i\hbar\frac{\partial\psi_i}{\partial t}+\frac{\hbar^2}{4m}\Delta\psi_i-\left\{\int G(|\mathbf{r}-\mathbf{r}'|)\times\sum_j|\psi_j(\mathbf{r}')|^2d\mathbf{r}'\right\}\psi_i(\mathbf{r})=0 \quad (1)$$

let us make the substitution

$$\psi_i(\mathbf{r},t)=\sqrt{P_i(\mathbf{r},t)}\exp\{-iS_i(\mathbf{r},t)/\hbar\}.$$

This leads to the system of equations

$$\partial P_i/\partial t+m^{-1}\operatorname{div}(P_i\nabla S_i)=0, \quad (2)$$

$$\frac{\partial}{\partial t}S_i+\frac{1}{2m}(\nabla S_i)^2+\int G(|\mathbf{r}-\mathbf{r}'|)\times\sum_j P_j(\mathbf{r}')\,dr'-\frac{\hbar^2}{4m}\left\{\frac{\Delta P_i}{P_i}-\frac{1}{2}\left(\frac{\nabla P_i}{P_i}\right)^2\right\}=0.$$

The form of these equations is identical to the form of the equations of irrotational motion of an ideal compressible fluid. The states of the system which are close to a constant space density of particles can be described by equations obtained by the linearization of equations (2) near the solutions, with $P_j^0=\text{const}=P_0$, $S_j^0=E_j^0t+\overline{S}_j^0(\mathbf{r})$; $\Delta S_j^0=mv_j^0$ [$\mathbf{v}_j^0$ is the velocity of the jth particle in the state of a uniform space density of particles, $E_j^0=m(v_j^0)^2/2$].

Let us look for the solutions P_jS_j of the linearized eqations in the form of a superposition of plane waves [$\sim\exp(i\mathbf{kr}-i\omega t)$]. The conditions of the solvability of homogeneous algebraic equations for the amplitudes gives the dispersion relation

$$1 = P_0k^2 (G(k)/m) \sum_j [(\omega - \mathbf{k}\mathbf{v}_j^0)^2 - \hbar^2k^4/4m^2]^{-1}, \quad (3)$$

where $G(k)$ is the Fourier component of the interaction potential $G(r)$.

Equation (3), whose solution gives the dependence of ω on k, coincides with the dispersion relation derived in Ref. 3 by another method.

The advantage of the collective description of the interaction by Eqs. (1) is that these equations permit the formulation of the limiting problem of an isolated system of interacting particles confined to a bounded region of space (in analogy to the limiting problem of hydrodynamics of an ideal fluid).

In particular, we can use Eqs. (1) to formulate the problem of free surface oscillations of heavy nuclei (given the potential of interaction between nucleons). So far, we have not considered the effect of the symmetry of the wave function on Eq. (3). In the case of the Fermi statistics, when each fermion state is filled by two particles, i.e., the resulting spin is equal to zero, the Hartree-Fock equations (taking into account the antisymmetry of the wave function) differ from the Hartree Eq. (1) by the additional term

$$-\int G(|\mathbf{r} - \mathbf{r}|) \sum_j \psi_j^*(\mathbf{r}) \psi_j(\mathbf{r}') \psi_i(\mathbf{r}')\, d\mathbf{r}',$$

which takes into account the exchange effect.

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Some Remarks Concerning the Macroscopic Theory of Superconductivity

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In the macroscopic theory of superconductivity developed in Ref. 1 (see also Ref. 2, in which further pertinent works are cited), the free energy density for a superconductor in the absence of a magnetic field is taken to be

$$F_{s0}(T) = F_{n0}(T) + \alpha(T)|\Psi|^2 + {}^1/_2\beta|\Psi|^4, \quad (1)$$

where F_{n0} is the free energy density in the normal state and $|\Psi|^2$ is the concentration of "superconducting electrons". Further, α and β are coefficients expressible in terms of the critical magnetic field for the bulk metal H_{cm} and the weak field penetration depth δ_0:

$$H_{cm}^2 = 4\pi\alpha^2/\beta; \quad \delta_0^2 = mc^2\beta/4\pi e^2|\alpha|. \quad (2)$$

Equation (1) represents an expansion in powers of $|\Psi|^2$; in general, however, it is possible to break off the expansion after the $|\Psi|^4$ term only in the immediate vicinity of the second-order phase transition under consideration, i.e., for $T_c - T \ll T_c$, where T_c is the critical temperature. Under these conditions it is also possible to set $\alpha = (d\alpha/dT)_c(T - T_c)$ and $\beta = \beta(T_c)$, as was done in Ref. 1 and subsequently. As we move away from T_c and, in particular, as $T \to 0$ it becomes impossible to write an expression for $F_{s0}(T)$ based upon general considerations; on the other hand, it would be desirable to obtain even semi-empirical formulas which would permit comparison of theory with experiment for all temperatures. For this purpose Bardeen[3] adopted the expression:

$$F_{s0}(T) = F_{n0}(T) + \frac{H_0^2}{4\pi}\left\{\left(\frac{T}{T_c}\right)^2\left(1 - \sqrt{1 - \left|\frac{\Psi}{\Psi_0}\right|^2}\right) - \frac{1}{2}\left|\frac{\Psi}{\Psi_0}\right|^2\right\}, \quad (3)$$

(Ψ_0 being the equilibrium value of Ψ at $T = 0$) which is used in connection with the so-called two-fluid model for a superconductor.[4] The two-fluid model, however, meets with serious objections[2,4], and the use of Eq. (3) is actually based only upon