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SPINS AND PARITIES OF THE HYPERFRAGMENT H^4_Λ AND OF THE K MESON

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In this note we shall give a summary of the angular correlations in the cascades:

$$\pi^- + \mathrm{He}^4 \rightarrow H^4_\Lambda + K,\ H^4_\Lambda \rightarrow \mathrm{He}^4 + \pi,\ K \rightarrow \pi + \pi; \quad (1)$$

$$K^- + \mathrm{He}^4 \rightarrow H^4_\Lambda + \pi,\ H^4_\Lambda \rightarrow \mathrm{He}^4 + \pi \quad (2)$$

for several variants of spins in parities of H^4_Λ and K.

We assume at first that the spin of the K meson is zero. If in cascade (1) the first reaction takes place near the threshold (kinetic energy of the π^- mesons in the laboratory is 620 to 640 Mev), then it is natural to assume that H^4_Λ and K are formed predominantly in the s state if π (the product of the parities of π^-, He^4, H^4_Λ, and K) is $(-1)^i$ (i is the spin of the hyperfragment), and in the p state if $\pi = (-1)^5$ (in this case the production in the s state is forbidden). The distribution about the angle γ between the direction of the incident pions and the H^4_Λ decay products (in the system where H^4_Λ is at rest), given in the table, has been obtained under these assumptions. As can be seen, it is possible in principle to determine not only i, but also the products of the parities of H^4_Λ and K (assuming that the product of the parities of the π^- and He^4 is -1).

Parity variant	Spin variant		
	0	1	2
$\pi = (-1)^i$	1	$3\cos^2\gamma$	$^5/_4(1-6\cos^2\gamma + 9\cos^4\gamma)$
$\pi = -(-1)^i$	Forbidden reaction	$^3/_2(1-\cos^2\gamma)$	$^{15}/_2(\cos^2\gamma - \cos^4\gamma)$

Cascade (1) contains three reactions, and it therefore permits also the determination of the spin of the K meson by the Adair method[1] (true, if $k \neq 0$, the product of the parities of H^4_Λ and K is no longer determined by the angular correlations). For this purpose one first selects such cases of the reaction $\pi^- + He^4 \rightarrow H^4_\Lambda + K$, in which the hyperfragment and the K meson make (in the center of mass system) small angles $\vartheta_f \approx 0$ with the direction of the incident pions (aligned with the z axis). If the H^4_Λ decays associated with the $K \rightarrow \pi + \pi$ decays are further selected such that the pions make small angles $\vartheta \leq \Delta\vartheta$ with the same z axis, then the distributions about γ, which are chosen on the basis of this selection and which determine the spin i, will be the same as on the threshold in the variant $\pi = (-1)^i$ (see table). If one chooses instead the decays $K \rightarrow \pi + \pi$, associated with the H^4_Λ decays along the z axis, it is possible to determine k. The correlation relative to the angle between the z axis and the direction of the decay products of K (in the system where the K meson is at rest) is given as a function of k in the same first line of the table.[1] The value of the permissible intervals of small angles ϑ_f and ϑ ($\Delta\vartheta_f$ and $\Delta\vartheta$) diminishes with increasing ℓ'_{max} — the maximum important orbital momentum of the products of the reaction $K^- + He^4$ $H^4_\Lambda + K$ — and spin k respectively. If $\ell'_{max} = 1$, we get $\Delta\vartheta_f \approx 20°$.

Cascade (2) was first proposed by Dalitz,[3] and Gell-Mann[4] gives a set of correlations for this cascade. If $k = 0$, these correlations have the same form as in the table, but relative to another angle θ, see Ref. 4. We emphasize here only that these formulas must be compared with the experimental distributions, obtained for the reactions $K^- + He^4 \rightarrow H^4_\Lambda + \pi^0$ without preliminary formation of a mesonic atom. If we verify somehow that the reaction took place "in flight," one can expect that at K-meson energies up to

20 Mev (but above 0.01 Mev) the He^4 nucleus captures the K meson in the s state [or in the p state, if $\pi = -(-1)^i$] by some specific (non-electromagnetic) short-lived forces.

At greater K-meson energies the correlation formulas are the same, but are valid only for reaction products making small angles with the direction of the incident K meson.

Cascade (2) does not permit determination of the spin of the K meson, and the effect of $k \neq 0$ on the discussed correlations relative to θ can be investigated only qualitatively. If $k \neq 0$, the correlation corresponding to a given i becomes less anisotropic, smoothes out, and thereby yields too low values of the hyperfragment spins.

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RADIATION FROM AN ELECTRON TRAVERSING A SLAB

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WHEN an electron moves in an inhomogeneous medium it radiates. If its velocity is greater than the phase velocity of light, it will also emit Cerenkov radiation. The radiation emitted by an electron moving at right angles to the boundary between two media was first investigated by Ginzburg and Frank[1] (see also Refs. 2 and 4). In the present paper we wish to communicate the results of calculations on the angular distribution of the radiation emitted by a charge moving perpendicularly to a slab placed in a vacuum.

The energy emitted into the half-space in front of the slab ($z < 0$) is as follows:

$$W = \frac{2e^2v^2}{\pi c^3}\int_0^\infty d\omega \int_0^{\pi/2} \sin^3\vartheta \cos^2\vartheta \,|A(\omega,\vartheta)|^2 d\vartheta, \tag{1}$$

$$A(\omega,\vartheta) = (\varepsilon' - 1)\left[e^{-ixd\omega/c}(1+\beta x)(x-y)(1-\beta^2-\beta x) + e^{-ixd\omega/c}(1-\beta x)(x+y)(1-\beta^2+\beta x)\right.$$
$$\left. - 2xe^{id\omega/v}(1-\beta\cos\vartheta)(1+\beta\cos\vartheta-\varepsilon'\beta^2)\right]\left[e^{-ixd\omega/c}(x-y)^2 - e^{ixd\omega/c}(x+y)^2\right]^{-1}(1-\beta^2\cos^2\vartheta)^{-1}(1-\beta^2x^2)^{-1}; \tag{2}$$
$$x = \sqrt{\varepsilon' - \sin^2\vartheta}. \quad y = \varepsilon'\cos\vartheta.$$

The z axis is in the direction of the moving electron; d is the thickness of the slab, whose dielectric constant ϵ' may be complex (if there is absorption);* ϑ is the angle between the z axis and the direction of observation.

The angular distribution of the radiation behind the slab (in the half-space $z > d$) is obtained by replacing v by $-v$. If d is allowed to increase to infinity, and at the same time the absorption is taken to be finite, with $\mathrm{Re}(ix) > 0$, then the formula above reduces to the result of Ginzburg and Frank† for the radiation emitted by an electron flying into an infinite medium.

Analysis of the solution shows that for a nonrelativistic electron the angular distribution of the radiation is the same in the forward direction as it is in the backward direction. For a thin slab ($d \ll \omega\sqrt{\epsilon/c}$), the angular distribution of the radiation emitted by a nonrelativistic electron turns out to be the same as the angular distribution of the radiation from an oscillating dipole; in the most favorable case, i.e., for