As is well known, a simple classical consideration[2] leads to an excess of π^- mesons over π^+ mesons during their production respectively on neutrons and protons. A similar model is applied to the photoproduction of strange particles.

We will consider in particular the processes:

$$\gamma + p \rightarrow \Sigma^0 + K^+, \tag{3^0}$$

$$\gamma + n \rightarrow \Sigma^- + K^+. \tag{3^-}$$

While these processes are equivalent with regard to the interaction of the γ-quanta fields with the K^+ meson currents, they differ from one another with regard to the interaction of the γ-quanta with the hyperon currents.

Similarly to Ref. 2, the ratio of the cross sections of these processes is (in the laboratory system):

$$\frac{\sigma^0}{\sigma^-} = \frac{|(\mathbf{jA})_K|^2}{|(\mathbf{jA})_{\Sigma^-} + (\mathbf{jA})_K|^2}, \tag{4}$$

where $\mathbf{j}$ is the particle current, and $\mathbf{A}$ is the vector potential of the electromagnetic field. Applying conservation laws, we have (for nonpolarized γ-quanta):

$$\sigma^0/\sigma^- = [1 - (\varepsilon/m)(1 - v\cos\theta)]^2, \tag{5}$$

where ϵ is the total energy of the K^+ meson, v is its velocity, and θ is the angle between the directions of the γ-quantum and the K^+ meson. It is interesting that this equation coincides in form with the equation obtained by Brueckner and Goldberger[2] (m is the nucleon mass, $c = 1$).

If the magnetic interactions predominate over those of the currents, we obtain for σ^0/σ^- (compare Ref. 3):

$$\frac{\sigma^0}{\sigma^-} = \left(\frac{b}{a}\right)^2\left[1 + \frac{(a\mu_p - b\mu_n)(\varepsilon/M)(1 - v\cos\theta)}{1 + b\mu_n(\varepsilon/M)(1 - v\cos\theta)}\right]^2, \tag{6}$$

where M is the mass of the Σ hyperon,

$$\frac{1}{a} = \mu_{\Sigma^0} - \frac{m}{M}\mu_p, \quad \frac{1}{b} = \mu_{\Sigma^-} - \frac{m}{M}\mu_n,$$

and μ is the magnetic moment of the respective particle in Bohr magnetons.

[1] D. C. Peaslee, Phys. Rev. 105, 1034 (1957).
[2] K. A. Brueckner and M. L. Goldberger, Phys. Rev. 76, 1725 (1949).
[3] K. A. Brueckner, Phys. Rev. 79, 641 (1950).

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217

ON THE USE OF TWO AUXILIARY FIELDS TO OBTAIN EMISSION STATES IN QUANTUM MECHANICAL AMPLIFIERS AND GENERATORS

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In order that a system of particles have negative absorption, it is necessary to produce an excess number of particles (active "molecules") in the upper energy level (m) of the given transition (m → q). A number of methods allows one to obtain active molecules by means of an auxiliary high frequency field with the auxiliary field having, in those cases when in the excitation process the distances between the levels remains unaltered, a frequency either greater than[1,2] of equal to[2,3] the transition frequency ω_{mq}. As is shown below, the last method — the method of "pulse inversion" — allows one by using two auxiliary fields to obtain active molecules with frequencies of the auxiliary fields being somewhat lower than the frequency of the main transition.*

We consider a system with four levels $m > p > n > q$ and with the equilibrium population of the i-th level given by N_i. We apply a pulse of the resonance field of frequency ω_{mn} which leads to a perturbation of the Hamiltonian of the form:

$$V = F^+ \exp(-i\omega_{mn}t) + F^- \exp(i\omega_{mn}t).$$

Thanks to the periodic transition of the particles from the state m to the state n and back with the period[4] $2T_{mn} = \pi\hbar/|F_{mn}|$ if the duration of the pulse τ is equal to an odd number of half periods, the system will turn out to be inverted[3] (there will be N_n particles in the level m, and N_m particles in the level n). We assume that the relaxation time is large compared to τ. By applying a pulse of the second resonance field of frequency ω_{pq} which lasts an odd number of half periods T_{pq} we invert the population of the levels p and q. By choosing the field amplitudes in such a way that the same pulse length corresponds to the simultaneous inversion of the population of both pairs of levels, it is possible to act on the system with both fields simultaneously by a pulse of duration

$$\tau = (2k+1)\,T_{mn} = (2l+1)\,T_{pq}.$$

The two auxiliary fields enable us to obtain $N_n - N_p$ active molecules for the transition of frequency $\omega_{mq} > \omega_{mn}, \omega_{pq}$. Obviously $\omega_{mq} < \omega_{mn} + \omega_{pq}$. It is assumed above that any non-resonance influence of the field ω_{mn} on the transition pq and vice versa is excluded (either owing to the separation of the frequencies ω_{mn} and ω_{pq}, or owing to different polarization properties of these transitions). The frequencies ω_{mn} and ω_{pq} may coincide (for example, the two π-components right- and left-circularly polarized in the hyperfine structure spectrum; the transition $m \to q$ corresponds to the σ-component.† In this case it is sufficient to act on the system by a single auxiliary field which contains components of the required polarization (linearly polarized in the plane perpendicular to the magnetic field in the example discussed above) in order to obtain active molecules for the higher frequency transition.

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*We note, however, that this requires a special set of energy levels, transitions between which are allowed, and also that the frequency of at least one of the two auxiliary fields may be below ω_{mq} by not more than a factor two.

†The transition $(F, m \to F', m')$, σ-components $(3/2, 1/2 \to 1/2, -1/2)$ and $(3/2, -1/2 \to 1/2, -1/2)$, π-component $(3/2, 1/2 \to 1/2, 1/2)$, F and m are quantum numbers of the total angular momentum and of its projection (for a nuclear spin of 1).[5]

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[2] J. Wittke, Proc. I.R.E. **45**, 291 (1957).

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[4] L. D. Landau and E. M. Lifshitz, Квантовая механика (Quantum Mechanics), Gostekhizdat, (1948) p. 171.

[5] J. Nafe and E. Nelson, Phys. Rev. **73**, 718 (1948); Townsend, Weissman, and Pake, Phys. Rev. **89**, 606 (1953).

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218