transformation. Thus, the plot of the rate of nucleation against $\Delta\mu$ should have two branches corresponding to the formation of a relaxed (partially coherent) phase[4]. Since the rate of nucleation is proportional to $\exp(-F^*/kT)$, it follows that the rate of nucleation during the formation of a low-temperature phase from a high-temperature one should be nonmonotonic (Fig. b).

The absolute values of the rates of nucleation of coherent and partly-coherent phases may differ significantly. For example, at small $\Delta\mu$, when $\tau^* \gg r_c$ and $\rho^* \simeq \varepsilon_0/b$, $F^* = (16\pi/3)(\sigma^0 + \alpha Gb\varepsilon_0)^3/\Gamma\mu^2$ and, if $\sigma^0 < \alpha Gb\varepsilon_0$, the rate of nucleation of the relaxed phase is lower by several orders of magnitude than the rate of coherent nucleation at equal values of the moving force. It is necessary to add to the already noted difference between the barriers to nucleation also the difference between the mobilities of the interphase boundaries [1], which makes the rate of transition with formation of a coherent phase much larger than for the transition with formation of a relaxed phase. The formation of a coherent or partly coherent phase corresponds apparently to two known kinetic types of transition in a single-component system, viz., normal and martensitic [2].

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$\rho^0 - \omega$ INTERFRENCE IN THE REACTIONS $\gamma N \to \pi^+\pi^-\Delta$

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1. At the present time, the main information concerning the magnitude and phase of the $\omega \to \pi^+\pi^-$ decay due to electromagnetic $\rho^0 - \omega$ mixing [1 - 3] is obtained from experiments on the study of the effects of $\rho^0 - \omega$ interference in $\pi^+\pi^-$ mass spectra [4 - 6]. For a quantitative determination of the parameters of the electromagnetic $\rho^0 - \omega$ mixing it is important to know the relative magnitude, the relative phase, and the degree of coherence of the amplitudes of ρ^0- and ω-meson production reactions. Therefore reactions with known simple mechanisms of ρ^0 and ω production are most convenient for the study of the $\rho^0 - \omega$ mixing.

At the same time, the $\rho^0 - \omega$ interference in the $\pi^+\pi^-$ system can be used to verify and refine the theoretical mechanisms of ρ^0 and ω production [4].

In both cases, special interest attaches to processes in which the cross sections for ω-meson production are much larger than ρ^0-production cross sections, since it is necessary to expect for them a considerable enhancement of the $\rho^0 - \omega$ interference.

We wish to note in the present article that examples of such reactions are the reactions $\gamma N \to \rho^0\Sigma$ and $\gamma N \to \omega\Delta$, experiments on which are being performed at present and for which the first data have already been obtained [7 - 12].

[4] If the relaxation takes place with participation of more than one type of dislocation, then their sequential inclusion in the process may become manifest by the appearance of new kinetic branches of the transformation.

We shall show that theoretical considerations lead us to expect in the reactions $\gamma N \to \pi^+\pi^-\Delta$ a much stronger $\rho^0 - \omega$ interference effect than in the well-studied reactions $\gamma A \to \pi^+\pi^- A$ (see the figure).

2. The mass spectrum of the $\pi^+\pi^-$ mesons with allowance for $\rho^0 - \omega$ mixing in the resonance region is written in the form (cf., e.g., [4]):

$$\frac{dN(\pi^+\pi^-)}{dm} \sim \frac{N_\rho \Gamma_\rho}{|D_\rho(m)|^2}\left(1 + 2d\cos\phi \left|\frac{\delta}{D_\omega(m)}\right| \frac{N_\omega^{1/2}}{N_\rho^{1/2}} + \frac{N_\omega}{N_\rho}\left|\frac{\delta}{D_\omega(m)}\right|^2\right). \qquad (1)$$

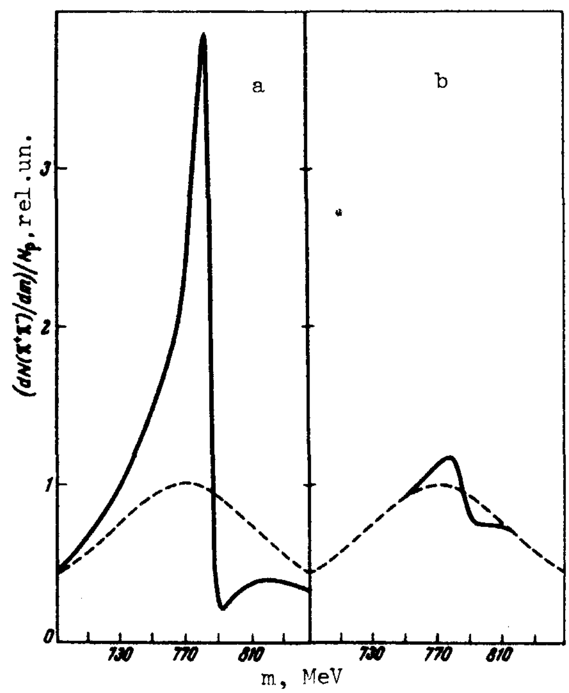
Here m is the invariant mass of the $\pi^+\pi^-$ system, N_V is the total number of V-meson production events ($V = \rho^0, \omega$), $D_V(m) = m - m_V + i\Gamma_V/2$, m_V and Γ_V are respectively the mass and width of the V meson, and δ is the amplitude of the electromagnetic $\rho^0 - \omega$ transition. The coherence factor d and the phase ϕ are given by

$$d = \left|\sum_i A_i^\rho A_i^\omega\right| \Big/ \left[\left(\sum_i |A_i^\rho|^2\right)\left(\sum_i |A_i^\omega|^2\right)\right]^{1/2};$$

$$\phi = \phi_\delta + \operatorname{arc\,tg}\frac{\Gamma_\omega}{2(m_\omega - m)} + \operatorname{arc\,tg}\left(\sum_i |A_i^\rho||A_i^\omega|\sin\phi_i\right)\Big/\left(\sum_i |A_i^\rho||A_i^\omega|\cos\phi_i\right), \qquad (2)$$

where A_i^V is the amplitude for the production of a V meson with definite spin configuration of the particles that take part in the reaction, ϕ_δ is the phase of δ, and ϕ_i is the relative phase shift between the amplitudes A_i^ρ and A_i^ω.

To see that $\rho^0 - \omega$ interference effect can be expected in the reactions $\gamma N \to \pi^+\pi^-\Delta$ at high energies, let us attempt to establish the relative values and relative phase shifts of the $\rho^0\Delta$ and $\omega\Delta$ photoproduction amplitudes. To this end let us consider the mechanisms of the processes $\gamma N \to \rho^0\Delta$ and $\gamma N \to \omega\Delta$. The $\gamma N \to \omega\Delta$ amplitudes are due to the exchange of the following quantum numbers in the t channel: the isotopic spin I = 1, the charge parity C = +1, and the parity P = ±1. In the $\gamma N \to \rho^0\Delta$ reaction, besides the exchanges of the same quantum numbers in the t-channel, the exchange I = 2 is also possible. In addition, the interference between the amplitudes with I = 2 and I = 1 can be excluded by considering the sum of the cross sections of the reactions $\gamma p \to \rho^0\Delta^0$ and $\gamma n \to \rho^0\Delta^0$. We shall henceforth neglect the exchange I = 2 in the t-channel. Then the mechanisms of the $\rho^0\Delta$ and $\omega\Delta$ photoproduction will be due to exchange of fully identical t-channel quantum numbers. We assume furthermore that at high energies the intermediate states of the t-channel of the $\gamma N \to V\Delta$ reactions are only SU(3) octets, which is valid, for example, the Regge-pole model and in the model of poles with absorption. Applying now SU(3) symmetry to the t-channel amplitudes of the $\gamma N \to V\Delta$ reactions,



$\rho^0 - \omega$ interference in the following reactions: a) $\gamma N \to \pi^+\pi^-\Delta$, b) $\gamma A \to \pi^+\pi^- A$. Γ_ρ = 140 MeV, m_ρ = 770 MeV, Γ_ω = 12 MeV, m_ω = 784 MeV, δ = 2.9 MeV.

we obtain the relation

$$A_i^{\rho}(\gamma N \to \rho^\circ \Delta) \approx \frac{1}{3} A_i^{\omega}(\gamma N \to \omega \Delta) . \tag{3}$$

We have used here also the fact that the sine of the mixing angle of the ω and φ mesons is equal to $1/\sqrt{3}$, and have neglected the amplitudes of the $\gamma N \to \phi\Delta$ reaction, since the φ meson is practically not connected with nonstrange particles[1]. Consequently,

$$N_\omega \approx 9N_\rho , \quad d \approx 1, \quad \phi = \phi_\delta + \operatorname{arc\,tg} \frac{\Gamma_\omega}{2(m_\omega - m)} . \tag{4}$$

The available experimental data on $\rho^0 - \omega$ interference in $\pi^+\pi^-$ mass spectra indicate that δ is practically pure real, and $\Gamma_{\omega 2\pi}/\Gamma_{\omega 3\pi} \simeq 1 - 4\%$, cf., e.g., [4 - 6], in accord with the theoretical estimates [1 - 3]. The continuous curve of Fig. a is a plot of the quantity $(dN(\pi^+\pi^-)/dm)/N_\rho$ for the reactions $\gamma N \to \pi^+\pi^-\Delta$, calculated from formula (1) with allowance for (3) and the value $\delta = 2.9$ MeV, corresponding to $\Gamma_{\omega 2\pi}/\Gamma_{\omega 3\pi} \simeq 2\%$, $(\Gamma_{\omega 2\pi} \simeq 4|\delta|^2/\Gamma_\rho)$, while the dashed line corresponds only to the ρ^0 meson. Figure b shows the same for the reactions $\gamma A \to \pi^+\pi^-A$, and it is assumed here, as usual, that the main factor is the exchange of vacuum quantum numbers and the following relation is satisfied (cf., e.g., [4, 5]):

$$A_i^{\rho}(\gamma A \to \rho^\circ A) \approx 3A_i^{\omega}(\gamma A \to \omega A) . \tag{5}$$

As seen from (3) and (5), the interference term in (1) for $\gamma N \to \pi^+\pi^-\Delta$ is enhanced by a factor 9 compared with the interference term for $\gamma A \to \pi^+\pi^-A$. This is also indicated by the presented diagrams.

3. In the study of quasi-two-particle reactions there arises the general question of separating the nonresonant background processes. In this case, the principal ones among them are apparently the processes $\gamma p \to (\rho^0, \omega)\pi^+ n$ and $\gamma n \to (\rho^0, \omega)\pi^- p$, which are large at high energies and are nonresonant in the region of Δ, and in which the πN system is in a state with I = 1/2, while exchange of vacuum quantum numbers takes place in the t-channel. Their admixture may, in principle, smooth out the described picture of the $\rho^0 - \omega$ interference in the reactions $\gamma N \to \pi^+\pi^-\Delta \to \pi^+\pi^-(\pi N)$, since relation (5) is satisfied for the amplitudes of such nonresonant reactions. If we take in the region of the Δ-resonance the sum of the cross sections of the processes $\gamma p \to \pi^+\pi^-(\pi^+ n)$ and $\gamma n \to \pi^+\pi^-(\pi^- p)$, then the interference with the indicated background vanishes and it can be separated as incoherent.

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QUANTUM NUMBERS AND TOTAL AND PARTIAL WIDTHS OF THE RESONANCE $N\bar{N}(1970)$

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We have previously considered [1] the resonant states in the nucleon-antinucleon system. A characteristic feature of these resonances is the large partial width of the decay through the nucleon-antinucleon channel. Calculations show that for resonances consisting of a nucleon and an antinucleon, the partial width $\Gamma_{N\bar{N}}$ is of the same order of magnitude as the total width Γ [1]. For mesons of a different nature, in the same mass region, the $N\bar{N}$ channel is not singled out in any way, and estimates based on the statistical theory yield $\Gamma_{N\bar{N}}/\Gamma \sim 0.1 - 1\%$.

In the present paper, on the basis of experimental data, we estimate the ratio $\Gamma_{N\bar{N}}/\Gamma$ for the meson $N\bar{N}(1970)$. This meson was observed in two independent experiments: in the reaction

$$\bar{p}p \to K_S^0 K_L^0 \tag{1}$$

and in elastic backward $\bar{p}p$ scattering [2, 3]. In [2] they investigated the cross section of reaction (1) and the angular distribution of $K_S^0K_L^0$ at an incident-antiproton momentum lower than 800 MeV/c. The final state of $K_S^0K_L^0$ has negative C-parity (accurate to CP-violation, which is immaterial here). In the investigated region of incident antiproton momenta, the main contribution to the cross section of process (1) is made by the initial states of the $\bar{p}p$ system with orbital angular momentum ℓ not larger than two [4]. From C- and P-parity conservation it follows that at $\ell \leq 2$ only the $^3S_1$, $^3D_1$, and $^3D_3$ states of the $\bar{p}p$ system can participate in the reaction (1).

As was established in [2], the cross section of the process (1) has a clearly pronounced resonant character with a maximum in the 600 MeV/c region, corresponding to a resonance mass equal to 1970 MeV. The maximum value of the cross section in the resonant region exceeds by 3 - 4 times the background level. Therefore the cross section σ of reaction (1) can be represented in the form of an incoherent superposition of the smooth background σ^0 and the Briet-Wigner resonance. At resonance we obtain the following expression for the sought ratio $\Gamma_{N\bar{N}}/\Gamma$:

$$\frac{\Gamma_{N\bar{N}}}{\Gamma} = \left(\frac{\Gamma}{\Gamma_{K_S K_L}}\right)\frac{(\sigma - \sigma_0)p^2}{\pi(2l + 1)} , \tag{2}$$