The obtained experimental data serve as a basis for developing a low-temperature quartz generator having, owing to the exceptionally large Q, the highest short-time generated-frequency stability and, owing to the very low temperature, a high long-time stability, practically comparable with that of atomic-molecular standards.

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DIFFRACTION GENERATION OF PARTICLES BY PROTONS FROM EMULSION NUCLEI IN A PULSED MAGNETIC FIELD

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A photographic emulsion exposed in a strong (pulsed) magnetic field can serve as an effective means of investigating inelastic diffraction processes on complex nuclei at energies of several dozen GeV, since it not only permits observation of small excitations of the nuclei themselves, but also affords a possibility of investigating quite accurately the emission angles, the momenta, and the nature of all the observed particles. We have observed 107 stars of the 0 + 0 + 3p type, unaccompanied by tracks of recoil nuclei or slow electrons, in Ilford G-5 and K-5 emulsions (600 μ thick exposed in a 180-kOe pulsed field in the CERN proton beams (momenta 24 and 21 GeV/c, total length 1676 m). The experimental conditions made it possible to measure the momenta of all the particles accurate to 10 - 15%, and the effective masses of the $p\pi^+\pi^-$ systems accurate to 5 - 7%.

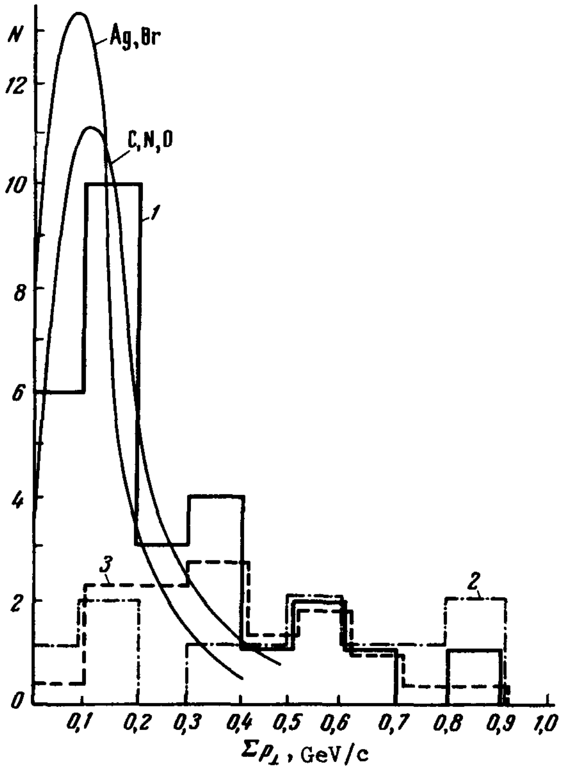

Fig.1

Out of the 107 stars, we selected 28 satisfying the following three necessary conditions of the diffraction process:

1) One of the three relativistic particles is a positive or negative pion.

2) $\delta = \sin\theta_{\pi 1} + \sin\theta_{\pi 2} + (M_N/\mu)\sin\theta_p \leqslant A^{-1/3} + M_N^2/2\mu p_0$ for A = 14, where θ_π and θ_p are the pion and proton emission angles, M_N and μ the nucleon and pion masses, and p_0 the initial momentum.

3) The total momentum of the secondary charged particles is $\sum_{i=1}^{3} p_i \geq 0.85p_0$ (thereby excluding to a considerable degree the presence of neutral particles).

Figure 1 shows the distribution, with respect to the total transverse momentum of the secondary particles ($p_\perp$), of the stars selected by us (1) and the analogous distribution of the background three-prong stars (2) and of the recoil protons in four-prong stars (3). It also shows plots of

$$N(p_\perp)dp_\perp = p_\perp \exp[-(p_\perp R/2)^2]dp_\perp ,$$

pertaining to light (C, N, O) and heavy (Ag, Br) emulsion nuclei ($R \sim A^{1/3}$ is the radius of the nucleus). It is seen from an analysis of Fig. 1 that at values $p_\perp \leq 0.2$ GeV/c the investigated phenomenon is apparently accompaniedby a slight background due to peripheral interactions with individual (quasi-free) nucleons of the nuclei. If we take $p_\perp = 0.2$ GeV/c as the limiting value for diffraction processes, then an estimate of the corresponding particle free path in the emulsion amounts to 85^{+27}_{-18} m (16 events). This is much less than data of [1] (although without contradicting them), obtained for an emulsion without a magnetic field, and is also less than the theoretical rough estimate of [2].

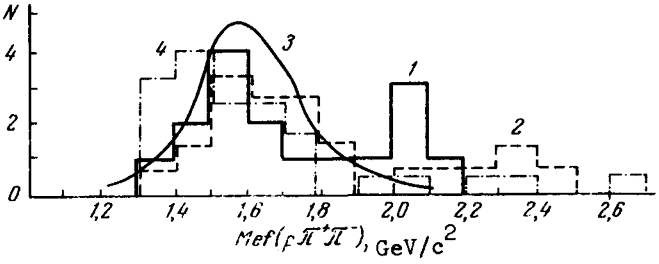

Fig. 2

Figure 2 shows the distribution of the effective masses $M_{eff}(p\pi^+\pi)$ for the indicated 16 events (1), together with the corresponding distribution for the background events (2) and the calculated distribution obtained by Nagy [3] from purely kinematic considerations for nonresonant diffraction generation of two pions by the aggregate of the light and heavy emulsion nuclei (3). We note that the greater part of the values of M_{eff} observed by us are grouped near the threshold value 1.5 GeV/c^2, which is characteristic of diffraction by light emulsion nuclei at an initial momentum p_{01} = 13 GeV/c and by heavy nuclei at p_{02} = 23 GeV/c. It can be concluded that, say, the resonant diffraction generation of two pions via a ρ meson cannot be readily reconciled with experiment, owing to the relatively small values of the effective masses.

Figure 2 shows also the distribution over M_{eff} (4) obtained in [1]. We see that besides the admixture of background events in the region of large M_{eff} there is also a systematic shift of the entire distribution to the left, relative to the plot of the phase volumes not observed in this work.

Finally, Fig. 3 shows the angular distribution of all the secondary particles (with the protons separated) pertaining to the $p\pi^+\pi^-$ system, with the Z axis chosen in the direction of the primary proton. This distribution is almost isotropic (χ^2 = 3 for four degrees of freedom), unlike the usual peripheral interactions, which are interpreted as the result of single-particle exchange (see [4]). Incidentally, the inadequate statistics of the result leave this question open for the time being.

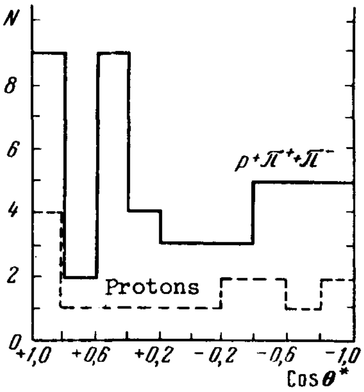

Fig. 3

Recent data [5] point to a rapid increase of the free path for the diffraction generation of particles in emulsion at average energies near 200 GeV (in cosmic rays). It is essential in this connection to set up an accelerator experiment similar to that described above at particle (proton and pion) energies 60 - 70 GeV, at which the production threshold will be exceeded for the more prevalent nucleon isobars with both three-particle and five-particle decay.

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INTERFERENCE EFFECTS IN COLLISIONS OF COMPLEX NUCLEI

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It is common knowledge that if the formation of a system in the final state following scattering is described by a pair* of divergent waves that are coherent and have comparable amplitudes, then an interference term appears in the differential cross section. The angular-distribution singularities due this term are of greatest interest when the interference waves correspond to a reversal of the sign of the relative momentum of the colliding particles, and the scattering process is strongly influenced by the Coulomb repulsion potential acting between them. This situation is typical of the physics of multiply-charged ions, or more accurately for collisions between complex nuclei having equal or near-equal masses. Namely, for example, if identical nuclei collide (or are produced), then the interfering waves are due to their quantum-mechanical indistinguishability; this case is considered in detail in [1, 2], in which it is predicted that the angular distributions will contain considerable oscillations, with properties determined by a number of the most important characteristics of the states taking part in the process. Another class of examples is associated with the fact that the large number of open channels leading to the formation of a given final state frequently include a pair satisfying the conditions formulated above. In this note we consider, by way of a very simple example of this kind, the elastic subbarrier scattering of nuclei of a beam A by a target of nuclei B, which can be effectively represented as a bound system of a certain nuclear particle α (${}_0h^1$, ${}_1H^1$, ${}_1D^2$, ${}_2He^4$) and a core A_2 which is identical to the beam nuclei. In this case a coherent contribution to the elastic-scattering amplitude will be made by the amplitude of the Rutherford Coulomb scattering through an angle θ and the amplitude of the resonant transfer of the particle α from the nucleus of the target A_2 to the nucleus of the beam A_1, with scattering of the beam nuclei through an angle π - θ. As is well