EOI - 0022
SSCL SR 1218

~~Letter of Intent~~, 1992
(To be considered as EOI as per memo from Gilman 7/27/92 to Schwitters/Luth)

COHERENT PRODUCTION OF ε^+ PARTICLES IN CRYSTAL USING PROTON BEAM FROM SSC

V.V.Okorokov, A.Yu.Dubin (ITEP, Moscow, Russia)

The unique possibilities of the SSC can be ideally used for a new generation of coherent generation experiments with relativistic protons which require 20 Tev energy of the incident beam. The availability of 20 Tev proton beam at SSC allows new experiments on coherent production of ε^+ particle by relativistic proton in crystal. Experiments carried out at low energies (coherent excitation experiment [1, 2]) can now be extended with protons in very narow energy region (resonanse energy, which easy can be calculated) using the new accelerator facilities at SSC [3,4].

We propose to study coherent production via the Coulomb field of the cristal atoms to excite the transition $p + \gamma \Rightarrow \varepsilon^+$ (1189).

COHERENT EXCITATIONS AND COHERENT PRODUCTION BY THE COULOMB FIELD OF CRYSTAL ATOMS

Physics of the coherent excitation consists in the sharp increase of the transition probability of the discret levels of the projectile particle moving through a cristal in the case when one of the harmonics of the "collision" frequency $\nu_{coll} = V/a_o$ is equal to the transition frequency $\nu_{tr} = \Delta E/h$ between the levels of the projectile particle

$$\frac{\Delta E}{h} = \frac{V}{a_o} \cdot n \qquad (1)$$

(n = 1, 2, 3... V - velositi of the projectile particle, a_o

distance between the crystal atoms).

This phenomenon has been already confirmed experimentally for excitation of the atomic levels of the ions transmited through the monocrystalline foils. There is no scientific reasons for the absence of a similar effect of coherent excitation for the nuclear levels, coherent excitation or for coherent production of ε^+ particle by proton of "resonanse" energy of proton in crystal.

The experimental results testifying the existanse of the analogous phenomenon in case of nuclear levels excitation will actually mean the discovery of a new type nuclear reaction proceeding through collective interaction of the projective nucleus with the crystal atoms. Such experiments are being prepared in France (GANIL) and Germany (GSJ). Coherent excitation of nuclear levels is expected to proceed with larger probability ($\sim 10^5$-10^6) compared to the usual Coulomb excitation of the nuclei moving through the isotropic target. The reaction must have a specific resonance dependence upon the energy of the projectile nuclei, which stipulated the multiple and perspective possibilities of the utilization of effect in physics at relativistic and ultrarelativistic energies [3]. One of the oportunities - is the suggested experiment on coherent production of ε^+ hyperons by relativistic protons in crystal target. For relativistic energy Eq.(1) can be written as follows

$$\frac{\Delta E}{h} = \frac{V}{a_o} \cdot n \frac{1}{\sqrt{1 - V^2/c^2}} \qquad (2)$$

Lorentz factor $\gamma = 1/\sqrt{1 - V^2/c^2}$ is associates with the

contraction of the crystal dimentions in the coordinate sistem where the projectile particle is at rest. From the relation 2 it is simple to obtain the expression for the kinetic energy of the relativistic proton kinematically satisfying the condition of the coherent production process $p + \gamma \Rightarrow \varepsilon^+$ in tungten crystal (a_o = 3.0 Å).

$$E_3 = 22.4 \text{ TeV for 3-th harmonic}$$

$$E_4 = 16.6 \text{ TeV for 4-th harmonic}$$

$$E_5 = 13.32 \text{ TeV for 5-th harmonic}$$

The experiment is relatively simple and required conventional detector equipment. using monocrystalline target of W, Ge or Si. The signal from the produced ε^+ hyperons should be searched as a function of smoothly changing energy of the primary proton beam. As in the case nuclear levels coherent excitation of the relativistic nucleous in a crystal:

1. The experimental results testifying the existence of the coherent generation of the ε^+ particle by the protons in crystal will actually mean the discovery of a new type particle generation proceeding the collective interaction of the projectile protons with the crystal atoms.

2. Coherent generation of the ε^+ particle must proceed with far larger probability (by 10^6-10^7 in comparison with the usual Coulomb interaction of the projectile proton with the isotropic target nucleus. Therefore, the probability of coherent production of ε^+ by protons of resonance energy using thin (1mm) target is approximately the same as it were in isotropic target 10^3-10^4 meters thick. Such thick targets seem unrealistic, whereas the proposed experiment on ε^+ production by coherent excitation using

cristall targets appears feasible. A by - product of the proposed experiment is an accurate calibration of 20 Tev proton beam of SSC.

REFERENCES

1. V.V.Okorokov at all. Phys. Lett. 43A (1973) 485.
2. S.Datz at all. Phys. Rev. A19 (1979) 977.
3. V.V.Okorokov at all. Preprint ITEP-19 (1973) Moscow.
4. A.Yu.Dubin. Journal of Nuclear Physics. V.52. N 5 (1990). 1243.