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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

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MEMORANDUM

To : Professor P. Preiswerk, Chairman of the E.E.C.

From : C. Rubbia

Subject : Letter of intention: determination of the Ξ^- parity

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A proposal for the determination of the parity of the Σ^- particle[1] has been submitted for the attention of the E.E.C. and N.P.R.C. The purpose of the present "letter of intention" is to indicate that we consider this experiment as the first step of a research programme to determine the intrinsic parity of hyperons.

We are at present actively considering as well the possibility of an experimental determination of the parity of the Ξ^- hyperon quantity, up to now completely unknown. The experimental approach discussed here follows very closely the already-mentioned experiment on the Σ^+ parity. It is essentially based on a polarized proton target of the same type but of larger size ($5 \times 2 \times 2$ cm^3) and it requires the construction of a small "ad-hoc" magnet. A target of this volume is under development in Saclay and it may be available by the beginning of 1964. A polarization of $40 \div 50\%$ is expected, even on rather conservative grounds.

The application of the Bohr theorem to reaction (1) requires an angle polarization in the production process.

Recent results of Berkeley and UCLA[2] groups indicate at 1.8 GeV/c for the reaction

$$K^- + p \rightarrow \Xi^- + K^+ \qquad (1)$$

a cross-section of the order of 200 μb and a polarization with respect to the production normal, $\langle P_{\Xi^-} \rangle = +0.8 \pm 0.3$, when $\langle P \rangle$ is the average over <u>all</u> production angles. We would prefer to select backward emitted

K^+'s, although forward emitted K's could also be accepted. The angle dependence of the polarization is in principle contained in the mentioned bubble chamber data and no preliminary experiment to determine the actual value of P_Ξ is needed. Evidently, under the reserve of choosing between forward or backward emitted K^+ mesons, one can expect a value for P_Ξ at least equal to $\langle P_{\Xi^-} \rangle$. This value is close to the one for the Σ^+ at the angle and energy chosen in Ref. 1.

Let us consider now the expected counting rate. The beam recently developed by the Lundby group (A4) appears to be the most suitable one for its short length and high acceptance. Barbier et al.[3] indicate that for 1.8 GeV/c ($\Delta p/p \sim 1\%$) and at 22 metres from the target (in the focus), a K^- flux at 6×10^3/pulse and a π^- flux of $\sim 10^6$/pulse. The spot-rise is ~ 1 cm^2. A 5 cm thick target of polarized protons (partial hydrogen density ~ 0.07) is assumed. The expected Ξ^- production rate is:

$$R_{\Xi^- K^+} = 6 \times 10^{23} \times 0.06 \times 5 \times 2 \times 10^{-28} \times 6 \times 10^3 = 0.215\ \Xi^- K^+/\text{pulse} .$$

Assume first that the polarization for forward emitted Ξ^- is large. The bulk of the K's associated with those Σ^- emerge in the lab at angles between 80° and 50°. They are 30% of all K^+'s produced[2]. For the arrangement shown in Fig. 1, about ¼ of them are entering the K^+ detector, similar to the one described in the Σ proposal. The kinetic energy of K^+ mesons varies between 80 MeV and 250 MeV. Over-all efficiency of ~ 0.4 may be anticipated. The number of recorded events from free and polarized protons is then

$$0.215 \times 0.4 \times 0.3 \times 1/4 = 6.5 \times 10^{-3}/\text{pulse},$$

that is slightly above one event for 200 machine pulse, which was the rate predicted for the Σ^+ parity experiment. Similar conclusions hold if forward emitted K's are selected.

A point which deserves direct experimental investigation is whether the K^+ detector may be badly upset by the large π^-'s flux (10^6/pulse) when associated with the K^- mesons.

There are a number of arguments which seem to indicate that this is probably a controlable source of background events.

i) A Čerenkov counter is rejecting events in which a π^- particle is entering in the experimental apparatus.

ii) The K^+ detector is probably at a large angle from the beam. The bulk of the π^- interactions are expected to be going in the very forward cone.

iii) Cork et al.[4] have studied the reaction $\pi^+ + p \to K^+ + \Sigma^+$ with a K^+ detector of the type discussed here and an incident π^+ flux contaminated by $\sim 10^6$ protons/pulse and with a much worse duty cycle.

iv) Detailed numerical calculations taking into account the various possible processes.

The rejection of events due to inelastic interactions cannot be predicted at present. Considerations similar to the ones already mentioned for the Σ^+ parity apply. However, even if for an inelastic contribution equal to twice the hydrogen one, the separation between the two cases will be of the order of 10 standard deviations for 100 hours of effective measurement with the PS machine operated at 19 GeV and 4×10^{11} circulating protons/pulse.

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REFERENCES

1. A. Abragam et al., Proposed determination of the K - N - Σ parity. Proposal to the E.E.C. and N.P.R.C., 10th June 1963.

2. A. Alvarez et al., Proc.Int.Conf.on High-Energy Phys. CERN 1962, p. 433.

3. M. Barbier et al., Nuclear Inst.and Methods 20, 66 (1963).

4. B. Cork et al., Phys.Rev. 120, 1000 (1960).

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