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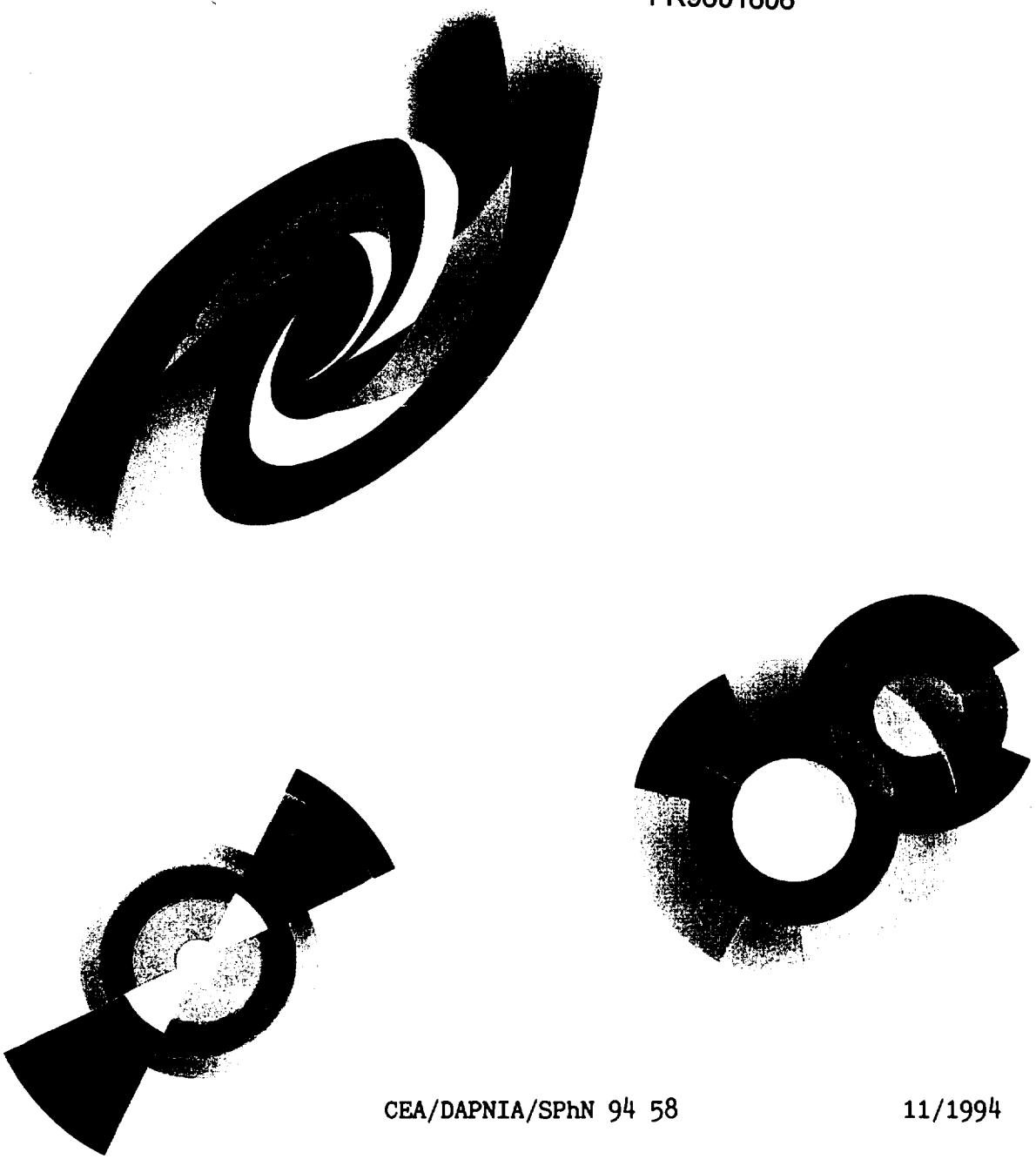

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Intermediate Energy Electromagnetic Interactions

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Abstract. A brief summary of contributions to the parallel session on Intermediate Energy Electromagnetic Physics is given.

INTRODUCTION

Without being exhaustive, one can sketch the following history of the field of polarization measurements in electromagnetic interactions. Until a few years ago, very few precise measurements of spin observables were performed.

This was especially the case for experiments with lepton beams: there were pioneering experiments to study parity violation with polarized electron and muon beams, respectively at SLAC and Serpukhov; polarized targets were also used at SLAC together with the polarized electron beam. In order to determine the deuteron form factors in elastic electron-deuteron scattering, the first use of a polarized atomic beam was done inside an electron ring at Novosibirsk, and the recoil deuteron tensor polarization was first measured at Bates (MIT).

With photon beams, it has always been easier to use cryogenic solid polarized targets and consequently many measurements like photoproduction of mesons on polarized protons were performed, for example at DESY. In the study of deuteron photodisintegration, polarized photon beams were used at Kharkov and Frascati, proton recoil polarization was measured at Tokyo and Kharkov.

Due to smaller cross-sections, to limitations in the luminosity and in the degree of polarization attainable, the field of polarization has been much less rich in the study of electromagnetic processes than in the one of hadronic processes.

Technical improvements have recently led to:

- deep inelastic scattering of polarized electrons and muons off polarized targets,
- spin correlation and spin transfer coefficients to extract nucleon electromagnetic form factors, and

- parity violation as a tool to extract nucleon weak form factors,

and these subjects have been developed in other parallel sessions at this conference.

The use of spin observables in electromagnetic processes

- to study nuclear structure and important reaction mechanisms such as relativistic effects, modification of nucleon properties in the medium,
- to elucidate properties of baryonic resonances, and
- to understand the transition from meson-nucleon dynamics to quark-gluon dynamics,

is barely starting. We anticipate a large number of new experiments addressing these questions in the next few years. Experiments and calculations reported in our session are evidence for this trend.

PHOTOPRODUCTION OF PSEUDOSCALAR MESONS ON THE PROTON

The first polarization experiment at ELSA, the stretcher ring installed at the Bonn synchrotron, was presented at this conference. Using tagged photons, a frozen spin target and the detector PHOENICS, the target asymmetry was measured in the reactions $\gamma\vec{p} \rightarrow \pi^+ n$ and $\gamma\vec{p} \rightarrow \pi^0 p$. 3150 data points were obtained for $220 < E_\gamma < 800$ MeV and $35° < \theta_\pi^{c.m.} < 135°$.

A new multipole analysis of pion photoproduction is in progress. It should allow to extract the strength of the (small!) E2 transition for this process. If this transition does occur, it could be a sign, but this is a model dependent statement that will require much investigation, of a D-wave component in the Δ resonance.

$\gamma\vec{p} \rightarrow \eta p$ will be measured soon at ELSA, and we were presented with theoretical predictions which will shed light on the role, if any, of the Roper (P_{11}) resonance in this process.

As for kaon photoproduction ($\gamma p \rightarrow K\Lambda$ and $\gamma p \rightarrow K\Sigma$), the latest calculations of the Saclay-Lyon group were presented. The present data set is well described up to $E_\gamma = 2$ GeV in a model incorporating proton resonances in the s channel, K resonances in the t channel, and hyperon resonances in the u-channel, using coupling constants in agreement with SU(3). An analysis in terms of helicity amplitudes (Saclay-Pittsburgh) allows to group the observables in classes according to their decomposition in Legendre polynomials; the number of nodes in an observable (for example the beam asymmetry) gives then an indication of the spin of intermediate resonances in the process. A conclusive test of these models will come from experiments planned at ELSA, GRAAL (tagged polarized photon beams at ESRF-Grenoble) and CEBAF.

PHOTONUCLEAR REACTIONS

In addition to the new results on deuterium and ^{3}He, and presented in the plenary session by A. Sandorfi, the LEGS collaboration at BNL has investigated $^{16}O(\vec{\gamma}, p\pi^-)$ and $^{16}O(\vec{\gamma}, pp)$ reactions. The first one aims at creating a Δ in the interior of the nucleus and study its propagation in the nuclear medium, while the second one addresses the question of short range two-nucleon correlations in the nucleus. For both cases, double differential cross-sections and beam asymmetries, as a function of the angles of the two outgoing particles, were extracted. The comparisons with model calculations were still preliminary and not conclusive at this stage.

DEUTERON ELECTROMAGNETIC STRUCTURE

The separate determination of the charge and quadrupole electric form factors of the deuteron necessitates the measurement of a polarization observable. Though very important for the understanding of the short-range nucleon-nucleon interaction and of the role of non-nucleonic degrees of freedom in nuclei, the measurements of such an observable are very few, for reasons given in the introduction. The observable of choice so far has been t_{20}, a measure of the alignment of the deuterons produced in the scattering. One needs either to use a tensor polarized target, or to measure the tensor polarization of the recoil deuterons.

The Novosibirsk-Argonne collaboration at VEPP-3 has been improving its measurements with an internal polarized atomic beam trapped in a cell. The target polarization is now monitored by a continuous measurement of e-d tensor asymmetry at low transfer, where it is well known. The new results presented at this conference, at Q = 3.6 fm^{-1}, are in agreement, (but with poor statistical significance) with earlier results from the same group shown at previous conferences, but in apparent disagreement (about 2.2 standard deviations) with the latest, and more precise, Bates data. Our understanding of isoscalar meson exchanges and of relativistic effects depends significantly on which data to believe, so that this discrepancy, if it should remain, should be clarified. The achievable luminosity should be greatly improved next year at VEPP-3 with the use of a spin-exchange optically pumped target.

The polarimeter POLDER for tensor polarized deuterons in the energy range 175 < E_d < 500 MeV was calibrated at Saturne and is to be used at CEBAF for measurements at still higher momentum transfers (4.0 < Q < 6.8 fm^{-1}) of the t_{20} observable.

In quasi-elastic scattering off a tensor polarized target ($\vec{d}(e, e'p)n$), one has access, supposing the validity of the impulse approximation, to the ratio of D and S wave functions in momentum space. Such a measurement is being prepared in the stretcher ring at NIKHEF, using an internal polarized target.

There was an interesting discussion about how to deal with background rates in an electron ring.

SPIN PHYSICS AT CEBAF

There are great expectations from this new facility, which delivered its first beam on target this last July. The first polarized beam is planned for the end of 1995. The equipment that will allow the measurements of polarization observables is being implemented, either at CEBAF or by users: this includes beam polarimeters, polarized (gas or solid) targets, recoil polarimeters for protons, neutrons and deuterons. S. Nanda gave a survey of the spin physics program, and I can only refer to his written contribution for a clear overview of what to expect by the time of the next symposium.

SPIN PHYSICS AT ELFE

Looking into the more distant future, J.M. Laget presented the project ELFE (Electron Laboratory for Europe). The aim of this project is to study how nucleons and nuclei are built of quarks and gluons. A high duty cycle at energies sufficient to probe the quark structure of nucleons is needed because only through exclusive reactions performed at high momentum transfer can one select specific configurations in the nucleon wave function. We were given several examples on how polarization observables will here also play a great role. Many working groups in Europe have been studying the experimental aspects of this program and letters of intent were written. The case for a 15 to 30 GeV high duty cycle electron accelerator seems well established.