POLARIZED SEA MEASUREMENTS AT JPARC

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Large double spin-asymmetries can be foreseen for Drell-Yan production in pp scattering at JPARC energies. The sign of the asymmetries can be used to discriminate between different model calculation of sea quark distributions.

1. Introduction

Helicity distributions of valence quarks have been investigated in many experiments and are now well known. On the other hand, the distributions of the polarized sea are poorly known. In particular, concerning $\Delta\bar{u}(x)$, fits assuming a totally flavour symmetric sea suggest a sign opposite respect to fits based on a flavour broken sea [1].

The situation is even more confused concerning the transversity polarized sea. While the estimate of the numerical value of $\delta u(x)$ is more or less similar in all model calculations (the discrepancy is a factor 2 roughly), the uncertainties in the theoretical predictions for $\delta\bar{u}(x)$ are much more significant. Actually, there are essentially only two model calculations, one based on the Chiral Color-Dielectric Model (CCDM) [2] and one on the so-called Chiral Quark-Soliton Model (CQSM) [3]. The two predictions differ not only on the size of the polarized sea, but also on the sign. While an experiment based on Drell-Yan production in pp scattering could only extract with large error bars the transversity polarized quark distributions, the sign of the asymmetry could be determined without any ambiguity, as long as the valence region is tested ($x_B > 0.1$). An experiment at $\sqrt{s} \sim 10$ GeV as foreseen at JPARC can explore this region.

2. Double spin asymmetries in Drell-Yan production at JPARC

Longitudinal case The helicity distributions have been estimated using the two different scenarios discussed in Ref. [1]:

- valence scenario:

$$\frac{\Delta\bar{d}(x,\mu)}{\Delta\bar{u}(x,\mu)} = \frac{\Delta u(x,\mu)}{\Delta d(x,\mu)}; \Delta s(x,\mu) = \Delta\bar{s}(x,\mu) = 0. \tag{1}$$

- standard scenario:

$$\Delta\bar{u}(x,\mu) = \Delta u_{sea}(x,\mu) = \Delta\bar{d}(x,\mu) = \Delta d_{sea}(x,\mu) = \Delta\bar{s}(x,\mu) = \Delta s(x,\mu) \tag{2}$$

The longitudinal double spin asymmetry (A_{LL}) in Drell-Yan production has then been evaluated for $\sqrt{s} \sim 10$ GeV corresponding to the c.m. energy of the fixed target experiments foreseen at JPARC:

$$A_{LL} = \hat{a}_{LL} \frac{\sum_q e_q^2 [\Delta q(x_1)\Delta\bar{q}(x_2) + \Delta\bar{q}(x_1)\Delta q(x_2)]}{\sum_q e_q^2 [q(x_1)\bar{q}(x_2) + \bar{q}(x_1)q(x_2)]} \tag{3}$$

The results are reported in Fig. 1. The asymmetries foreseen at JPARC energy are much larger than the ones predicted for RHIC with $\sqrt{s} \sim 200 GeV$ where a polarized Drell-Yan experiment has also been proposed [4]. It is worthwhile to remark the different sign of the asymmetry in the two scenarios at high values of x_F. It is also interesting to remark that also the CCDM and the CQSM both predict a positive sign.

Transverse case The evolution of the transversity distributions has been evaluated starting from two different assumptions:

- $$\delta\bar{u}(x,\mu) = \Delta\bar{u}(x,\mu) \tag{4}$$

  consistent with the CCDM in Ref. [2]

- $$\delta\bar{u}(x,\mu) = -\Delta\bar{u}(x,\mu) \tag{5}$$

  consistent with the CQSM in Ref. [3]

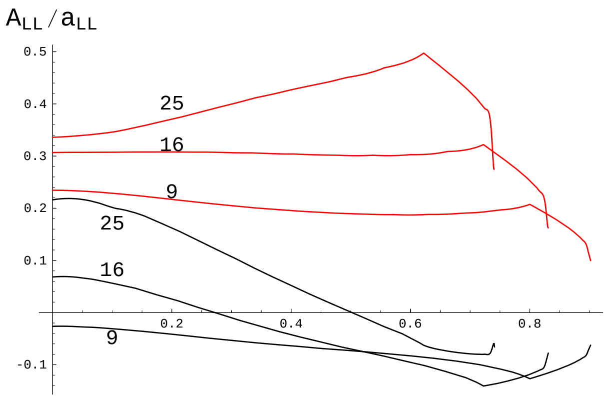

Figure 1. Longitudinal double spin asymmetries for Drell-Yan production at JPARC energies for different values of Q^2 as a function of x_F. The upper curves are related to the evolution of the so called valence scenario of Ref. [1], while the lower ones to the standard scenario.

The asymmetry in Drell-Yan production for the case of double transverse polarization (A_{TT}) has then been estimated: [a]

$$A_{TT} = \hat{a}_{TT} \frac{\sum_q e_q^2[\delta q(x_1)\delta\bar{q}(x_2) + \delta\bar{q}(x_1)\delta q(x_2)]}{\sum_q e_q^2[q(x_1)\bar{q}(x_2) + \bar{q}(x_1)q(x_2)]} \tag{6}$$

The asymmetry is reported in Fig. 2. Also in this case the asymmetries are predicted to be considerably larger than those foreseen at RHIC. It is remarkable to notice how the different assumptions at the model scale, reflect themselves in the sign of the asymmetry giving a chance to directly discriminate between the models.

3. Discussion and Conclusions

It must be remarked that the differences between the previsions of the two models for the transversity distribution should actually be attributed not only to the differences between the two models, but also to the different technique adopted in the evaluation of the antiquark distributions. In Ref. [2] the matrix element defining the antiquark distribution has been evaluated

[a]Note that the asymmetry is dominated by the $\delta\bar{u}$ distribution.

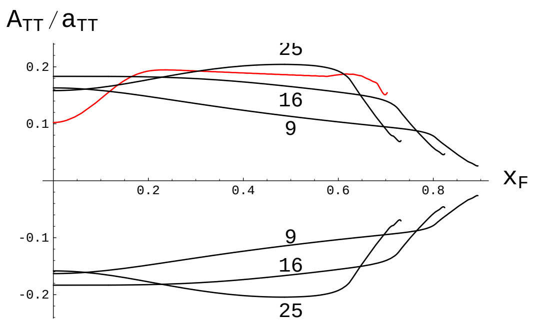

Figure 2. Transverse double spin asymmetries for Drell-Yan production at JPARC energies for different values of Q^2 as a function of x_F. The upper curves correspond to the evolution starting from the assumption consistent with the CCDM, while the lower ones with the one consistent with the CQSM. The thin line in the upper part is a prevision of the CCDM

by an explicit insertion of 4q intermediate states. In Ref. [3], use has been made of an analytic continuation to negative values of x, a procedure that is probably unsafe [5,6]. [b]

A polarized Drell-Yan experiment testing both A_{LL} and A_{TT} could provide a clear answer to the problem of computing antiquark distributions in quark models, a question which is of paramount importance in the theoretical calculations.

References

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[b] Notice that this discrepancy between the previsions of the two calculations shows up also for the longitudinal polarized sea, as discussed in Ref. [7].