Measuring the Sea Polarization by Drell-Yan Production at Moderate Energies

V.Barone[1], M.Contalbrigo[2], A.Drago[2] and P.Lenisa[2]

1) Università PiemonteOrientale and INFN Alessandria – Italy
2) Università di Ferrara and INFN Ferrara - Italy

Elicity distributions of valence quarks have been investigated in many experiments and are now rather well known. On the other hand, the distributions of the polarized sea are poorly known. In particular, concerning $\Delta\bar{u}$ (x), fits based assuming a totally flavor symmetric sea suggest a sign ($\Delta\bar{u}(x) < 0$) opposite respect to fits based on a flavor broken sea [1]. Model calculations also indicate $\Delta\bar{u}(x) > 0$.

The situation is even more confused concerning the transversely 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 of 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 [2] and one on the so-called Chiral Quark-Soliton Model [3]. The two predictions differ not only on the size of the polarized sea, but also on the sign. In particular, the CCDM indicates $\delta\bar{u}(x) > 0$, while the CQSM gives a negative sign and a significantly larger absolute value.

It must be remarked that the differences between the two previsions should actually be attributed not so much to the differences between the two models, but to the different technique adopted in the evaluation of the antiquark distributions. In [2] the matrix element defining the antiquark distribution has been evaluated by an explicit insertion of 4q intermediate states. In [3], use has been made of an analytic continuation to negative values of x, a procedure that is probably unsafe [4,5]. Notice that this discrepancy between the previsions of the two calculations shows up also for the longitudinally polarized sea, as discussed in [6].

While an experiment based on p-p Drell-Yan scattering can extract the transversely polarized quark distributions only with large error bars, the sign of the asymmetry can be determined without any ambiguity, as long as the valence region is tested ($x > 0.1$). An experiment at $\sqrt{s} \approx 10$ GeV can explore this region. Moreover, model calculations indicate an asymmetry exceeding 10% for both A_{LL} and A_{TT}.

The signs of A_{LL} and of A_{TT}, as suggested by the various models are:
1) $A_{LL} < 0$, $A_{TT} < 0$, assuming a flavor symmetric sea and assuming a transverse sea equal to the longitudinal sea at a very low scale;
2) $A_{LL} > 0$, $A_{TT} < 0$, in the CQSM;
3) $A_{LL} > 0$, $A_{TT} > 0$, in the CCDM.
A polarized Drell-Yan experiment testing both A_{LL} and A_{TT} can therefore 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.

[1] M.Gluck, E.Reya, M.Stratmann, W.Vogelsang; Phys.Rev. D 63 (2001) 094005
[2] V.Barone, T.Calarco, A.Drago; Phys.Lett.B 390 (1997) 287
[3] M.Wakamatsu, T.Kubota; Phys. Rev. D 60 (1999) 034020
[4] R.L.Jaffe, Nucl. Phys. B 229 (1983) 205
[5] V.Barone, A.Drago, P.Ratcliffe, Phys. Rep. 359 (2002) 1
[6] V.Barone, T.Calarco, A.Drago, C.Simani, Phys. Lett. B571 (2003) 50