Spin and low-*x* physics with STAR at RHIC

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and the STAR Collaboration

During the past year, we have continued our focus on the analysis of STAR inclusive jet data from longitudinally polarized p+p collisions to determine the contribution that gluons make to the proton spin. We completed the analysis of the data that were recorded during 2005. As described in last year's progress report, our group, together with R. Fatemi (now at University of Kentucky), developed a new analysis procedure that accounts for most of the distortions that are introduced in the A_{LL} measurement by the STAR detector. This allowed us to perform a quantitative comparison of our measured A_{LL} results to global fits of polarized deep-inelastic scattering (DIS) data within the GRSV framework for various fixed values of ΔG [1]. The primary results are shown in Fig. 1. The data exclude models where the gluon polarization makes a large positive contribution to the nucleon spin. The data also disfavor models where the gluon polarization is maximally negative. A paper describing this work has been submitted to Physical Review Letters [2]. M. Sarsour is one of the six principal authors of that paper and served as a member of the god-parent committee.

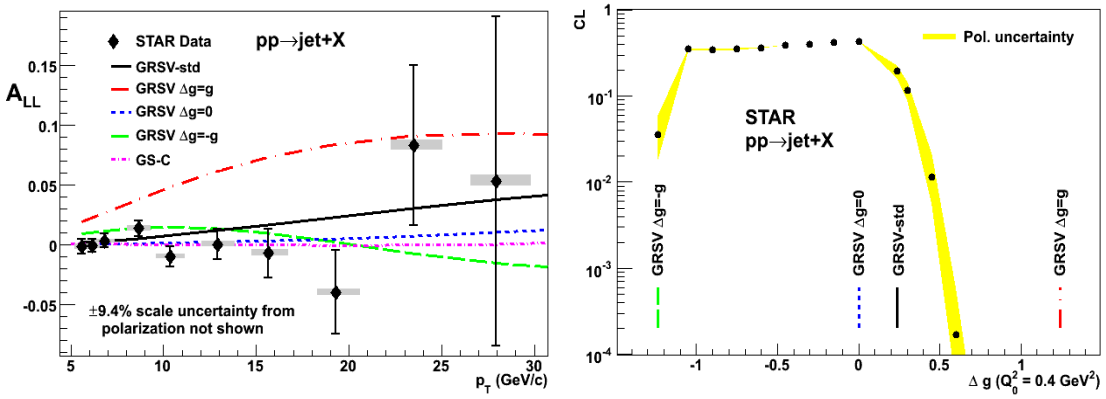

Figure 1. The left panel shows A_{LL} versus p_T for inclusive jets from data recorded in 2005, together with predictions from five previous global analyses of polarized DIS data. The right panel shows the confidence level (CL) for comparisons of the A_{LL} measurements to predictions from fits to the polarized DIS data within the GRSV framework for various fixed values of ΔG [1]. Both figures are from [2].

In parallel, we have now analyzed the inclusive jet data that were recorded during 2006 to determine A_{LL} with higher precision. The analysis procedures were similar to those we developed for the 2005 analysis. However, the increased calorimeter coverage during Run 6 allowed us to increase the jet cone radius from 0.4 to 0.7. We also improved the treatment of several of the systematic uncertainties, especially those due to beam-gas and pile-up backgrounds. M. Sarsour gave the first public presentation of the preliminary 2006 results in a talk at the DNP meeting in Newport News. (The same talk also included the first public presentation of the final 2005 results described above.) Figure 2 shows the

results. The statistical uncertainties in A_{LL} are a factor of 3 to 4 smaller at high p_T. The increased precision leads to significantly more stringent constraints on gluon polarization models. We find that the gluon polarization must be small or negative, or the momentum-dependence of the gluon polarization must be more complex than has been assumed in most recent global analyses. The 2007 NSAC Long-Range Plan for Nuclear Science identified the STAR preliminary 2006 inclusive jet A_{LL} results, in conjunction with preliminary 2006 inclusive π^0 measurements from PHENIX, as one of the highlights of the past five years.

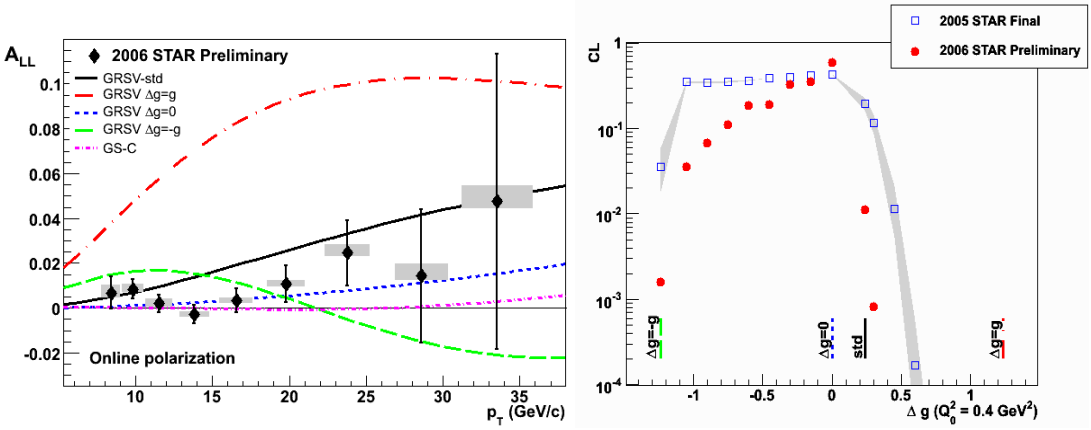

Figure 2. The left panel shows the preliminary 2006 STAR results for A_{LL} versus p_T for inclusive jets, together with predictions from five previous global analyses of polarized DIS data. The right panel shows the CL for comparisons of the A_{LL} measurements to predictions from fits to the polarized DIS data within the GRSV framework for various fixed values of ΔG [1].

Since the DNP meeting, we have made a few additional improvements in the 2006 data analysis. We have also applied all of the improvements that we developed during the 2006 analysis to the 2005 data. Meanwhile, collaborators at UCLA have learned how to use the program of Jager *et al.* [3] to perform next-to-leading-order calculations of A_{LL} for inclusive jet production using essentially any set of polarized parton distribution functions. This allows us to calculate confidence levels for global analyses outside the GRSV framework, and we have done this with our 2005 results. The 2005 and 2006 A_{LL} measurements cannot be combined in the conventional way because the two analyses utilize different jet cone radii. Therefore, we are currently modifying our CL code so that it will perform a simultaneous fit to the results from both years. Once that is complete, we will be ready to write up the results for publication.

The STAR Forward Meson Spectrometer (FMS) is a new addition to the STAR electromagnetic calorimetry, providing complete coverage over the pseudorapidity region $2.5 < \eta < 4$, which is the deuteron forward direction when RHIC studies d+A collisions, and nearly complete EMC coverage over the range $-1 < \eta < +4$. The FMS enables STAR to search for mono-jet production in d+Au collisions. It will also facilitate measurements of gluon polarization in the proton at low-x and detailed studies of the dynamics that underlie the significant single-spin asymmetries that have been seen in forward π^0

production at RHIC. J. Drachenberg assisted with the final construction and commissioning of the FMS this past year. The FMS was then used in Run 8 to take data during the d+Au and polarized p+p runs. J. Drachenberg will analyze the FMS data that were recorded during the p+p run to determine A_N for inclusive jets at forward rapidity. This will provide a clean way to distinguish between the initial-state ('Sivers effect') and final-state ('Collins effect') explanations for the large π^0 single-spin asymmetries, because only the Sivers effect can produce a non-zero A_N for inclusive jets.

We also carried administrative responsibilities in STAR. This past year, Dr. Gagliardi served as Deputy Spokesperson of the STAR Collaboration. Dr. Gagliardi also served on the STAR Advisory and Trigger Boards, and Drs. Gagliardi and Tribble participated on several STAR god-parent committees.

[1] M. Gluck *et al*., Phys. Rev. D **63**, 094005 (2001) ; M. Stratmann and W. Vogelsang (private communication).
[2] B.I. Abelev *et al*. (STAR Collaboration), arXiv:0710.2048 [hep-ex].
[3] B. Jager, M. Stratmann, and W. Vogelsang, Phys. Rev. D **70**, 034010 (2004).